Installing Services (2017 NEC) (Homestudy)

Idaho Electrical License

This course will focus on the 2017 National Electrical Code rules for installing Service Equipment and Conductors including Service Basics, Overground and Underground Services, Service Entrance Conductors, Service Equipment, and exercises using a Strip Shopping Center.

Course# 20-621647 4 Industry Related (IR) Credit Hours $55.00

This course is currently approved by the Idaho Electrical Bureau under course number 20-621647.

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: 4/26/2020.

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Installing Services (2017 NEC) (Homestudy) - ID

Service Basics.

Question 1: 230.1 Scope.

Question ID#: 11391.0

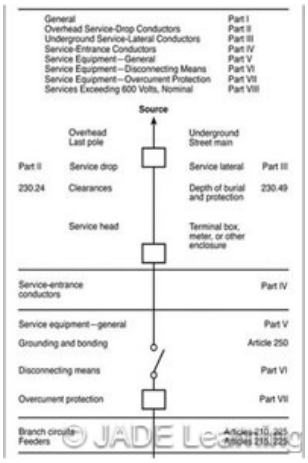

Figure 230.1 Services is a roadmap to Article 230.

Article 230 covers the equipment and conductors that are installed from the utility point of connection to the service equipment. Included are sections on service equipment, service conductors, overhead service conductors, and underground service conductors. Also covered are the number of services that can be installed on a building or structure, overhead and underground services, installation and sizing of service entrance conductors, location, size, and installation of service disconnects and overcurrent protection.

Figure 230.1 is a schematic of how Article 230 is organized. It looks like a one-line diagram, but it really is a quick way to find what you are looking for in Article 230.

Question 1: Which section of Article 230 has the requirements for service disconnecting means?

A: Part VIII.
B: Part II.
C: Part V.
D: Part VI.

Question 2: 230.1 Scope.

Question ID#: 11391.1

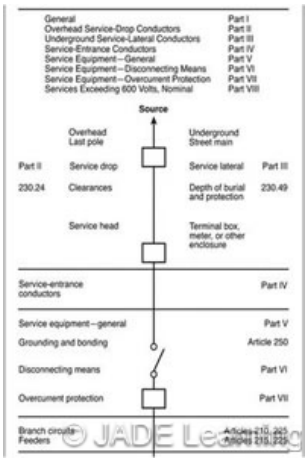

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Figure 230.1 is a schematic of how Article 230 is organized. It looks like a one-line diagram, but it really is a quick way to find what you are looking for in Article 230.

Question 2: Which part of Article 230 contains the requirements for Service-Entrance Conductors?

A: Part III.
B: Part IV.
C: Part II.
D: Part V.

Question 3: Article 100 Definitions: Service.

Question ID#: 11392.0

The electric service is made up of the conductors and equipment from the utility point of connection to the premises wiring system, including the service disconnecting means.

Service: ***The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.***

According to this definition, only a utility can supply a service. Conductors and equipment from solar photovoltaic systems, wind generators, and other optional standby systems are not considered part of the service. They are considered feeders.

A service is where the utility wiring ends and the premises wiring begins. Wiring downstream of the service equipment is considered feeder or branch circuit wiring.

Question 3: Which of the following statements about service wiring is true?

A: The wiring from a solar photovoltaic system is considered service wiring.
B: The wiring from an optional standby generator is considered service wiring.
C: The wiring from a serving utility is considered service wiring.
D: The wiring from a wind generator is considered service wiring.

Question 4: Article 100 Definitions: Service.

Question ID#: 11392.1

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A service is where the utility wiring ends and the premises wiring begins. Wiring downstream of the service equipment is considered feeder or branch circuit wiring.

Question 4: Which of the following is considered service wiring?

A: The wiring from an emergency generator system.
B: The wiring from the building main service feeder to a sub-panel in the same building.
C: The wiring from the main service feeder to a sub-panel in another building.
D: The wiring from the serving utility to the wiring system of the premises served.

Overhead and Underground Services.

Question 5: Article 100 Definitions: Service-Entrance Conductors, Overhead System.

Question ID#: 11394.0

Service-Entrance Conductors, Overhead System.

The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop or overhead service conductors.

The ***service point*** is the point of connection between the facilities of the serving utility and the premises wiring.

Where practicable, service-entrance conductors in an overhead system are spliced to the utility service drop conductors at the point of attachment and connect to the service equipment.

Clearances above roofs, from windows, and from grade are important requirements for overhead service-entrance conductors.

Overhead service-entrance conductors extend from the terminals of the service equipment to the connection to the service drop or overhead service conductors.

Question 5: A utility supplies a building with an overhead service.Â Which of the following are the service-entrance conductors?

A: The utility owned wires from the utility transformer to the service point.
B: The wires connected to the load side of the service disconnecting means.
C: The wires from the point of connection to the serviceÂ drop to the terminals of the service equipment.
D: The utility-owned service drop conductors that are spliced at the masthead.

Question 6: Article 100 Definitions: Service-Entrance Conductors, Overhead System.

Question ID#: 11394.1

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Question 6: Which of the following is the best description of overhead service conductors?

A: The conductors installed from the utility transmission lines to the utility transformer.
B: The conductors installed from the electrical meter terminals to the main service panel.
C: The conductors installed between the service point and the service-entrance conductors at the building or other structure.
D: The utility service drop conductors that are spliced at the masthead.

Question 7: Article 100 Definitions: Service-Entrance Conductors, Underground System.

Question ID#: 11395.0

The definition of "Service-Entrance Conductors, Underground System", is: The conductors of the service installed between the line-side terminals of the service equipment (ex. main circuit-breaker panel) and the point in the ground where those conductors attach to either the Service Lateral (which is the utility-owned underground conductor set, originating from the utility-owned transformer), or the ***Underground Service Conductors*** (which are similar to the service lateral conductors, but these conductors are the underground conductors attached to the service lateral conductors owned by the utility company, to extend those conductors closer to the building or structure.)

Underground service-entrance conductors are installed between the terminals of the service equipment and the point of connection to the service lateral or underground service conductors.

If the service conductors that extend the service lateral terminate onto service equipment ***(not the meter)*** mounted outside the building, they are said to be service conductors. If they travel into the building, such as to service equipment INSIDE a garage, they are said to be service ENTRANCE conductors.

Remember: The NEC declares meters are NOT considered service equipment.

In some cases, there may not be any service entrance conductors (not by name anyway)- for example, if all of the electrical service components were located outside the building walls, then the utility company may just run the service lateral all the way to and through the meter base, and to the service equipment. In this case, the lateral IS THE service entrance conductor.

It is important to know the definition of electric service lateral; it is defined as: the underground conductors between the utility electric supply system (transformer) and the service point (The "service point" is the point where the utility company owned wiring ends. This "end" point can be in a number of different places along the service wiring, depending on the jurisdiction. So it is important to know this, as it affects where the other service conductors begin and end. Be aware, in many cases the service lateral is installed by the utility company up to the meter base, and is therefore not subject to the rules within the NEC. Often times, the utility company will run their lateral up to the line side of the meter base, and then stop. When this is the case the service entrance conductors would be those conductors run from the load side of the meter base, to the line side of the panel (or whatever is being used as service equipment).

Depending on the utility company "service point", the definitions and locations of these conductors can become a gray area. Each jurisdiction has their way of doing things, as well as defining where certain conductors begin and end.

Question 7: A service lateral supplies a single family dwelling and terminates at the line side of the utility meter outside the house. Which of the following are considered the service-entrance conductors?

A: The conductors from the utility transformer to the utility meter.
B: The conductors on the line side of the utility meter.
C: The conductors downstream from the service disconnect.
D: The conductors from the load side of the meter to the line side of the service disconnect.

Question 8: Article 100 Definitions: Service-Entrance Conductors, Underground System.

Question ID#: 11395.1

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Depending on the utility company "service point", the definitions and locations of these conductors can become a gray area. Each jurisdiction has their way of doing things, as well as defining where certain conductors begin and end.

Question 8: A service lateral feeds a commercial tenant space and terminates at the line side of the utility meter outside the building. The service entrance conductors are:

A: There are no service-entrance conductors. The service lateral terminates at the terminals of the service equipment.
B: The conductors on the line side of the utility meter.
C: The conductors on the load side of the service disconnect.
D: The conductors from the load side of the meter to the line-side of the service disconnecting means.

Question 9: 230.2 Number of Services.

Question ID#: 11396.0

The general requirement is that only one service is allowed per building or structure.

Under certain conditions additional services can be added. A second service can be added for special conditions like fire pumps, emergency systems, and legally required or optional standby systems. Other conditions that would permit more than one service are for special occupancies like multiple occupancy buildings and buildings too large for one service, the load capacity requirements of the building exceed 2000 amps, or different types of services are required, such as different phases or voltages.

There is an additional requirement that when more than one service is installed on a building or structure a permanent plaque or directory shall be installed at each service disconnect showing the location of all other services.

Note also that in a large building that is divided by a four hour firewall, the building is considered as two buildings and a separate service can be installed on each side of the firewall.

The general rule is one service per building. Additional services are allowed under certain conditions.

Question 9: One of the requirements for adding more than one service on a building is:

A: The customer wants an additional service.
B: One service is single phase the other service is three phase.
C: The calculated load is more than 1000 amps.
D: A building addition would make an additional service convenient.

Question 10: 230.2 Number of Services.

Question ID#: 11396.1

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Note also that in a large building that is divided by a four hour firewall, the building is considered as two buildings and a separate service can be installed on each side of the firewall.

The general rule is one service per building. Additional services are allowed under certain conditions.

Question 10: When can a building have more than a single service?

A: When the building requires different voltages.
B: If the premises is equipped with pool pump motors and equipment.
C: When the building owner requests and pays for the additional service.
D: When the calculated load is greater than the engineer's specifications on the plans.

Question 11: 230.24(A) Clearances. Above Roofs.

Question ID#: 11397.0

The service mast must be high enough to provide for the minimum clearance from the ground.

Overhead service conductors passing over the top of a roof surface, must maintain certain clearances. Whatever that required clearance is above the roof surface, the conductors must also maintain a minimum distance of 3 ft. in all directions from the edge of that roof. This requirement is to guarantee that service drop conductors are never easily reached from someone located at the roof's edge.

There are 5 exceptions to the rule about clearances of overhead service conductors over roofs, but without applying any exceptions, overhead service conductors cannot have less than 8 ft. of clearance above a roof.

Exceptions to the requirement to maintain an 8 ft. clearance over roofs include:

- If the roof is subject to pedestrian or vehicular traffic, the clearances must be same as the clearances from grade in 230.24(B).
- Where the voltage between conductors is not greater than 300 volts, and the roof has a slope of 4 in. in 12 in. or greater, a minimum clearance of 3 ft. is permitted.
- Where the voltage between conductors is not greater than 300 volts, a clearance of 18 in. is permitted above only the overhanging part of the roof, if not more than 4 ft. pass over the roof overhang, and the service is terminated at a through-the-roof raceway or approved support.
- When a service drop is attached to the side of a building, maintaining a clearance of 3 ft. above the roof for the final conductor span is not required.
- Where the voltage between conductors does not exceed 300 volts and the roof area is guarded or isolated, a reduction in clearance to 3 ft. is permitted.

Question 11: Without applying any exceptions, the minimum clearance for overhead service conductors passing over a flat roof is:

A: 8 ft. above the entire roof surface, and then 3 ft. clearance in all directions from the edge of the roof.
B: 3 ft. above the entire roof surface, and then 3 ft. clearance in all directions from the edge of the roof.
C: 8 ft. above the entire roof surface, and then 8 ft. clearance in all directions from the edge of the roof.
D: 3 ft. above the entire roof surface, and then 8 ft. clearance in all directions from the edge of the roof.

Question 12: 230.24(A) Clearances. Above Roofs.

Question ID#: 11397.1

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raceway or approved support.

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- Where the voltage between conductors does not exceed 300 volts and the roof area is guarded or isolated, a reduction in clearance to 3 ft. is permitted.

Question 12: A 208/120 volt, 3-phase service drop is connected to a service mast which is secured above the top deck of a parking garage with cars (not trucks) driving onto and off the top deck. What is the minimum required clearance for overhead service conductors above the parking deck?
You may wish to consult NEC Section 230.24(B)

A: 8 ft.
B: 18 ft.
C: 12 ft.
D: 10 ft.

Question 13: 230.24(A) Clearances. Above Roofs. Exception No. 1.

Question ID#: 11398.0

Exception No.1 to 230.24(A) requires conductor above areas of a roof subject to vehicle or pedestrian traffic to meet the clearance required by 230.24(B). Examples include rooftop parking for vehicles, rooftop gardens, or roof top areas that have been converted to commercial use such as a restaurant, or other rooftop areas subject to pedestrian traffic.

