
# Installing Services (2014 NEC) (Homestudy)

## Oregon Electrical License

This course will focus on the 2014 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# 104 4 Code Related Credit Hours $55.00**

This course is currently approved by the Oregon Building Codes Division under course number 104.

Completion of this continuing education course will satisfy 4.000 credit hours of course credit type 'Code Related' for Electrical license renewal in the state of Oregon. Course credit type 'Code Related'. Board issued approval date: 7/24/2014. Board issued expiration date: 10/1/2017. .

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# Installing Services (2014 NEC) (Homestudy) - OR

## Service Basics.

### Question 1: 230.1 Scope.

Question ID#: 10275.0

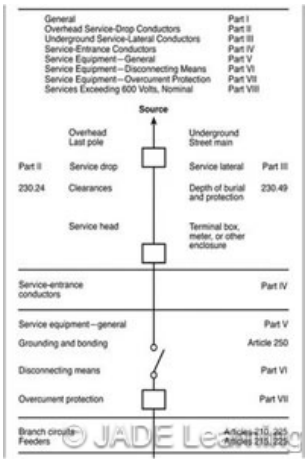



***Figure 230.1 Services is a roadmap to Article 230.***

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

### Question 2: Article 100 Definitions: Service.

Question ID#: 10276.0


***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 2: Which of the following statements about service wiring is true?

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

# Overhead and Underground Services.

## Question 3: Article 100 Definitions: Service-Entrance Conductors, Overhead System.

Question ID#: 10278.0

***Service 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.***

Question 3: 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 from the point of connection to the serviceÂ drop to the terminals of the service equipment.
C: The utility-owned service drop conductors that are spliced at the masthead.
D: The wires connected to the load side of the service disconnecting means.

## Question 4: Article 100 Definitions: Service-Entrance Conductors, Underground System.

Question ID#: 10279.0

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

***Service Conductors, Underground System.*** ***The service conductors between the terminals of the service equipment and the point of connection to the service lateral or undrground service conductors.***

If there is not a terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.

If all of the service equipment is located outside the building walls, there may be no service-entrance conductors or they may be entirely outside the building.

A service lateral is defined as the underground conductors between the utility electric supply system and the service point.

Important considerations for service-entrance conductors which are part of an underground system are burial depths and protection from physical damage.

Question 4: 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 load side of the meter to the line side of the service disconnect.
B: The conductors from the utility transformer to the utility meter.
C: The conductors on the line side of the utility meter.
D: The conductors downstream from the service disconnect.

## Question 5: Article 230.2 Number of Services.

Question ID#: 10280.0

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

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

## Question 6: Article 230.24(A) Clearances Above Roofs.

Question ID#: 10281.0

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

Overhead service conductors passing over a roof must maintain certain clearances. The required clearance above the roof must be maintained for a distance of 3 ft. in all directions from the edge of the roof. This is to guarantee that service drop conductors are never readily accessible.

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 6: Without applying any exceptions, the minimum height for overhead service conductors over a flat roof is:

A: 3 ft. above the roof and 3 ft. in all directions from the edge of the roof.
B: 8 ft. above the roof and 3 ft. in all directions from the edge of the roof.
C: 3 ft. above the roof and 8 ft. in all directions from the edge of the roof.
D: 8 ft. above the roof and 8 ft. in all directions from the edge of the roof.

## Question 7: Article 230.24(A) Exception 1.

Question ID#: 10282.0

Areas on top of a roof such as rooftop parking for vehicles, rooftop gardens, or roofs that are subject to pedestrian traffic must meet the clearance requirements listed in 230.24(B).

For example, with an overhead service crossing a roof with pedestrian traffic and a voltage of less than 300 volts to ground, the clearance from the lowest point of the overhead service to the rooftop is 12 ft. If the voltage was not greater than 150 volts 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.***

Question 7: 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 8: 230.24(A) Exceptions 2 & 3.

Question ID#: 10283.0


***Clearances over roofs can be reduced if the voltage is not greater than 300 volts and no more than 6 ft. of conductors pass over the roof***

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.

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 6 ft. of conductor passes over the roof, a clearance above the roof of 18 inches is allowed.