For example, with an overhead service crossing a roof with pedestrian traffic and a voltage to ground of more than 150 volts but not more than 300 volts, the clearance from the lowest point of the overhead service to the rooftop is 12 ft. If the voltage is not greater than 150 voltst to ground, the required clearance is 10 ft. If the voltage is greater than 300 volts to ground the required clearance is 15 ft.

A clearance of 12 ft. is required over flat roofs subject to pedestrian traffic when the voltage to ground is over 150 volts but not over 300 volts.

Question 13: What is the clearance required when an overhead service crosses a roof subject to vehicular traffic, but not subject to truck traffic, and the voltage is 277 volts to ground?

A: 10 ft.
B: 12 ft.
C: 15 ft.
D: 18 ft.

Question 14: 230.24(A) Clearances. Above Roofs. Exception No. 1.

Question ID#: 11398.1

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Question 14: A service drop travels across the area above a roof surface subject to pedestrian traffic. The service-drop cables are supported on and cabled together with a grounded bare messenger wire. The voltage is 125 volts to ground. What is the minimum vertical clearance from the overhead service conductors to the roof surface?

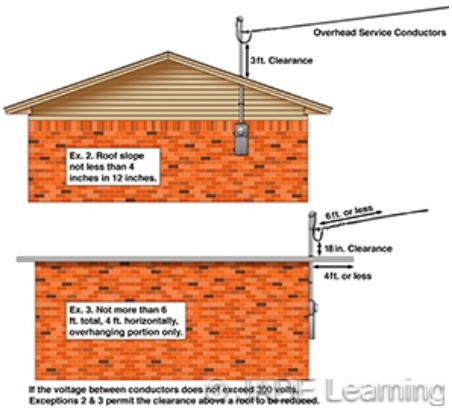
A: 10 ft.
B: 12 ft.
C: 15 ft.
D: 18 ft.

Question 15: 230.24(A) Clearances. Above Roofs. Exceptions 2 & 3.

Question ID#: 11399.0

When voltage does not exceed 300 volts between conductors and the slope of the roof is 4 inches in 12 inches or greater, the clearance above the roof is allowed to be reduced to 3 ft in accordance with Exception No. 2 to 230.24(A).

If the service riser above the roof is within 4 ft. of the edge of the roof, measured from the side of the building to the edge of the overhang, and no more than a total of 6 ft. of conductor passes over the roof, Exception No. 3 permits the clearance above the roof to be reduced to 18 inches.



If the voltage between conductors does not exceed 300 volts, Exceptions 2 & 3 permit the clearance above a roof to be reduced.

Question 15: A service extends above a roof with a slope that is 4 inches in 12 inches and the voltage between conductors is 240 volts, what is the minimum clearance above the roof?

A: 24 inches.
B: 3 ft.
C: 8 ft.
D: 12 inches.

Question 16: 230.24(A) Clearances. Above Roofs. Exceptions 2 & 3.

Question ID#: 11399.1

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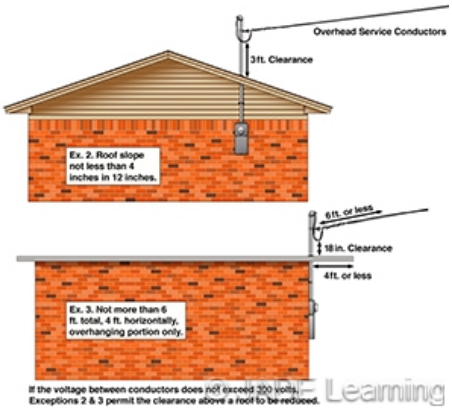

If the voltage between conductors does not exceed 300 volts, Exceptions 2 & 3 permit the clearance above a roof to be reduced.

Question 16: A 120/240 volt, 3-wire, single-phase service to a single family dwelling is terminated at a through-the-roof raceway. The service drop conductors pass above the overhanging portion of the roof for 4 ft. What is the minimum clearance of the service drop conductors above the overhanging portion of the roof?

A: 36 inches.
B: 18 inches.
C: 24 inches.
D: 12 inches.

Question 17: 230.24 (B) Vertical Clearances for Overhead Service Conductors.

Question ID#: 11400.0

The vertical clearance for overhead service conductors is measured from the lowest point of the conductors to the surface below the overhead service conductors. The measurement is made from the lowest portion of the overhead service conductors and not from the service head.

The installer must locate the service head high enough for the overhead service conductors to maintain the minimum clearances. For areas subject to foot traffic only and with a voltage to ground of not more than 150 volts the clearance is 10 ft.

The code bases the minimum vertical clearance on the ***voltage to ground; not on the system voltage between ungrounded conductors***. For example, the voltage to ground for 120/240-volt single phase systems and 208Y/120-volt, 3-phase systems is the same (120-volts). In a 480Y/277 volt system the voltage to ground is 277-volts.

For areas over residential property and driveways, and those commercial areas not subject to truck traffic with a voltage to ground of not more than 300 volts the clearance is 12 ft.

For areas over residential property and driveways, and those commercial areas not subject to commercial traffic with a voltage to ground of more than 300 volts the clearance is 15 ft.

Overhead service conductors that pass over public streets, alleys, and roads require a clearance of 18 ft.

Where overhead service conductors pass over railroad tracks the minimum clearance is 24.5 ft.

If the voltage does not exceed 150 volts to ground the minimum vertical clearance from the lowest point of the overhead service conductors to ground is 10 ft.

Question 17: A set of overhead service conductors, rated 277/480 volts, passes over a sidewalk in a strip shopping center where it is not subject to truck traffic. What is the required clearance?

A: 18 ft.
B: 10 ft.
C: 12 ft.
D: 15 ft.

Question 18: 230.24 (B) Vertical Clearances for Overhead Service Conductors.

Question ID#: 11400.1

The vertical clearance for overhead service conductors is measured from the lowest point of the conductors to the surface below the overhead service conductors. The measurement is made from the lowest portion of the overhead service conductors and not from the service head.

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Where overhead service conductors pass over railroad tracks the minimum clearance is 24.5 ft.

If the voltage does not exceed 150 volts to ground the minimum vertical clearance from the lowest point of the overhead service conductors to ground is 10 ft.

Question 18: A new commercial building is being supplied from a 600V, 3-phase service. The service-drop conductors cross an alley commercial trucks use for deliveries. What is the minimum vertical clearance from final grade for the conductors?

A: 12 feet.
B: 10 feet.
C: 18 feet.
D: 8 feet.

Question 19: 230.28 Service Masts as Supports.

Question ID#: 11401.0

Service drops or overhead service conductors are the only things permitted to be attached to service masts; nothing else is permitted to be secured to or supported by a service mast. When service masts are to be used to support overhead service conductors or service drops they must be strong enough to support the mechanical load of the service drop or overhead service conductors connected to the mast. The NEC does not specify that you must use braces or guy wires for every mast, only those that are not strong enough to support their load.

Often utility companies or local jurisdictions require guy wires or other mechanical means to be installed to give additional support to the service mast, even if the service mast is durable enough to hold the imposed load.

The NEC does not say what size the service mast riser must be, or how guy wires must be installed, but the serving utility usually has guidelines for the minimum size and type of raceway used for the service mast. The minimum size conduit that utilities will usually accept is 2 inch rigid metal conduit, but this is not required by the NEC as many materials are approved by the NEC.

Service drops or overhead service conductors cannot be connected between a service head (aka weather head) and a conduit coupling located below the last spot where the conduit is secured to the building or structure. A conduit coupling can weaken the service mast and the weight of the service drop conductors could easily cause the conduit to bend at an unsupported coupling.

Service masts must be strong enough to support the strain of the overhead service conductors. Service masts may require braces or guys. Raceway fittings must be identified for use with service masts.

Question 19: Which of the following statements about service masts is true?

A: Braces or guy wires are required on a service mast if the mast is not strong enough to support the mechanical load of the overhead service conductors.
B: The NEC requires service masts to be a minimum of 2 in. rigid metal conduit.
C: Cable TV conductors can be supported by a service mast.
D: A security camera monitoring a parking lot can be mounted on a service mast.

Question 20: 230.28 Service Masts as Supports.

Question ID#: 11401.1

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cause the conduit to bend at an unsupported coupling.

Question 20: Which of the following types of conductors can be attached to the service mast?

A: Telephone conductors.
B: Cable TV conductors.
C: Satellite TV dish conductors.
D: Utility service drop conductors.

Underground Service-Lateral Conductors.

Question 21: 230.32 Protection Against Damage.

Question ID#: 11403.0

Underground service conductors must be protected from physical damage. Cover requirements are determined by Table 300.5.

When installing underground service conductors, they must be covered to the depth required by NEC Table 300.5. For example, direct burial cables in most locations must be covered by at least 24 inches of earth. A warning ribbon must be placed in the trench at least 12 in. above underground service conductors that are not encased in concrete to warn that these conductors are present. Hopefully a person would stop digging if he or she uncovered the warning ribbon and not damage the underground service conductors.

Underground service conductors emerging from grade must be protected above ground by a raceway listed in 230.43, which lists wiring methods for services 1000 volts or less. Section 230.43 provides 19 different wiring methods permitted for service entrance conductors including but not limited to:

- Rigid Metal Conduit
- Intermediate Metal Conduit
- Electrical Metallic Tubing
- Rigid PVC
- MI Cable
- MC Cable

According to 230.6, if underground service conductors are run under a building or encased in 2 inches of concrete or brick, they are still considered to be outside the building.

Service lateral conductors that are installed by the utility are not covered by the NEC.

Question 21: Which of the following installations of underground service conductors is a code VIOLATION?

A: Direct buried cable installed in a trench 30 inches deep with a warning ribbon placed 12 inches above the conductors.
B: Underground service conductorsÂ installed in rigid metal conduit 6 inches deep and encased in 2 inches of concrete.
C: Schedule 80Â rigidÂ PVC conduitÂ used to protect underground service conductors emerging from grade.
D: Direct buried cable installed in a trench 20 inches deep.

Question 22: 230.32 Protection Against Damage.

Question ID#: 11403.1

Underground service conductors must be protected from physical damage. Cover requirements are determined by Table 300.5.

When installing underground service conductors, they must be covered to the depth required by NEC Table 300.5. For example, direct burial cables in most locations must be covered by at least 24 inches of earth. A warning ribbon must be placed in the trench at least 12 in. above underground service conductors that are not encased in concrete to warn that these conductors are present. Hopefully a person would stop digging if he or she uncovered the warning ribbon and not damage the underground service conductors.

Underground service conductors emerging from grade must be protected above ground by a raceway listed in 230.43, which lists wiring methods for services 1000 volts or less. Section 230.43 provides 19 different wiring methods permitted for service entrance conductors including but not limited to:

- Rigid Metal Conduit
- Intermediate Metal Conduit
- Electrical Metallic Tubing
- Rigid PVC
- MI Cable
- MC Cable

According to 230.6, if underground service conductors are run under a building or encased in 2 inches of concrete or brick, they are still considered to be outside the building.

Service lateral conductors that are installed by the utility are not covered by the NEC.

Question 22: A licensed electrician is installing underground service conductors. He is using 4 inch Poly Vinyl Chloride (PVC). Beginning at the utility service, he will be underground for 20 ft. across a grassy, open field, and then crossing 16 feet under a parking lot. What are the minimum burial depths he must use to meet the code requirements?

A: 18 inches in the field and 24 inches under the parking lot.
B: 12 inches in the field and 18 inches under the parking lot.
C: 18 inches in the field and 18 inches under the parking lot.
D: 6 inches in the field and 6 inches under the parking lot.

Service Entrance Conductors.

Question 23: 230.40 Number of Service-Entrance Conductor Sets.

Question ID#: 11405.0

The general rule is that only one set of service entrance conductors is permitted per service. Exceptions to the general rule state that:

- Multi-occupancy buildings like apartment buildings or shopping centers are allowed to have a separate set of service entrance conductors run to each occupancy. Each disconnect location must have a permanent plaque that identifies the location of the other service disconnects. If more than six disconnects are permitted by this exception a graphic or text description of all service locations must be posted in a readily accessible location.
- A single family dwelling and its accessory structures are allowed to have a separate set of service entrance conductors.
- A house panel for a two-family, multi-family dwelling or multi-occupancy building is allowed to have a separate set of service entrance conductors.
- A separate set of service entrance conductors from a single service drop or service lateral can be installed to each service disconnect, if the service disconnects are grouped at one location and serve different loads.

The general rule is that only one set of service entrance conductors are permitted per service. Exceptions allow for more than a single set of service entrance conductors per service.

Question 23: Which statement about the number of service-entrance conductor sets is FALSE?

A: A separate set of service entrance conductors can supply up to six service- disconnect enclosures grouped together in one location.
B: At a single-family dwelling, a separate set of service entrance conductors can be installed to serve separate service disconnects, with one service disconnect installed inside the dwelling, and the other service disconnect installed outside the dwelling.
C: A separate set of service entrance conductors can feed a house panel on a multi-occupancy building.
D: A separate set of service entrance conductors can be installed to each tenant space in a multi-tenant building.

Question 24: 230.40 Number of Service-Entrance Conductor Sets.

Question ID#: 11405.1

The general rule is that only one set of service entrance conductors is permitted per service. Exceptions to the general rule state that:

- Multi-occupancy buildings like apartment buildings or shopping centers are allowed to have a separate set of service entrance conductors run to each occupancy. Each disconnect location must have a permanent plaque that identifies the location of the other service disconnects. If more than six disconnects are permitted by this exception a graphic or text description of all service locations must be posted in a readily accessible location.
- A single family dwelling and its accessory structures are allowed to have a separate set of service entrance conductors.
- A house panel for a two-family, multi-family dwelling or multi-occupancy building is allowed to have a separate set of service entrance conductors.
- A separate set of service entrance conductors from a single service drop or service lateral can be installed to each service disconnect, if the service disconnects are grouped at one location and serve different loads.

The general rule is that only one set of service entrance conductors are permitted per service. Exceptions allow for more than a single set of service entrance conductors per service.

Question 24: Which statement about the number of service-entrance conductor sets is true?

A: Each occupancy in a multi-occupancy building is required to have a separate set of service- entrance conductors.
B: A single-family dwelling unit and a detached garage must have a single set of service -entrance conductors run to both locations from a single service drop or lateral.
C: A single-family dwelling unit shall be permitted to have one set of service -entrance conductors installed to supply the circuits to a central alarm system.
D: Where two to six service disconnecting means in separate enclosures are grouped in one location and supply separate

loads from one service drop or lateral, one set of service-entrance conductors shall be permitted to supply each of several such service equipment enclosures.

Question 25: 230.42 Minimum Size and Rating.

Question ID#: 11406.0

Service entrance conductors are sized according to Article 220 for the calculated load.

The minimum size of service entrance conductors is calculated according to the requirements of article 220.

Non-continuous loads are calculated at 100% of connected load. Continuous loads are calculated at 125% of the connected load. Depending on the type of occupancy, demand factors can be applied to the connected load to account for the diversity of load in dwelling units and commercial buildings.

The minimum size of service entrance conductors is also based on the minimum size service disconnect required in 230.79. The minimum size for a one circuit service is 15 amps and the minimum size for a two circuit service is 30 amps. A single family dwelling cannot have a service smaller than 100 amps. Other types of services cannot be smaller than 60 amps.

The neutral is sized to carry the maximum unbalance of the load on any one conductor, but cannot be smaller than specified in Table 250.102(C)(1) for ungrounded conductors up to 1100 kcmil, or not smaller than 12.5 % of phase conductors larger than 1100 kcmil copper or 1750 kcmil aluminum. If a grounded conductor is not connected to an overcurrent device there is no need to increase the size of the conductor for continuous loading. Even for a continuous load, a grounded conductor that is solidly connected to a terminal bar can be calculated at 100%, not 125%.

Question 25: A commercial building has a continuous lighting load of 100 amps and a non-continuous load of 50 amps. What is the minimum ampacity of the service entrance conductors?

A: 175 amps.
B: 187.5 amps.
C: 160 amps.
D: 200 amps.

Question 26: 230.42 Minimum Size and Rating.

Question ID#: 11406.1

Service entrance conductors are sized according to Article 220 for the calculated load.

The minimum size of service entrance conductors is calculated according to the requirements of article 220.

Non-continuous loads are calculated at 100% of connected load. Continuous loads are calculated at 125% of the connected load. Depending on the type of occupancy, demand factors can be applied to the connected load to account for the diversity of load in dwelling units and commercial buildings.

The minimum size of service entrance conductors is also based on the minimum size service disconnect required in 230.79. The minimum size for a one circuit service is 15 amps and the minimum size for a two circuit service is 30 amps. A single family dwelling cannot have a service smaller than 100 amps. Other types of services cannot be smaller than 60 amps.

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grounded conductor that is solidly connected to a terminal bar can be calculated at 100%, not 125%.

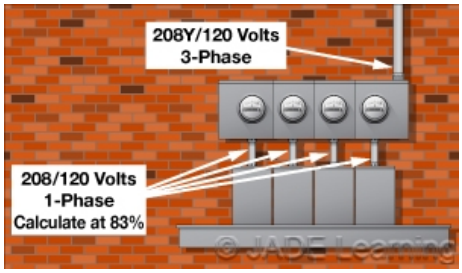
Question 26: A furniture warehouse has a 200 ampere main service panel. Both the main circuit breaker and the panel assembly are listed for operation at 100 percent of their rating. The warehouse has a 150 ampere continuous load and a 50 ampere noncontinuous load. What is the minimum ampacity required for the service-entrance conductors?

A: 250 amperes.
B: 150 amperes.
C: 225 amperes.
D: 200 amperes.

Question 27: 310.15(B)(7) 120/240 V, Single-Phase Dwelling Service and Feeders.

Question ID#: 11407.0

NEC 310.15(B)(7) was revised extensively in the 2014 NEC, and a familiar Table was deleted. Rather than using ***Table 310.15(B)(7)*** to determine the minimum service and feeder conductor sizes required for single-phase dwelling units, Section 310.15(B)(7) is now used, and it requires the electrician to perform a calculation.



For dwellings, use section 310.15(B)(7) if the service conductors carry 100% of the load.

Service and feeder conductors that carry the entire load for a single-phase dwelling can be selected based on 83% of the rating of the service. The calculation now required in Section 310.15(B)(7), is meant to calculate that 83% conductor.

The 2017 NEC permits the 83% calculation to be used with single-phase 120/240 volt systems, such as you would find at a regular single-family home. It can also be used for three-phase 208Y/120 volt systems, such as you would find feeding apartment complexes, but only when you are feeding a single dwelling unit in the complex with just two ungrounded conductors and the neutral conductor from that 208Y/120-volt system.

For example, if an apartment building is supplied by a 3-phase 208Y/120 volt 4-wire service. The individual feeders to each apartment would consist of two ungrounded conductors and a neutral. These feeders can now be sized in accordance with 310.15(B)(7) as long as the feeder supplies ***the entire load of the individual dwelling unit***.

Reducing the required ampacity of service and feeder conductors for single-phase dwelling unit services to 83% of the wire ampacity values found in Table 310.15(B)(16) should result in the same sizes of conductors that were in the old Table 310.15(B)(7) that was deleted. So, wiring practices for single-family dwelling services and feeders will not change by using the newly required 83% calculation.

Example

For example, to calculate the minimum ampacity of ungrounded service or feeder conductors that carry the whole load for a 225-amp, single-phase dwelling:
225 amp service rating x .83 = 187 amps. The minimum size conductor required is 3/0 AWG copper (per Table 310.15(B)(16); this is the same size as was permitted in the deleted Table 310.15(B)(7).

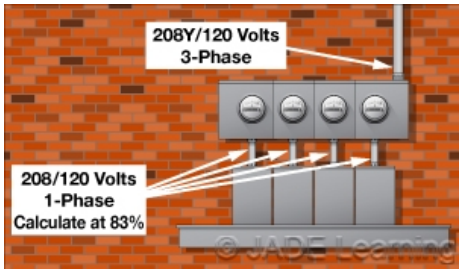
Question 27: What is the minimum ampacity required for ungrounded service conductors that supply the entire load in an individual dwelling in a multifamily dwelling if the individual dwelling is rated for 200 amps?

A: 166
B: 83
C: 150
D: 200

Question 28: 310.15(B)(7) 120/240 V, Single-Phase Dwelling Service and Feeders.

Question ID#: 11407.1

NEC 310.15(B)(7) was revised extensively in the 2014 NEC, and a familiar Table was deleted. Rather than using ***Table 310.15(B)(7)*** to determine the minimum service and feeder conductor sizes required for single-phase dwelling units, Section 310.15(B)(7) is now used, and it requires the electrician to perform a calculation.



For dwellings, use section 310.15(B)(7) if the service conductors carry 100% of the load.

Service and feeder conductors that carry the entire load for a single-phase dwelling can be selected based on 83% of the rating of the service. The calculation now required in Section 310.15(B)(7), is meant to calculate that 83% conductor.

The 2017 NEC permits the 83% calculation to be used with single-phase 120/240 volt systems, such as you would find at a regular single-family home. It can also be used for three-phase 208Y/120 volt systems, such as you would find feeding apartment complexes, but only when you are feeding a single dwelling unit in the complex with just two ungrounded conductors and the neutral conductor from that 208Y/120-volt system.

For example, if an apartment building is supplied by a 3-phase 208Y/120 volt 4-wire service. The individual feeders to each apartment would consist of two ungrounded conductors and a neutral. These feeders can now be sized in accordance with 310.15(B)(7) as long as the feeder supplies ***the entire load of the individual dwelling unit***.

Reducing the required ampacity of service and feeder conductors for single-phase dwelling unit services to 83% of the wire ampacity values found in Table 310.15(B)(16) should result in the same sizes of conductors that were in the old Table 310.15(B)(7) that was deleted. So, wiring practices for single-family dwelling services and feeders will not change by using the newly required 83% calculation.

Example

For example, to calculate the minimum ampacity of ungrounded service or feeder conductors that carry the whole load for a 225-amp, single-phase dwelling:
225 amp service rating x .83 = 187 amps. The minimum size conductor required is 3/0 AWG copper (per Table 310.15(B)(16); this is the same size as was permitted in the deleted Table 310.15(B)(7).

Question 28: What minimum size copper feeder conductors are used to supply 400 amp dwelling service equipment where the conductors carry the whole load of the dwelling?

A: 600 kcmil copper conductors.
B: 400 kcmil copper conductors.
C: 500 kcmil copper conductors.
D: 350 kcmil copper conductors.

Question 29: 230.43 Wiring Methods for 1000 Volts, Nominal or Less.

Question ID#: 11408.0

Not all types of wiring methods are listed for installation of service conductors. When choosing a wiring method, you must comply with the article that governs that wiring method. For example, if you are using rigid metal conduit you must follow the rules in Article 344.

Approved wiring methods for services rated 1000-volts or less include: RMC, IMC, EMT, ENT, RNC, Type MC Cable, FMC or LFMC not over 6 ft. long, LFNC, and SE cable. Wireways, busways, & auxiliary gutters are also approved.

If the service conductors are subject to physical damage then only Rigid Metal Conduit, Intermediate Metal Conduit, Schedule 80 PVC, Electrical Metallic Tubing, or Type RTRC conduit can be used.

RMC, IMC, EMT, RNC, Type MC Cable, FMC or LFMC not over 6 ft. long, & LFNC are permitted wiring methods for service entrance conductors.

Question 29: Which of the following wiring methods is NOT approved for service-entrance conductors?

A: Rigid metal conduit.
B: AC cable.
C: Electrical metallic tubing.
D: MC cable.

Question 30: 230.43 Wiring Methods for 1000 Volts, Nominal or Less.

Question ID#: 11408.1

Not all types of wiring methods are listed for installation of service conductors. When choosing a wiring method, you must comply with the article that governs that wiring method. For example, if you are using rigid metal conduit you must follow the rules in Article 344.

Approved wiring methods for services rated 1000-volts or less include: RMC, IMC, EMT, ENT, RNC, Type MC Cable, FMC or LFMC not over 6 ft. long, LFNC, and SE cable. Wireways, busways, & auxiliary gutters are also approved.

If the service conductors are subject to physical damage then only Rigid Metal Conduit, Intermediate Metal Conduit, Schedule 80 PVC, Electrical Metallic Tubing, or Type RTRC conduit can be used.

RMC, IMC, EMT, RNC, Type MC Cable, FMC or LFMC not over 6 ft. long, & LFNC are permitted wiring methods for service entrance conductors.

Question 30: Which one of the following wiring methods cannot be used as a wiring method for service-entrance conductors 1000 volts, nominal or less?

A: Busways.
B: Intermediate Metal Conduit (IMC).
C: Nonmetallic Sheathed Cable.
D: Electrical nonmetallic tubing (ENT).

Question 31: 230.46 Spliced Conductors.