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

## Question 9: 230.24 (B) Vertical Clearances for Overhead Service Conductors.

Question ID#: 10284.0

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 maximum system voltage***. The voltage to ground for 120/240, 120/208, and 277/480 volts systems is the lower of the two system voltages. For example, the voltage to ground of a 120/208 volt 3-phase, 4-wire grounded system is 120 volts; the voltage to ground of a 120/240 volt 3-phase, 4-wire grounded system is 120 volts; the voltage to ground of a 277/480 volt 3-phase, 4-wire grounded system is 277 volts.

For areas over residential property and driveways, and those commercial areas not subject to commercial 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.


***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 9: 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: 10 ft.
B: 12 ft.
C: 15 ft.
D: 18 ft.

## Question 10: 230.28 Service Masts as Supports.

Question ID#: 10285.0

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 they must be strong enough to support the mechanical load of the service drop conductors connected to the mast. 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 in. rigid metal conduit. Often utility companies or local jurisdictions require guy wires or other mechanical means to be installed to give additional support to the service mast.

Service drops or overhead conductors cannot be connected between a weatherhead and a conduit coupling that is located beyond the last place where the conduit is supported by 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 10: Which of the following statements about service masts is true?

A: A security camera monitoring a parking lot can be mounted on a service mast.
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: 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.

# Underground Service-Lateral Conductors.

## Question 11: 230.32 Protection Against Damage.

Question ID#: 10287.0

***Underground service conductors must be protected from physical damage. Burial depths are determined by Table 300.5.***

When installing underground service conductors they must be buried to a depth listed in NEC table 300.5. For example, direct burial cables must be buried 24 inches deep. A warning ribbon must be placed in the trench at least 12 in. above the conductors to warn that these conductors are present. Hopefully a backhoe operator would stop digging if he 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
- Elctrical Metallic Tubing
- Rigid PVC
- MI Cable
- MC Cable

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

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

Question 11: Which of the following installations of underground service conductors is a code violation?

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

# Service Entrance Conductors.

## Question 12: 230.40 Number of Service-Entrance Conductor Sets.

Question ID#: 10289.0

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 12: 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, if they are grouped together.
B: A separate set of service entrance conductors can be installed to two panelboards in a single family dwelling, one panelboard inside the dwelling and the other panelboard outside the dwelling.
C: A separate set of service entrance conductors can be installed to each occupant in a multi-tenant building.
D: A separate set of service entrance conductors can feed a house panel on a multi-occupancy building.

## Question 13: 230.42 Minimum Size and Rating.

Question ID#: 10290.0

***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 13: 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: 160 amps.
C: 200 amps.
D: 187.5 amps.

## Question 14: 310.15(B)(7) 120/240 V, Single-Phase Dwelling Service and Feeders.

Question ID#: 10291.0

Section 310.15(B)(7) was revised extensively in the 2014 NEC and a familiar table was deleted. Now, rather than using Table 310.15(B)(7) to determine conductor sizes for services and feeders required for single-phase dwellings, section 310.15(B)(7) requires a calculation. Service and feeder conductors that carry the whole load for a single-phase dwelling can be selected based on 83% of the rating of the service.

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

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 rating x .83 = 187 amps. The minimum size conductor required is 3/0 AWG copper; this is the same size as was permitted in the deleted Table 310.15(B)(7).

Question 14: 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: 200
B: 166
C: 150
D: 83

## Question 15: 230.43 Wiring Methods for 1000 Volts, Nominal or Less.

Question ID#: 10292.0

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

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 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, or Electrical Metallic Tubing can be used.

Question 15: Which of the following wiring methods is NOT approved for service-entrance conductors?

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

## Question 16: 230.46 Spliced Conductors.

Question ID#: 10293.0


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

Service 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 in conduit. For underground installations, a box is not required if a listed underground splice kit is used.

Question 16: Which of the following statements about splicing service-entrance conductors is correct?

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

## Question 17: 230.50 Protection Against Physical Damage.

Question ID#: 10294.0

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 17: 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 18: 230.54(C) Service Heads and Goosenecks above Service-Drop Attachments.

Question ID#: 10295.0

Where practicable, service heads and goosenecks in service-entrance cables must be located above the point of attachment of the service-drop 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 to 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 18: Which statement about service heads and goosenecks is false?