Question ID#: 11409.0

Service-entrance conductors can be spliced. However, the splicing device must be approved for the conductor type. For example, when splicing a copper conductor to an aluminum conductor with a split-bolt, the split-bolt must be listed for both copper and aluminum. The divider for the split-bolt must be installed so the copper and aluminum are not in contact with each other.

Splices are never allowed to be made inside of a conduit. For underground installations, a box is not required if a listed underground splice kit is used.

Service-entrance conductors can be spliced. Splice kits are required underground.

Question 31: Which of the following statements about splicing service-entrance conductors is correct?

A: Splices made in underground service-entrance conductors must be inside an approved enclosure.
B: The splicing device shall be approved for the conductor type.
C: Service-entrance conductors cannot be spliced.
D: Service-entrance conductors can be spliced and pulled into a conduit.

Question 32: 230.46 Spliced Conductors.

Question ID#: 11409.1

Service-entrance conductors can be spliced. However, the splicing device must be approved for the conductor type. For example, when splicing a copper conductor to an aluminum conductor with a split-bolt, the split-bolt must be listed for both copper and aluminum. The divider for the split-bolt must be installed so the copper and aluminum are not in contact with each other.

Splices are never allowed to be made inside of a conduit. For underground installations, a box is not required if a listed underground splice kit is used.

Service-entrance conductors can be spliced. Splice kits are required underground.

Question 32: Which one of the following statements concerning splicing service-entrance conductors is false?

A: Splices shall not be soldered.
B: The conductors shall be spliced or joined with splicing devices identified for the use.
C: Splices made in underground service-entrance conductors can be made in a splice box.
D: Splicing of service entrance conductors shall not be permitted.

Question 33: 230.50 Protection Against Physical Damage.

Question ID#: 11410.0

Service entrance conductors must be protected against physical damage. The authority having jurisdiction determines when the service-entrance conductors are subject to physical damage. Most inspectors look for physical damage that would occur under normal conditions. If service-entrance conductors are in areas subject to vehicular traffic they are definitely subject to physical damage and require protection.

Types of raceways that protect service-entrance conductors include: Rigid Metal Conduit, Intermediate Metal Conduit, Schedule 80 PVC Conduit, Electrical Metallic Tubing and Reinforced Thermosetting Resin Conduit.

Underground service entrance conductors must be buried at depths according to Table 300.5. When the conductors are not encased in concrete a warning ribbon must be installed 12 inches above the conductors.

When subject to physical damage service entrance conductors must be protected by RMC, IMC, Schedule 80 PVC, EMT or RTRC.

Question 33: Which of the following raceways will not protect service cables from physical damage?

A: Flexible Metal Conduit.
B: Rigid Metal Conduit.
C: Electrical Metallic Tubing.
D: Schedule 80 PVC Conduit.

Question 34: 230.50 Protection Against Physical Damage.

Question ID#: 11410.1

Service entrance conductors must be protected against physical damage. The authority having jurisdiction determines when the service-entrance conductors are subject to physical damage. Most inspectors look for physical damage that would occur under normal conditions. If service-entrance conductors are in areas subject to vehicular traffic they are definitely subject to physical damage and require protection.

Types of raceways that protect service-entrance conductors include: Rigid Metal Conduit, Intermediate Metal Conduit, Schedule 80 PVC Conduit, Electrical Metallic Tubing and Reinforced Thermosetting Resin Conduit.

Underground service entrance conductors must be buried at depths according to Table 300.5. When the conductors are not encased in concrete a warning ribbon must be installed 12 inches above the conductors.

When subject to physical damage service entrance conductors must be protected by RMC, IMC, Schedule 80 PVC, EMT or RTRC.

Question 34: All service-entrance conductors shall be protected from physical damage. Which of the following wiring methods will provide protection from physical damage for service-entrance conductors?

A: Liquidtight flexible metal conduit (LFMC).
B: Flexible metal conduit (FMC).
C: Electrical metal conduit (EMT).
D: Electrical nonmetallic Tubing (ENT).

Question 35: 230.54(C) Service Heads and Goosenecks above Service-Drop Attachments.

Question ID#: 11411.0

Where practicable, service heads and goosenecks in service-entrance cables must be located above the point of attachment of the service-drop or overhead service conductors. When attached below the service head, the service-entrance conductors form a drip loop that prevents rain water from traveling down the service mast into the service equipment. An exception allows service-entrance conductors to be attached within 24 inches of the service head if it is impracticable to attach them below the service head.

The service head or goose neck must be installed high enough to maintain the proper clearance from the lowest point of the service-drop or overhead service conductors to grade. The lowest point of the drip loop must not be less than 10 ft. above finished grade. Required clearances of service-entrance conductors are in section 230.24.

Service heads and goosenecks must be located above the point of connection of the service-drop conductors.

Question 35: Which statement about service heads and goosenecks is FALSE?

A: Where the service-head cannot be located above the service drop connection, the service-drop connection must be located within 24 in.
B: The service-head must be located high enough to maintain the proper clearance from the service-drop to grade.
C: Where practicable, the service-head must be located high enough so that the service-drop can be connected below the service-head.
D: Service-drop conductorsÂ are required to be connected to the service entrance conductors above the service head.

Question 36: 230.54(C) Service Heads and Goosenecks above Service-Drop Attachments.

Question ID#: 11411.1

Where practicable, service heads and goosenecks in service-entrance cables must be located above the point of attachment of the service-drop or overhead service conductors. When attached below the service head, the service-entrance conductors form a drip loop that prevents rain water from traveling down the service mast into the service equipment. An exception allows service-entrance conductors to be attached within 24 inches of the service head if it is impracticable to attach them below the service head.

The service head or goose neck must be installed high enough to maintain the proper clearance from the lowest point of the service-drop or overhead service conductors to grade. The lowest point of the drip loop must not be less than 10 ft. above finished grade. Required clearances of service-entrance conductors are in section 230.24.

Service heads and goosenecks must be located above the point of connection of the service-drop conductors.

Question 36: Excluding all exceptions, which statement about service heads and goosenecks is TRUE?

A: Where it is impracticable to locate the service head or gooseneck below the point of attachment, the service head or gooseneck location shall be permitted not farther than 36 in. from the point of attachment.
B: Service heads and goosenecks in service-entrance cables shall be located beside the point of attachment of the service-drop conductors to the building.
C: Service heads and goosenecks in service-entrance cables shall be located above the point of attachment of the service-drop conductors to the building.
D: Service heads and goosenecks in service-entrance cables shall be located below the point of attachment of the service-drop conductors to the building.

Service Equipment- General Disconnecting Means.

Question 37: Article 100 Definitions Service Equipment.

Question ID#: 11413.0

Service Equipment includes the circuit breakers and fused switches to disconnect all the ungrounded conductors from the service-entrance conductors.

Service Equipment: ***The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.***

This definition clearly says overcurrent protection for service conductors, like fuses and circuit breakers, is considered service equipment. Also, equipment used to disconnect service conductors from the source of supply is service equipment. It is understood that raceways, fittings, and enclosures housing service conductors are also part of the service equipment.

According to 230.66, meter socket enclosures are not considered service equipment. Meter enclosures do not have interrupting ratings, disconnecting means, or overcurrent protection.

Question 37: Which of the following is considered service equipment?

A: A switchboard with overcurrent protection for service-entrance conductors.
B: A generator disconnect.
C: A circuit breaker panel mounted in a detached garage, supplied by a feeder from a service panel on a single family dwelling.
D: Conduit and fittings used to supply a sub-panel.

Question 38: Article 100 Definitions Service Equipment.

Question ID#: 11413.1

Service Equipment includes the circuit breakers and fused switches to disconnect all the ungrounded conductors from the service-entrance conductors.

Service Equipment: ***The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.***

This definition clearly says overcurrent protection for service conductors, like fuses and circuit breakers, is considered service equipment. Also, equipment used to disconnect service conductors from the source of supply is service equipment. It is understood that raceways, fittings, and enclosures housing service conductors are also part of the service equipment.

According to 230.66, meter socket enclosures are not considered service equipment. Meter enclosures do not have interrupting ratings, disconnecting means, or overcurrent protection.

Question 38: Which of the following is considered Service Equipment?

A: The conduit and wiring from the overhead service drop to the main service panel containing the service disconnect.
B: The conduit and wiring from the main service panel to a sub-panel controlling tennis court lighting.
C: Feeders from the secondary side of a 480/277 volt, non-utility installed transformer to a sub- panel used for charging electric fork trucks.
D: Feeders on the primary side of a 480/277 volt, non-utility installed transformer that supplies a sub- panel used for general lighting loads.

Question 39: 230.66 Service Rated Equipment.

Question ID#: 11414.0

Service Rated Equipment

All service equipment must be listed or field labeled. Listing means the manufacturer has had the equipment evaluated by a third-party testing agency and has passed tests for mechanical strength and durability, wire bending and connection space, electrical insulation, and other characteristics of the equipment that make for a safe installation. The third-party label is installed on the equipment at the factory.

Where equipment does not bear a third-party label the equipment must be evaluated in the field by an agency or organization that performs field evaluations of electrical equipment. Where the equipment is found to comply with the applicable standards, the agency representative will attach a label or other identifying mark to the equipment. See the new definitions in Article 100 of the 2017 NEC for "field labeled" and "field evaluation body."

For service equipment rated at 1000 volts or less, "Suitable Only for Use as Service Equipment" means the grounded conductor terminal is permanently bonded to the enclosure. "Suitable for Use as Service Equipment" marked on equipment means the grounded conductor terminal can be bonded to the enclosure by means of a bonding screw, busbar, or wire-type bonding jumper.

Panelboards and fusible disconnects can be used at the service or downstream from the service. Equipment marked "Suitable for Use as Service Equipment" can be used on the load side of the service disconnecting means, as long as, a bonding jumper is not installed to bond the grounded conductor to the enclosure. Service equipment marked "Suitable ***Only*** for Use as Service Equipment" is not permitted to be used as a sub-panel on the load side of the service equipment because the terminal for the grounded neutral conductor is bonded to the metal enclosure of the panelboard.

Question 39: A panelboard that was shipped with a green bonding screw to bond the grounded conductor to the enclosure would most likely be marked:

A: Suitable Only for Use as Service Equipment.
B: Suitable for equipment grounding only.
C: Suitable for Use as Service Equipment.
D: Cannot be used as service equipment.

Question 40: 230.66 Service Rated Equipment.

Question ID#: 11414.1

Service Rated Equipment

All service equipment must be listed or field labeled. Listing means the manufacturer has had the equipment evaluated by a third-party testing agency and has passed tests for mechanical strength and durability, wire bending and connection space, electrical insulation, and other characteristics of the equipment that make for a safe installation. The third-party label is installed on the equipment at the factory.

Where equipment does not bear a third-party label the equipment must be evaluated in the field by an agency or organization that performs field evaluations of electrical equipment. Where the equipment is found to comply with the applicable standards, the agency representative will attach a label or other identifying mark to the equipment. See the new definitions in Article 100 of the 2017 NEC for "field labeled" and "field evaluation body."

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Panelboards and fusible disconnects can be used at the service or downstream from the service. Equipment marked "Suitable for Use as Service Equipment" can be used on the load side of the service disconnecting means, as long as, a bonding jumper is not installed to bond the grounded conductor to the enclosure. Service equipment marked "Suitable ***Only*** for Use as Service Equipment" is not permitted to be used as a sub-panel on the load side of the service equipment because the terminal for the grounded neutral conductor is bonded to the metal enclosure of the panelboard.

Question 40: Which one of the following statements about Service Rated Equipment is true?

A: When the grounded conductor terminal is irreversibly bonded to the service equipment, the service equipment can be used as a distribution panel.
B: Service Equipment is not required to be listed.
C: Service Equipment rated at 1000 volts or less shall be marked to indentify it as being suitable for use as service equipment.
D: When the grounded conductor terminal is not bonded to the service equipment but the packaging includes a green bonding screw, the service equipment may not be installed as a distribution panel and must be used as service equipment only.

Service Equipment - Disconnecting Means.

Question 41: 230.70(A) Location.

Question ID#: 11416.0

A disconnecting means shall be installed to disconnect all conductors within a building (or other structure,) from the service entrance conductors feeding that building. The disconnecting means shall be installed at a ***readily accessible location*** (see Article 100 definitions***)*** either outside the building, or inside the building, nearest the point where the service entrance conductors actually enter the building.

The service disconnect(s) must be installed at a readily accessible location nearest the point of entrance of the service conductors.

The local Authority Having Jurisdiction will interpret where exactly the "nearest point of entrance" is, for every situation. For residential services where the disconnect is usually the main breaker within an electrical panel / load-center, it may mean the disconnect must be installed back-to-back with the meter base on the outside of the home, or the disconnect may be allowed to be one or even six stud-spaces over from where the service entrance conductors enter the building. Again, that is to be determined by your inspections dept.

It is interesting to note, ***there is a way*** of circumventing this service disconnect location requirement, while still staying compliant with the NEC.

For example: If your building has an electrical room in its center, and you don't wish to place a disconnect on the outside of the building, just to be able to place your electrical panel with main breaker (aka service disconnect), in that electrical room, there is a way to achieve this.

Without some strategic thinking, you would be required to put a disconnect outside first, to meet the Code. But instead, let's look at a way to bring the service entrance conductors all the way to the center of the building without ever entering the building. Remember, this must be achieved since the main breaker (service disconnect) has to be "nearest the point where the conductors enter the building." The solution is found in, 230.6 of your NEC! According to 230.6, service conductors/service entrance conductors that are installed under "not less than 2 inches of concrete" are considered ***outside the building***.

This means I can run my service entrance conductors under a concrete building slab and emerge from the slab, anywhere in the building that I wish, and set my panel with main breaker where I wish, while still meeting Code.

Question 41: Which of the following installations is a violation of the NEC requirements for locating the service disconnect?

A: The service disconnect located outside, 25 ft. from the utility meter which is also located outside the building.
B: The service disconnect located inside the building, 25 ft. from where the service conductors enter the building.
C: Service entrance conductors are installed under 2 inches of concrete and then emerge through the floor in the center of the building, to immediately terminate at the service disconnect located on the wall.
D: Service entrance conductors are installed in conduit, buried 24 inches below grade, and emerge on the outside of the building to immediately terminate at the service disconnect also located outside the building.

Question 42: 230.70(A) Location.

Question ID#: 11416.1

A disconnecting means shall be installed to disconnect all conductors within a building (or other structure,) from the service entrance conductors feeding that building. The disconnecting means shall be installed at a ***readily accessible location*** (see Article 100 definitions***)*** either outside the building, or inside the building, nearest the point where the service entrance conductors actually enter the building.

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This means I can run my service entrance conductors under a concrete building slab and emerge from the slab, anywhere in the building that I wish, and set my panel with main breaker where I wish, while still meeting Code.

Question 42: You are installing a new service for a new building. Which one of the following service installations meets the requirements for the service disconnecting means location?

A: The service disconnecting means is installed inside the building, 24 ft. from the point of entrance of the service conductors into the building.
B: The service disconnecting means is installed inside the buildingâ€™s bathroom at the nearest point of entrance into the building. It is located 10 feet 5 inches from any water source.
C: The service disconnecting means is installed inside the building. The main breaker is located 8 ft. above finished floor for flood protection. It is installed back to back with the outside utility meter, which is also located 8 ft. above finish grade.
D: The service disconnecting means is installed inside the building, back-to-back from the outside utility meter.

Question 43: 230.70(B)&(C) Marking. Suitable for Use.

Question ID#: 11417.0

Each service disconnect shall be permanently marked to identify it as a service disconnect. The Authority Having Jurisdiction decides what types of identification are acceptable. Most inspectors would not accept pencil markings, but would accept an engraved plate attached to the enclosure. Some jurisdictions accept marking with permanent Magic Marker; others do not.

The service disconnect enclosure must be suitable for the conditions. If it is installed outdoors, the enclosure must be listed for outdoor use. If it is subject to splashing water the enclosure must be constructed so that water cannot enter the equipment.

A service disconnecting means located in a hazardous area must meet all the requirements of Articles 500 through 517.

The service disconnecting means must be identified as the service disconnect.

Question 43: A service disconnect is mounted outside a building. Which installation would pass inspection?

A: An engraved plate that says "Service Disconnect" is attached to the outside front cover.
B: The disconnect is labeled "Service" on the inside front cover, written in ink.
C: The disconnect is listed for indoor use only.
D: The disconnect is marked 277/480 volts.

Question 44: 230.70(B)&(C) Marking. Suitable for Use.

Question ID#: 11417.1

Each service disconnect shall be permanently marked to identify it as a service disconnect. The Authority Having Jurisdiction decides what types of identification are acceptable. Most inspectors would not accept pencil markings, but would accept an engraved plate attached to the enclosure. Some jurisdictions accept marking with permanent Magic Marker; others do not.

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A service disconnecting means located in a hazardous area must meet all the requirements of Articles 500 through 517.

The service disconnecting means must be identified as the service disconnect.

Question 44: Which of the following types of marking is required to indentify the service disconnect?

A: A permanent label which simply states â€œService Disconnect â€œ.
B: A label permanently attached inside the disconnect door indicating if the disconnect is suitable for outdoor use.
C: A minimum 1 inch by 2 inch engraved plate or permanent marker stating the operating amperage and voltage.
D: A permanent label that provides the type of personal protection equipment required for servicing the equipment.

Question 45: 230.71 Maximum Number of Disconnects.

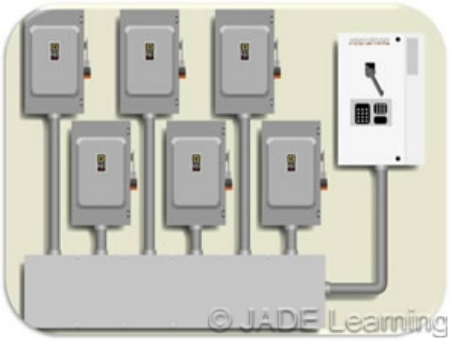
Question ID#: 11418.0

Each service, or each set of service entrance conductors, can have up to six disconnect switches or sets of circuit breakers. The service disconnects can be mounted in a single enclosure, in a group of separate enclosures, or in a switchboard.

A multi-occupancy building, like a strip shopping center, can have a separate set of service-entrance conductors run to each occupancy (230.40 Ex. 1). Each set of service entrance conductors run to each occupancy can have up to six disconnects.

Single-occupancy buildings, supplied by a single set of service entrance conductors, are limited to six service disconnects grouped at any one location.

Disconnects that are installed as part of listed equipment and are used for power monitoring, surge-protection, ground-fault protection or for a power-operated service disconnect are not included in the maximum six disconnects rule.



The maximum number of disconnects is 6 per service location or 6 per set of service entrance conductors.

Question 45: A strip shopping center has four tenants. A separate set of service entrance conductors is run to each tenant space. What is the maximum number of service disconnect switches that are permitted at each tenant location?

A: 3.
B: 5.
C: 1.
D: 6.

Question 46: 230.71 Maximum Number of Disconnects.

Question ID#: 11418.1

Each service, or each set of service entrance conductors, can have up to six disconnect switches or sets of circuit breakers. The service disconnects can be mounted in a single enclosure, in a group of separate enclosures, or in a switchboard.

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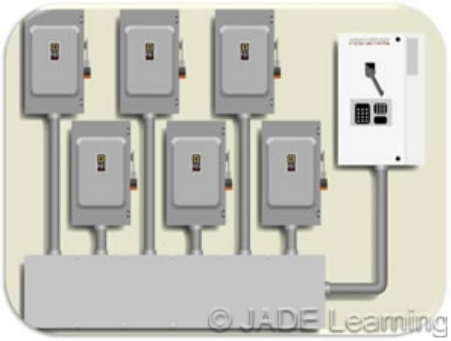

The maximum number of disconnects is 6 per service location or 6 per set of service entrance conductors.

Question 46: Which of the following statements about the maximum number of service disconnects for a single building is true?

A: A building with 8 tenants is limited to 8 service disconnects.
B: Disconnects for power monitoring equipment and surge-protective devices are not counted as service disconnecting means.
C: The â€œHouse Panelâ€• for an apartment building is not counted as a service disconnect.
D: Each set of service entrance conductors must have a single disconnecting means.

Question 47: 230.72 Grouping of Disconnects.

Question ID#: 11419.0

Service disconnects must be grouped in one location and marked to show the load served.

A multiple-occupancy building is a building with more than one tenant space inside. While the Code makes it clear that service disconnecting means requiring no more than 6 movements of the hand to de-energize be grouped together in one location, the Code also requires that when dealing with these ***multiple-occupancy*** buildings, those same grouped disconnects be located so that each tenant has access to the one (or more) movements of the hand that are necessary for the de-energizing of their particular tenant space. The exception to this requirement is when the building is under continuous building management supervision, the tenant disconnect switches can then be inaccessible to the tenant(s), as long as authorized maintenance staff have access to them.

Don't forget, each disconnect switch of the 6 or less making up the service disconnect, must be marked to identify the load it is controlling.

If there are service disconnects for fire pumps, emergency systems, legally required or optional standby systems, they must be located remotely from the disconnects for normal power. This will prevent a first responder from de-energizing the fire pump or emergency equipment by mistake. For fire pumps a plaque must be posted at the location of the grouped service disconnects describing the location of the remotely mounted fire pump disconnect.

Locating the disconnect switches so that tenants have access to the disconnect serving their tenant space, enables the tenant to serve in the capacity of first responder, if an emergency situation were to call for it. A tenant's ability to quickly de-energize the conductors serving their unit may be the difference between life and death for an occupant of that tenant space, experiencing electric shock.

Question 47: Which of the following statements about grouping service disconnects for a multi-occupancy building is true?

A: It is OK to have some disconnects grouped outside the building and some disconnects located in the tenant spaces.
B: If a fire pump is present, the disconnect for that pump must be on the front of the building regardless of the building disconnect location.
C: The service disconnecting means for all tenant spaces must be grouped together, and without regard to exception(s) must be accessible to the tenants.
D: If each tenant has a service disconnect in their tenant space, the main disconnect must be located outside.

Question 48: 230.72 Grouping of Disconnects.

Question ID#: 11419.1

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location of the grouped service disconnects describing the location of the remotely mounted fire pump disconnect.

Locating the disconnect switches so that tenants have access to the disconnect serving their tenant space, enables the tenant to serve in the capacity of first responder, if an emergency situation were to call for it. A tenant's ability to quickly de-energize the conductors serving their unit may be the difference between life and death for an occupant of that tenant space, experiencing electric shock.

Question 48: A multiple occupancy building has a single service disconnecting means and a separate service disconnecting means for a fire pump. Which of the following statements is a true?

A: The disconnect for the fire pump must be located outside the building.
B: A plaque describing the location of the fire pump disconnecting means must be installed at the service disconnect location.
C: A plaque describing the location of the service disconnect must be installed at the fire pump location.
D: The disconnect for the fire pump must grouped with the service disconnect at the same location.

Question 49: 230.79 Rating of Service Disconnecting Means.

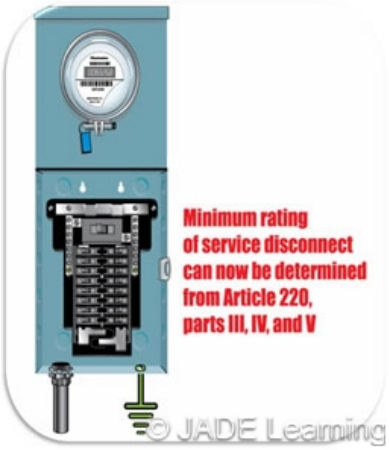
Question ID#: 11420.0

The rating of the service disconnect can never be less than the load calculated in Article 220. For residential, commercial or industrial installations the load calculation is done first. The service disconnect size must be at least as large as the calculated load.

There are some minimum ratings for service disconnects listed in this section.The service disconnect for a single family dwelling can be no smaller than 100 amps.

The minimum service rating for a single circuit installation, like a telephone booth, is 15 amps. The minimum service rating for a two circuit installation, like a sewer lift station with a pump and control circuit is 30 amps.

For all other services, the minimum service disconnect rating is 60 amps.



The rating of the service disconnect cannot be less than the calculated load.

Question 49: A home owner has a backyard shop with 3 circuits and wants a separate service to feed the building. What is the minimum rating of the service disconnecting means?

A: 200 amps.
B: 100 amps.
C: 60 amps.
D: 150 amps.

Question 50: 230.79 Rating of Service Disconnecting Means.

Question ID#: 11420.1

The rating of the service disconnect can never be less than the load calculated in Article 220. For residential, commercial or industrial installations the load calculation is done first. The service disconnect size must be at least as large as the calculated load.

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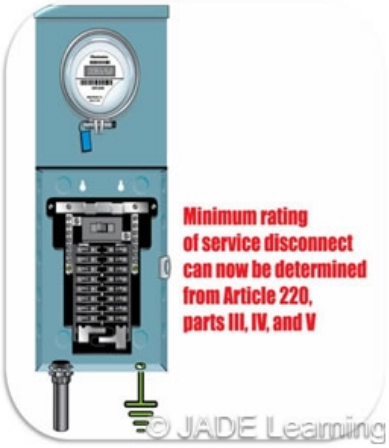

The rating of the service disconnect cannot be less than the calculated load.