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

# Service Equipment- General Disconnecting Means.

## Question 19: Article 100 Definitions Service Equipment.

Question ID#: 10297.0

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.

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

Question 19: 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 20: 230.66 Service Rated Equipment.

Question ID#: 10298.0


***Service Rated Equipment***

All service equipment must be listed. Listing means the equipment has been tested 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.

For service equipment rated at 1000 volts or less, "Suitable Only for Use as Service Equipment" means the grounded conductor terminal is bonded to the enclosure. "Suitable for Use as Service Equipment" marked on equipment means the grounded conductor terminal can be bonded to the enclosure.

Panelboards and fusible disconnects can be used at the service or downstream from the service. Equipment marked as "Suitable for Use as Service Equipment" can be used on the load side of the service disconnecting means, as long as the grounded conductor is not bonded to the enclosure. But service equipment must be marked "Suitable Only for Use as Service Equipment" or "Suitable for Use as Service Equipment," where the grounded conductor is bonded to the enclosure or could be bonded to the enclosure.

Question 20: 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: Cannot be used as service equipment.
C: Suitable for Use as Service Equipment.
D: Suitable for equipment grounding only.

# Service Equipment - Disconnecting Means.

## Question 21: 230.70(A) Location.

Question ID#: 10300.0


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

Means shall be provided to disconnect all conductors in a building or other structure from the service entrance conductors. The disconnecting means must be at a readily accessible location either outside the building, or inside nearest the point of entrance of the service entrance conductors.

The local Authority Having Jurisdiction will interpret where the "nearest point of entrance" is. For residential services it may mean the disconnect must be back-to-back with the meter enclosure, or the disconnect could be one stud bay over from where the service entrance conductors enter the building.

As long as the service conductors stay outside the building the service disconnect can be located anywhere. According to 230.6, service conductors that are installed under not less than 2 inches of concrete are considered outside the building. Service conductors are also considered outside the building if they are installed in conduit under not less than 18 inches of earth beneath a building.

Question 21: Which of the following installations is a violation of the NEC requirements for locating the service disconnect?

A: The service disconnect located 25 ft. from the utility meter outside the building.
B: The service disconnect is located inside the building, 25 ft. from the point of entrance.
C: Service entrance conductors are installed under 2 inches of concrete and terminated at the service disconnect 50 ft. inside the building.
D: Service entrance conductors are installed in conduit, buried 24 inches deep underneath the building, and terminated 10

ft. inside the building.

## Question 22: 230.70(B)&(C) Marking. Suitable for Use.

Question ID#: 10301.0


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

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.

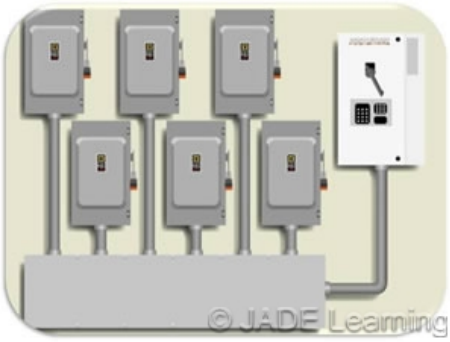
A service disconnecting means located in a hazardous area must meet all the requirements of Articles 500 through 517.

Question 22: A service disconnect is mounted outside a building. Which installation would pass inspection?

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

## Question 23: 230.71 Maximum Number of Disconnects.

Question ID#: 10302.0




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

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.

Question 23: 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 disconnects that are permitted at each tenant location?

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

## Question 24: 230.72 Grouping of Disconnects.

Question ID#: 10303.0

There are essentially two options for the location of multiple disconnects in buildings that have multiple tenants.

1). The service disconnects for all tenant spaces must be grouped together in one location.

OR

2.) The disconnects for each tenant space are permitted to be located seperately within the individual tenant spaces.

The requirement for grouping service disconnects permits emergency personnel to remove power from a building with no more than six quick motions of the hand. Each disconnect must be marked to show the load it controls.


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

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.