Question 50: A homeowner of a one-family dwelling calls you and wants a quote for installing an upgraded service to his old house. The existing service is 60 amperes, 2-wire. What is the minimum size service disconnecting means rating you can install?

A: 100 amperes, 2-wire.
B: 60 amperes, 3-wire.
C: 60 amperes, 2-wire.
D: 100 amperes, 3-wire.

Question 51: 230.80 Combined Rating of Disconnects.

Question ID#: 11421.0

When the service equipment consists of more than a single switch or circuit breaker, the combined ratings of all the disconnects cannot be less than the rating required to carry the calculated load.

For example, if the calculated load for a building was 180 amps, and multiple disconnecting means are used, it is permitted to use any combination of disconnect ratings, as long as the sum of the ratings of the disconnects is at least 180 amps. Two 100 amp disconnects are okay. A single 100 amp disconnect and two 60 amp disconnects are okay. Two disconnects rated 60 amps are a violation because the total rating of the disconnects is less than the calculated load.

The rating of all service disconnects, and the service-entrance conductors feeding them, are required to be large enough for the individual calculated loads they supply.

The combined rating of service disconnects must be at least equal to the rating required for a single disconnect.

Question 51: Which of the following combinations of service disconnecting means is correct for a service with a calculated load of 380 amps?

A: Three, 60 amp disconnects, and one 100 amp disconnect.
B: Two, 100 amp disconnects and one, 200 amp disconnect.
C: One, 200 amp disconnect and two, 60 amp disconnects.
D: Three, 100 amp disconnects and one, 60 amp disconnect.

Question 52: 230.80 Combined Rating of Disconnects.

Question ID#: 11421.1

When the service equipment consists of more than a single switch or circuit breaker, the combined ratings of all the disconnects cannot be less than the rating required to carry the calculated load.

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The rating of all service disconnects, and the service-entrance conductors feeding them, are required to be large enough for the individual calculated loads they supply.

The combined rating of service disconnects must be at least equal to the rating required for a single disconnect.

Question 52: A building has offices in the front and a warehouse in the rear. The calculated load for the entire service is 330 amperes. Which of the following combinations of service disconnecting means is correct for this building?

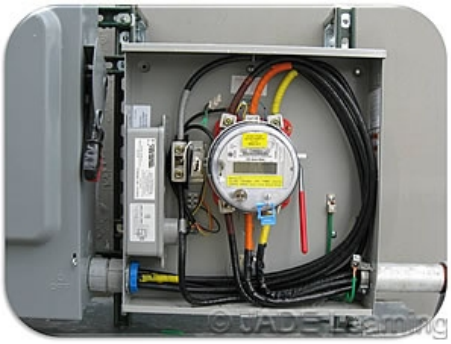
A: One, 125 amp disconnect and two, 100 amp disconnects.
B: One, 125 amp disconnect and one, 200 amp disconnect and one, 60 amp disconnect.
C: One, 200 amp disconnect and two, 60 amp disconnects.
D: Three, 60 amp disconnects and one, 125 amp disconnect.

Question 53: 230.82 Equipment Connected to the Supply Side of Service Disconnect.

Question ID#: 11422.0

Only certain types of equipment can be connected to the supply side of the service disconnecting means. The types of equipment that are permitted to be connected ahead of the service disconnect include:

- meter sockets
- meter disconnect switches
- load management devices
- surge arresters
- standby power systems
- fire pump systems
- fire and sprinkler alarms
- interconnected electric power production sources
- ground-fault protection for equipment
- Electric utility company communications equipment



Certain types of equipment, such as meter disconnects, can be connected to the supply side of the utiltiy meter.

If a piece of equipment is connected on the supply side of the service disconnect it will remain energized, even if the service disconnect is turned off. Equipment such as fire pumps, generators, and alternative energy sources like solar arrays or wind turbines must have their own disconnecting means.

Question 53: Which of the following is NOT allowed to be connected to the supply side of the service disconnect?

A: Standby power systems.
B: HVAC disconnect switches.
C: Meter disconnect switches.
D: Surge Arresters.

Question 54: 230.82 Equipment Connected to the Supply Side of Service Disconnect.

Question ID#: 11422.1

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- load management devices
- surge arresters
- standby power systems
- fire pump systems
- fire and sprinkler alarms
- interconnected electric power production sources
- ground-fault protection for equipment
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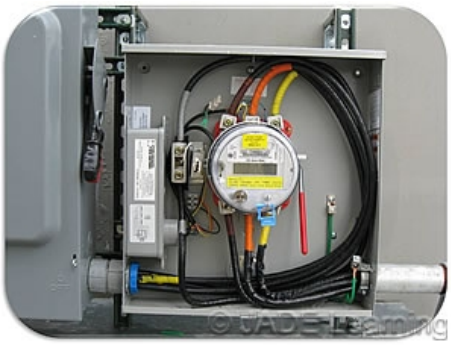

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If a piece of equipment is connected on the supply side of the service disconnect it will remain energized, even if the service disconnect is turned off. Equipment such as fire pumps, generators, and alternative energy sources like solar arrays or wind turbines must have their own disconnecting means.

Question 54: Which of the following types of equipment is not allowed to be connected to the supply side of the service disconnect?

A: Instrument transformers (current and voltage).
B: Industrial Control Panel disconnects.
C: Cable limiters or other current-limiting devices.
D: Meter disconnect switches.

Service Equipment -- Overcurrent Protection

Question 55: 230.90 Overcurrent Protection. Where Required.

Question ID#: 11424.0

Overcurrent protection is required in each ungrounded conductor. Overcurrent protection should not be used in the grounded conductor.

Overcurrent protection is required to be installed to protect each ungrounded conductor, but is not required for the grounded (neutral) conductor. No overcurrent device is permitted to be installed to protect a grounded (neutral) service conductor except a circuit breaker that simulatneously opens all conductors of the circuit (grounded and ungrounded).

Where the ampacity of an ungrounded conductor does not correspond to a standard overcurrent device rating, 240.4(B) permits the use of the next higher standard rating as long as the next standard rating does not exceed 800 amps.
Note:Permission to use the next higher standard rating for a fuse or circuit breaker only applies to standard overcurrent ratings of 800 amps or less. For conductor ampacities over 800 amps the next lower standard rating below the ampacity of the conductors is used (see 240.4(B) & 240.6). For example, if the allowable conductor ampacity is 950 amperes, the next lower standard rating below the ampacity of the conductors is 800 amps.

Where multiple breakers or fuses are used, the total rating of all the devices can exceed the ampacity of the service-entrance conductors. For example, it would be permitted to install three sets of 80 amp fuses in separate enclosures (combined rating 240 amps) for a service load calculated at 200 amps, as long as the service entrance conductors were rated for 200 amps.

Question 55: If the ampacity of three parallel runs of 500 kcmil copper service-entrance conductors is equal to 1140 amps, what is the maximum size overcurrent protection allowed for a single service overcurrent device?

A: 1200 amps.
B: 800 amps.
C: 1000 amps.
D: 500 amps.

Question 56: 230.90 Overcurrent Protection. Where Required.

Question ID#: 11424.1

Overcurrent protection is required in each ungrounded conductor. Overcurrent protection should not be used in the grounded conductor.

Overcurrent protection is required to be installed to protect each ungrounded conductor, but is not required for the grounded (neutral) conductor. No overcurrent device is permitted to be installed to protect a grounded (neutral) service conductor except a circuit breaker that simulatneously opens all conductors of the circuit (grounded and ungrounded).

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Question 56: An electrical service has a calculated load of 1148 amperes. Which of the following statements is true?

A: The service overcurrent protective device cannot be rated more than 1000 amps.
B: Overcurrent protection is required in the grounded conductor.
C: Overcurrent protection is not required because the calculated load of 1148 amperes does not exceed 1200 amperes.
D: You cannot use overcurrent protection in the grounded conductor unless a circuit breaker simultaneously opens all conductors of the circuit.

Question 57: 230.91 Location.

Question ID#: 11425.0

The overcurrent device must be part of the service disconnecting means or immediately adjacent to it.

If the service overcurrent device is not an integral part of the disconnecting means it must be immediately adjacent to the disconnect. When fuses are used for the service overcurrent protection, the disconnecting means must be located ahead of the supply side of the fuses. This will permit the power to the fuses to be turned off if a fuse needs to be replaced. An overcurrent device that is immediately adjacent to the service disconnect is located next to or adjoining the service disconnect.

For example, assume you are adding a generator to a dwelling service and the service main overcurrent device is located on the inside wall, back-to-back with the meter enclosure.

You want to add a non-fusible generator transfer switch adjacent to the meter enclosure outside the dwelling. This would be a violation because the transfer switch now becomes the main service disconnect.

Because the transfer switch has no overcurrent protection, and the existing service overcurrent device is located inside the dwelling, the overcurrent device and the service disconnect are not located immediately adjacent to each other. Therefore, the transfer switch must have overcurrent protection or have it added next to or adjoining it.

Note that the transfer switch would also have to be rated for use as service equipment.

Question 57: Which statement about the location of service overcurrent protection is correct?

A: Service overcurrent protection and the service disconnecting means must be within 50 ft. of each other.
B: Non-fusible service disconnects are never permitted.
C: Service overcurrent protection must be built into the service disconnecting means.
D: The service overcurrent protection and the service disconnecting means must be part of the same equipment or installed immediately adjacent to each other.

Question 58: 230.91 Location.

Question ID#: 11425.1

The overcurrent device must be part of the service disconnecting means or immediately adjacent to it.

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Because the transfer switch has no overcurrent protection, and the existing service overcurrent device is located inside the dwelling, the overcurrent device and the service disconnect are not located immediately adjacent to each other. Therefore, the transfer switch must have overcurrent protection or have it added next to or adjoining it.

Note that the transfer switch would also have to be rated for use as service equipment.

Question 58: Where can the service overcurrent device be located?

A: Either as an integral part of the service disconnecting means or located immediately adjacent thereto.
B: Within sight of the service disconnect.
C: Within 10 ft. of the service disconnect.
D: Within 20 feet of the service disconnect.

Question 59: 230.95 Ground-Fault Protection of Equipment.

Question ID#: 11426.0

Ground-fault protection is required on large services.

Ground-fault protection of equipment is required on solidly grounded wye electrical services rated more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amps or more. The most common example is a 3-phase, 480Y/277-volt service installed on a commercial building.

Where the service overcurrent device has an adjustable trip setting the highest trip setting is the rating used to determine whether ground-fault protection of equipment (GFPE) is required.

If the service disonnecting means consists of multiple circuit breakers all rated less than 1000 amps, then ground fault-protection of equipment is not required. GFPE is only required for service disconnects rated 1000 amps or more.

GFPE protects from line-to-ground faults that occur on the load side of the service disconnect. The maximum setting of the ground fault protection system is 1200 amps. There is no minimum setting. However, if the setting is too low nuisance tripping is likely.

The ground-fault protection system must be installed according to the manufacturer's instructions and listing requirements and be tested on site when first installed. Testing must be done by a qualified person using a process of primary current injection.

Question 59: Ground-fault protection of equipment is required on which of the following?

A: Service disconnects rated at 277/480 volts 800 amps.
B: Service disconnects rated at 120/240 volts 800 amps.
C: Service disconnects rated at 277/480 volts 1200 amps.
D: Service disconnects rated at 120/240 volts 1200 amps.

Question 60: 230.95 Ground-Fault Protection of Equipment.

Question ID#: 11426.1

Ground-fault protection is required on large services.

Ground-fault protection of equipment is required on solidly grounded wye electrical services rated more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amps or more. The most common example is a 3-phase, 480Y/277-volt service installed on a commercial building.

Where the service overcurrent device has an adjustable trip setting the highest trip setting is the rating used to determine whether ground-fault protection of equipment (GFPE) is required.

If the service disonnecting means consists of multiple circuit breakers all rated less than 1000 amps, then ground fault-protection of equipment is not required. GFPE is only required for service disconnects rated 1000 amps or more.

GFPE protects from line-to-ground faults that occur on the load side of the service disconnect. The maximum setting of the ground fault protection system is 1200 amps. There is no minimum setting. However, if the setting is too low nuisance tripping is likely.

The ground-fault protection system must be installed according to the manufacturer's instructions and listing requirements and be tested on site when first installed. Testing must be done by a qualified person using a process of primary current injection.

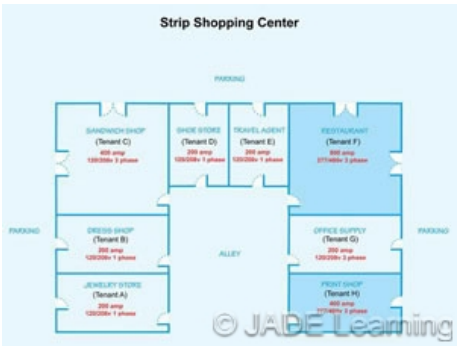
Question 60: Which statement is true for Ground-Fault Protection of Equipment?

A: The ground-fault provisions of this section shall also apply to service disconnects rated 600 amperes or more.
B: The maximum setting of the ground- fault protection is 1000 amperes.
C: The ground-fault protection system is required to be tested when first installed.
D: Ground-fault protection is required for 480/277 volt service disconnects rated 800 amps or more.

Strip Shopping Center

Question 61: Location of the 277/480 Volt Service.

Question ID#: 11428.0



The restaurant and the print shop are supplied by the 277/480 volt three-phase service.

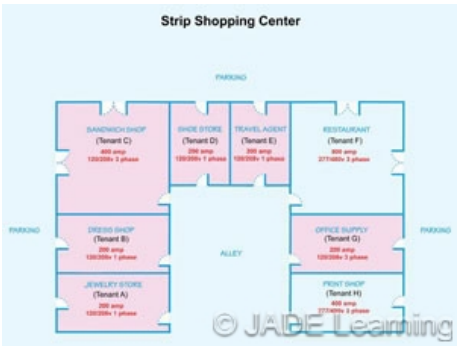
The Strip Shopping Center has 8 tenant spaces. The Restaurant and the Print Shop are served by a 277/480 Volt 3-phase service. The Jewelry Store, Dress Shop, Sandwich Shop, Shoe Store, Travel Agent, and Office Supply Store are supplied by a 120/208 volt 3-phase service. The Jewelry Store, Dress Shop, Shoe Store, and Travel Agent loads are single phase. The Sandwich Shop and the Office Supply Store have 3-phase loads.

Question 61: With the goal of keeping wire runs as short as possible, where is the best location for the 277/480 Volt 3-phase service equipment?

A: On the wall by the Office Supply.
B: On the wall by the Jewelry Store.
C: On the wall by the Dress Shop.
D: On the wall by the Print Shop.

Question 62: Location of the 120/208 Volt Service.

Question ID#: 11429.0



Six out of the eight tenant spaces are supplied by the 120/208 volt service.

The Sandwich Shop service disconnect is rated 400 amps. The other 120/208 volt service disconnects are rated 200 amps.

Question 62: Where is the best location for the 120/208 Volt 3-phase service equipment?

A: On the wall by the Jewelry Store.
B: On the wall by the Dress Shop.
C: On the wall by the Print Shop.
D: On the wall by the Office Supply.

Question 63: The Rating of the 277/480 Volt Service.

Question ID#: 11430.0

The rating of the disconnect for the restaurant is 800 amps. The rating of the disconnect for the print shop is 400 amps.

According to Section 230.80, when a service uses multiple disconnecting means the combined rating of all the service disconnects must be at least equal to the rating required to carry the calculated load. For example, if the load on a service was 760 amps, a single 800 amp service disconnect could be used. If there were multiple disconnects, the combined rating of all the service disconnects must be 760 amps or larger.

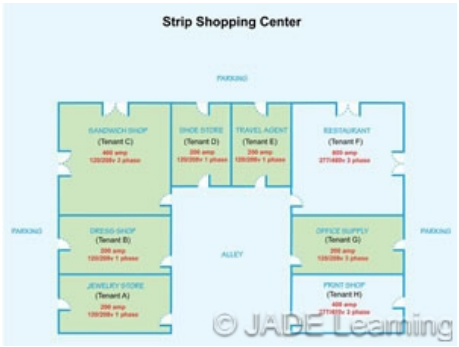
However, the equivalent rating of a service with multiple disconnecting means cannot be determined by adding up the rating of the individual disconnects. The rating of each service disconnect can be increased to the next standard size, so the sum total of the rating of each service disconnect may be greater than the rating of a single service disconnect sized to carry the calculated load.

Question 63: The calculated load for the 277/480 volt service is 1100 amps. What is the minimum required combined rating for the service disconnects supplying the 277/480 volt service?

A: 1100 amps.
B: 1000 amps.
C: 1600 amps.
D: 2000 amps.

Question 64: The Rating of the 120/208 Volt Service.

Question ID#: 11431.0



A single service disconnect must be at least as large as the calculated load.

The service equipment must always be large enough to supply the calculated load. Likewise, the service conductors must be large enough to carry the calculated load.

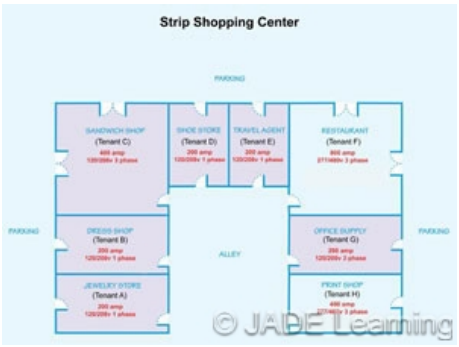
If the calculated load for a building is 375 amps, the service rating must be 400 amps. If a single service disconnect is used, a disconnect rated 400 amps is required. The service conductors must be large enough to carry the 375 amps of calculated load. If multiple disconnecting means are used the combined rating of the disconnects must be 400 amps or larger. The rating of the individual service disconnects is selected according to the load served.

Question 64: The calculated load for the 120/208 service is 950 amps. What is the minimum required rating of the 120/208 volt service if a single service disconnect is used?

A: 1000 amps.
B: 2000 amps.
C: 1600 amps.
D: 1200 amps.

Question 65: Ungrounded Conductors to Tenant Spaces A, B, D, E, G.

Question ID#: 11432.0



The ungrounded conductors to each tenant space will carry the load from that occupancy.

The Jewelry Store (Tenant A), the Dress Shop (Tenant B), the Shoe Store (Tenant D), the Travel Agent (Tenant E), and the Office Supply Store (Tenant G) are all supplied by 200-amp ungrounded conductors. The ungrounded conductors that supply the tenant spaces are selected from Table 310.15(B)(16).

Question 65: What is the minimum size ungrounded conductors, Type THW Cu., run to each of the 120/208 volt 200 amp tenant spaces A, B, D, E, G?

A: 3/0 THW.
B: 1/0 THW.
C: 4/0 THW.
D: 2/0 THW.

Question 66: Grounded Conductor to Tenant Spaces A, B, D, E, G.

Question ID#: 11433.0

Select a conductor large enough to carry the unbalanced load, but not smaller than permitted by Table 250.102(C)(1).

The grounded conductor for any service must be large enough to carry the maximum unbalanced load, but is not permitted to smaller than required by Table 250.102(C)(1).

According to 220.61, the maximum unbalanced load is the largest load connected between the neutral conductor and any one ungrounded conductor. Allowable ampacities of conductors in raceways and cables are found in Table 310.15(B)(16). The ampacity of the conductor selected must not be less than the unbalanced load.

In addition to being large enough to carry the unbalanced load, the grounded conductor can never be smaller than the size specified in Table 250.102(C)(1).

The size of the grounded conductor must satisfy both conditions.

Question 66: If the unbalanced load is 100 amps, what is the minimum size copper grounded conductor run to each of the 120/208 volt 200 amp tenant spaces A, B, D, E, and G?

A: #2 cu. THW.
B: #1 cu. THW.
C: #3 cu. THW.
D: #4 cu. THW.

Question 67: Ungrounded Conductors to Tenant Space C (Sandwich Shop).

Question ID#: 11434.0

The ungrounded conductors for the sandwich shop are protected at 400 amps.

The service disconnect and overcurrent protection for the Sandwich Shop is rated 400 Amps. The supply conductors are copper and the calculated load is 375 amps.

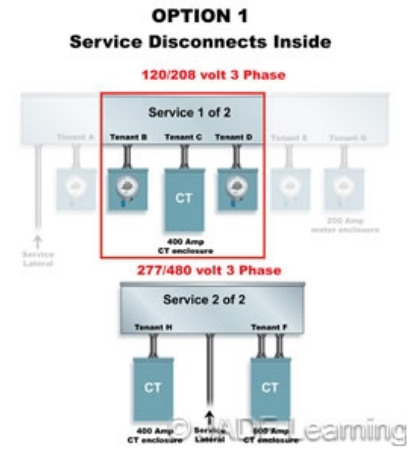
The current-carrying capacity of the selected conductors depends on the calculated load. The ampacity of the supply conductors can be less than 400 amps, as long as the 400 amp overcurrent protection is the next standard size rating, according to 240.6, above the ampacity of the conductors.

Question 67: What is the minimum size ungrounded conductors run to tenant space C (Sandwich Shop)?

A: 300 kcmil THW Cu.
B: 250 kcmil THW Cu.
C: 500 kcmil THW Cu.
D: 350 kcmil THW Cu.

Question 68: Grounded Conductor to Tenant Space C (Sandwich Shop).

Question ID#: 11435.0



The grounded conductor will carry the unbalanced load from the sandwich shop in tenant space C.

A service grounded conductor has two jobs. (1) It must carry the unbalanced load, and (2) it is part of the effective ground-fault current path and must carry ground-fault current, if there is a ground-fault on an ungrounded conductor.

The grounded conductor must be sized for both jobs. It must be large enough to carry the unbalanced load and at the same time be big enough to carry ground-fault current.

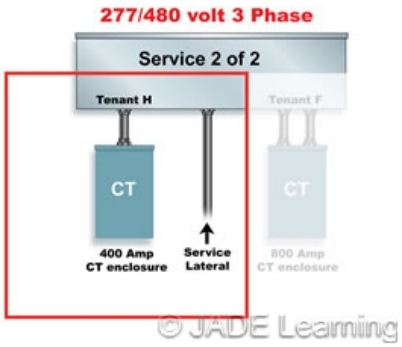
If the grounded conductor is sized no smaller than required from Table 250.102(C)(1), and if it has the current-carrying capacity equal to or greater than the unbalanced load, then the grounded conductor is considered large enough.

Question 68: What is the minimum size 75 degree C grounded conductor for the 120/208 volt 3-phase 400 amp tenant space C (Sandwich Shop) if the unbalanced load is 300 amps?

A: 300 kcmil THW Cu.
B: 500 kcmil THW Cu.
C: 250 kcmil THW Cu.
D: 350 kcmil THW Cu.

Question 69: Ungrounded Conductor to Tenant Space H (Print Shop).

Question ID#: 11436.0



The print shop is supplied by a 277/480 volt system rated 400 amps.

The service equipment for the Print Shop is rated 400 amps. The calculated load on the ungrounded conductors is 375 amps. The service conductors must be large enough to supply the calculated load.

When selecting a conductor size from Table 310.15(B)(16), use the 75 degree column, even if the conductors are rated for 90 degrees C. Section 110.14(C) requires conductors on circuits rated over 100 amps to use the 75 degree C ampacity rating.

Conductors with temperature ratings higher than specified for terminations shall be permitted to be used for ampacity adjustment, correction, or both.

Question 69: What is the minimum size copper ungrounded conductor, Type THW, required to supply the 277/480 volt 3 phase 400 amp tenant space H (Print Shop)?

A: 500 kcmil THW Cu.
B: 350 kcmil THW Cu.
C: 300 kcmil THW Cu.
D: 600 kcmil THW Cu.

Question 70: Grounded Conductor to Tenant Space H (Print Shop).

Question ID#: 11437.0

Size the grounded conductor for the print shop to carry the unbalanced load.

Section 250.24(C) requires the grounded conductor to be installed with the phase conductors:

This conductor shall be routed with the phase conductors and shall not be smaller than specified in Table 250.102(C)(1) but shall not be required to be larger than the largest ungrounded service-entrance phase conductor.

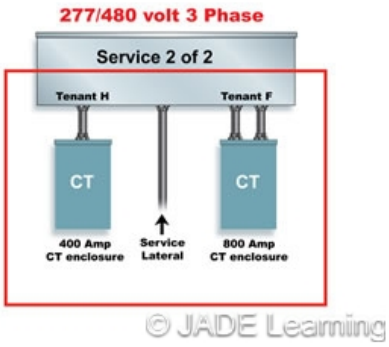
In addition, the grounded conductor must be large enough to carry the unbalanced load.

Question 70: What is the minimum size 75 degree C grounded conductor for the 277/480 volt 3 phase 400 amp tenant space H (Print Shop) if the unbalanced load is 130 amps? The phase conductors are 500 kcmil cu.

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

Question 71: Ungrounded Conductor to Tenant Space F (Restaurant).

Question ID#: 11438.0



The restaurant is supplied by a 277/480 volt system with service overcurrent protection set at 800 amps.

At 800 amps, the restaurant is the largest load in the Strip Shopping Center. The service conductors are installed in two parallel runs. The calculated load is 720 amps.

Section 310.10(H) requires parallel conductors to be a minimum size 1/0. The conductors for each phase, neutral, or equipment grounding conductor must be the same length, same conductor material, same size in circular mil area, same insulation type, and be terminated in the same manner.

The ampacity of paralleled conductors is the ampacity of a single conductor multiplied by the number of parallel runs. For example, a 2/0 copper 75 degree conductor can carry 175 amps. A parallel run of two 2/0 conductors can carry 350 amps: 175 amps x 2 = 350 amps. Three 2/0 conductors installed in parallel can carry 525 amps: 175 amps x 3 = 525 amps.

Question 71: What is the minimum size copper ungrounded service conductors installed for the 277/480 volt 3 phase 800 amp tenant space F (Restaurant)?

A: 2 sets of paralleled 350 kcmil THW conductors.
B: A single 600 kcmil THW conductor.
C: 2 sets of paralleled 3/0 THW conductors.
D: 2 sets of paralleled 500 kcmil THW conductors.

Question 72: Grounded Conductors to Tenant Space F (Restaurant).

Question ID#: 11439.0

The grounded conductors to the restaurant will be installed in parallel: One grounded conductor in each conduit.

If the grounded (white) conductor is to be routed with the ungrounded (energized) conductors, and those conductors are installed in parallel runs of conduit, the grounded (white) conductors must also be installed in parallel.

However, the minimum size of the grounded (white) conductor in each conduit is based on the size of the ungrounded (energized) conductors in EACH conduit, not the combined total of all ungrounded (energized) conductors run to the Restaurant.

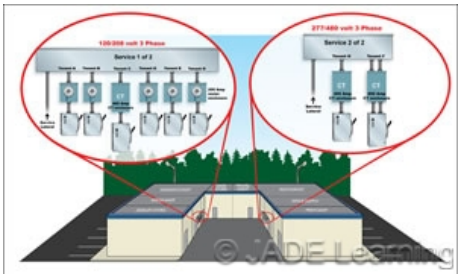
The grounded (white) conductors must carry the unbalanced load for the Restaurant, but if that unbalanced load is a small load, the grounded (white) conductor must still be NO SMALLER than specified in Table 250.102(C)(1).

Question 72: The grounded (white) conductor must be run in each parallel conduit with the ungrounded (energized) conductors. The grounded (white) conductor can be no smaller than specified in Table 250.102(C)(1), based on the size of the ungrounded (energized) conductors in each individual conduit - (See 250.24(C)(2).
Using 250.102(C)(1), what is the minimum size grounded (white) conductor allowed to be installed in each of the two paralleled raceways to the 277/480 volt 800 amp tenant space F (Restaurant)?

A: One 4/0 in each raceway.
B: One 2/0 in each raceway.
C: One 1/0 in each raceway.
D: One 3/0 in each raceway.

Question 73: Location of the 120/208 Volt Service.

Question ID#: 11440.0



The location of the service disconnecting means is an important Code requirement.

When there is more than a single service disconnect for a service, all the service disconnects must be grouped together and marked to show which load they serve (230.72).

Additional service disconnecting means for loads such as fire pumps and emergency standby systems shall be permitted to be installed remotely from the disconnects for the normal service.

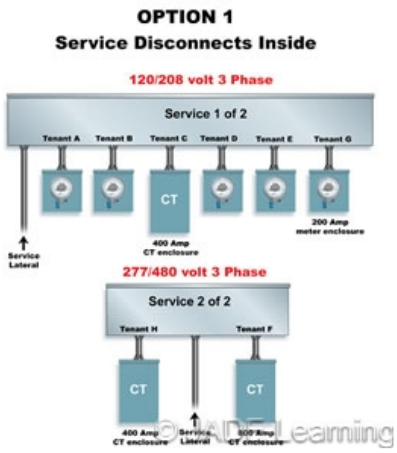
Service disconnects must be grouped together so that in an emergency, like a fire in the building, all the power can be quickly shut off.

Question 73: Which of the following is a code violation for the location of the 120/208 volt service for the strip shopping center?

A: Three disconnects located inside the tenant space, and the other three disconnects located outside the building.
B: All service disconnects located inside the building.
C: All service disconnects located outside the building.
D: A single main service disconnect located outside the building.

Question 74: Conduit Installation to Tenant Spaces.

Question ID#: 11441.0



Where service disconnects are located inside the building they must be located nearest the point of entrance of the service conductors into the building.

According to section 230.70(A)(1) the service disconnecting means must be installed at a readily accessible location either outside the building or inside the building nearest the point of entrance of the service conductors.

Exactly what "nearest the point of entrance" means is determined by the authority having jurisdiction. Most inspectors want the disconnecting means mounted within a few feet of where the service conductors enter the building.

From 230.6, service wiring is considered outside of the building if: (1) it is installed under not less than 2 in. of concrete beneath a building or other structure; (2) it is encased in concrete or brick not less than 2 in. thick if installed within a building; (3) it is installed in a transformer vault; (4) it is installed in conduit and under not less than 18 in. of earth beneath a building; (5) it is installed in overhead service masts on the outside surface of the building traveling through the eave of that building to meet the requirements of 230.24.

For example, a meter base is located on the exterior of a building and an individual conduit is run to a service disconnect located inside the building. If the conduit runs under the building slab in accordance with Condition 1 above (2 in. of concrete) it is considered to enter the building where it emerges from the slab inside the building. The service disconnecting means must be located near the point that the conduit emerges from the slab.

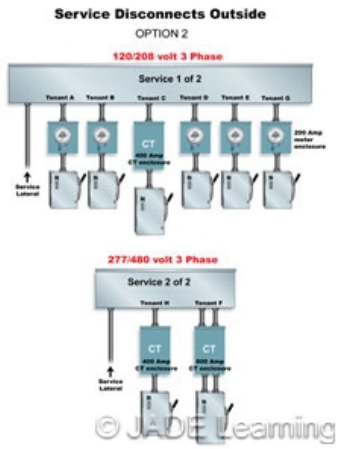
There is no maximum length for the service conduit run. As long as the conduit meets one of the conditions stated in 230.6 the conduit is considered to be outside the building.

Question 74: If a service disconnect is located inside the building, which of the following is an acceptable installation for the service conduit?

A: Through the ceiling joists.
B: Through the outside wall and overhead ceiling to each tenant space.
C: Under the 4-inch concrete slab.
D: Through the outside wall and interior walls.

Question 75: Location of Service Disconnects.

Question ID#: 11442.0



The disconnects are located in the tenant spaces.

Section 230.40 Exception No. 1 states: A building with more than one occupancy shall be permitted to have one set of service-entrance conductors for each service, as defined in 230.2, run to each occupancy or group of occupancies.

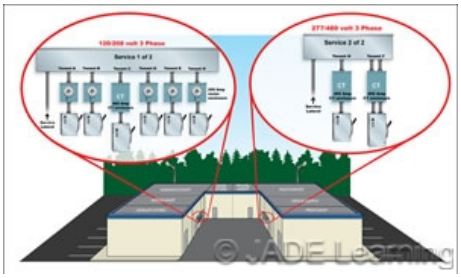
Using this exception, the service entrance conductors are run to each tenant space and the service disconnects located on the inside of the tenant space.

Question 75: Service disconnects can be located either inside or outside a building. Which of the following is a violation of the requirements for locating service disconnects for a multiple occupancy building?

A: Grouping all of the service disconnects together outside the building.
B: Locating the service disconnect for each tenant indoors within space controlled by that tenant.
C: Grouping all the service disconnects together outside the building and installing a disconnect for a fire pump in a remote location that is indicated on a plaque posted with the other grouped disconnects.
D: Grouping some of the service disconnects together outdoors and installing other service disconnects indoors in space controlled by that tenant.

Question 76: Two Services.

Question ID#: 11443.0



This multi-tenant building has two separate services.

A 120/208 volt 3-phase service and a 277/480 volt 3-phase service are installed for the strip shopping center.

More than a single service is permitted by section 230.2 if any of the following conditions exist:

- Special Conditions, such as fire pumps and emergency systems.
- Special Occupancies, such as multiple-occupancy buildings where there is no available space for service equipment accessible to all occupants, and very large buildings.
- Capacity Requirements, where the capacity requirements are in excess of 2000 amps.
- Different Characteristics, such as different voltages, frequencies, or phases.

Question 76: Why are two services permitted for this building?

A: Because there are two different voltages.
B: Because the building has more than 1500 amps of load.
C: Because the owner has requested two services.
D: Because it is a new building.

Question 77: House Load Panel.

Question ID#: 11444.0

A house panel serves common area loads.

Section 210.25 prohibits common area branch circuits, such as interior and exterior lighting, central alarm, and telphone from being supplied from equipment that supplies individual tenant spaces. Branch circuits for common areas must be supplied from a house load panel. The house load panel cannot supply loads in individual tenant spaces.

With a separate house load panel, common area branch circuits can be maintained without entering an individual tenant space. The house load panel is under control of the building management and the tenants cannot disconnect circuits that effect the whole building.

The house load panel disconnecting means is considered one of the six disconnects permitted for a service.

Question 77: The engineer forgot to add a panel for the house 277 volt common area lighting. What is the best solution?

A: Install the service disconnect for the house load panel on the 120/208 volt 3-phase service 50 ft. away from the existing disconnects mounted on the outside wall.
B: Supply the house panel from one of the tenant panels.
C: Install the service disconnect for the house load panel on the 277/480 volt 3-phase system grouped with the Print Shop and Restaurant service disconnect.
D: Install a 7th disconnect for the house load panel on the 120/208 volt 3-phase service, grouped with the six disconnects on the outside wall.

Question 78: Identifying Service Location.

Question ID#: 11445.0

Separate services must be individually identified.

The requirements for identifying services locations when there is more than a single service is in Section 230.2(E).

Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each.

According to 230.40 Exceptiion No. 1, if the number of service disconnect locations is more than 6, a plaque with a graphic or text description of all the service disconnect locations must be installed at a readily accessbile location on the building.

Question 78: Because there is more than one service on this building, what type of identification must be located at each service?

A: A permanent plaque or directory located at each main service disconnect indicating the other service and areas served.
B: No identification is required.
C: A description inside the disconnect cover of each main service disconnect showing the other service location.
D: A weatherproof tag located at each main service disconnect showing the location of the other service.

Question 79: Installing the Services.

Question ID#: 11446.0

The Code rules in Article 230 determine how a service is installed.

For the installation requirements for overhead service conductors see sections 230.22 - 230.29.

For the installation requirements for underground service conductors see sections 230.30 - 230.33.

For the installation requirements for service-entrance conductors see sections 230.40 - 230.56.

For the installation requirements for service equipment see sections 230.62 - 230.66.

For the installation requirements for disconnecting means for service equipment see section 230.70 - 230.82.

For the installation requirements for overcurrent protection for service equipment see sections 230.90 - 230.95.

Question 79: If the overhead service conductors cross the alley behind each occupancy, which statement about installing each of the two services is wrong?

A: Both 120/208 volt service and the 277/480 volt service can be located nearest the load to be served.
B: Both the 120/208 volt service and the 277/480 volt service can be located adjacent to each other.
C: If the service is overhead, the height of the service conductors is a minimum of 12 feet.
D: The 120/208 volt service and the 277/480 volt service can be located 50 ft. or more apart.

Question 80: Ground-Fault Protection.

Question ID#: 11447.0

Ground-fault protection may be required for some services.

As shown in the drawings, ground-fault protection for the strip shopping center services is not required. Ground-fault protection is required for service disconnects on solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1,000 volts phase-to-phase for each service disconnect rated 1000 amps or greater.

The maximum setting of the ground-fault protective device is 1200 amps and for ground faults of 3000 amps or greater, the maximum time delay before opening the circuit is 1 second.

Ground-fault protection for equipment is different than ground-fault protection for personnel. The purpose of ground-fault protection for service equipment is to prevent a ground-fault downstream of the service disconnect from creating a destructive arc-flash and arc-blast at the service equipment location.

Question 80: If the 277/480 volt service had a single service disconnecting means, what is the minimum rating that would require ground-fault protection of equipment?

A: 1200 amps.
B: 3000 amps.
C: 1000 amps.
D: 2000 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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