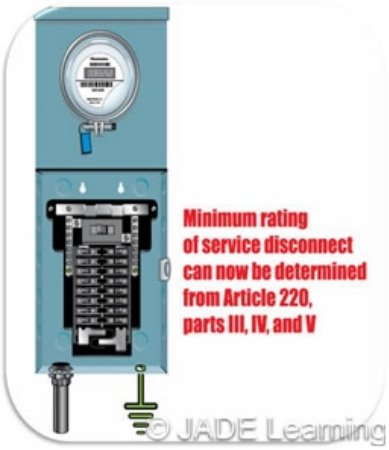
Locating the disconnects for each tenant space within the individual tenant space obviously gives tenants ready access to the disconnect serving that tenant's space. Each occupant in a multi-occupancy building must have access to the disconnect that feeds their tenant space. If the building is under continuous building management supervision, the tenant disconnects can be locked, as long as authorized maintenance staff have access.

Question 24: Which of the following statements about grouping service disconnects for a multi-occupancy building is true?

A: The service disconnects for all tenant spaces must be grouped together, or the disconnects for each tenant space can be located inside the tenant space.
B: If each tenant has a service disconnect in their tenant space, the main disconnect must be located outside.
C: It is OK to have some disconnects grouped outside the building and some disconnects located in the tenant spaces.
D: If a fire pump is present, the disconnect for the fire pump cannot be closer than 6 ft. from the other service disconnects.

## Question 25: 230.79 Rating of Service Disconnecting Means.

Question ID#: 10304.0




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

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.

Question 25: 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: 60 amps.
B: 100 amps.
C: 150 amps.
D: 200 amps.

## Question 26: 230.80 Combined Rating of Disconnects.

Question ID#: 10305.0

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

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.

Question 26: Which of the following combinations of service disconnecting means is correct for a service with a calculated load of 380 amps?

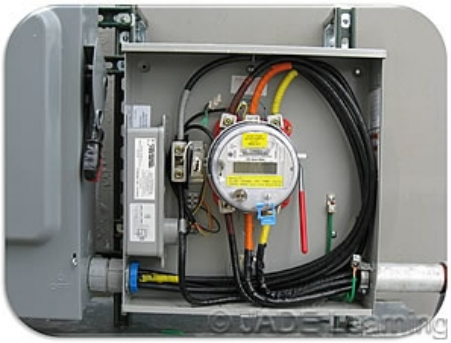
A: One, 200 amp disconnect and two, 60 amp disconnects.
B: Three, 100 amp disconnects and one, 60 amp disconnect.
C: Two, 100 amp disconnects and one, 200 amp disconnect.
D: Three, 60 amp disconnects, and one 100 amp disconnect.

## Question 27: 230.82 Equipment Connected to the Supply Side of Service Disconnect.

Question ID#: 10306.0

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 27: Which of the following is not allowed to be connected to the supply side of the service disconnect?

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

# Service Equipment -- Overcurrent Protection

## Question 28: 230.90 Overcurrent Protection. Where Required.

Question ID#: 10308.0

Overcurrent protection is required to be installed for each ungrounded conductor, but not for the grounded neutral conductor. Where the ampacity of the ungrounded conductor does not correspond to a standard overcurrent device rating, an exception to 240.4(B) permits the use of the next higher standard rating. However, the exception only applies to ratings of 800 amps or less. For ampacities over 800 amps the next lower rating must be used (see 240.4(B) & 240.6).

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.


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

Question 28: 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: 1000 amps.
C: 800 amps.

D: 500 amps.

## Question 29: 230.91 Location.

Question ID#: 10309.0

If the service overcurrent device is not an integral part of the disconnecting means it has to be immediately adjacent to it. An overcurrent device that is immediately adjacent to the service disconnect is next to or adjoining it.

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 have to be rated for service equipment.

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

Question 29: Which statement about the location of service overcurrent protection is correct?

A: Service overcurrent protection must be built into the service disconnecting means.
B: Non-fusible service disconnects are never permitted.
C: Service overcurrent protection and the service disconnecting means must be within 50 ft. of each other.
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 30: 230.95 Ground-Fault Protection of Equipment.

Question ID#: 10310.0

***Ground-fault protection is required on large services.***

Ground-fault protection of equipment is required on 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. This ground-fault protection protects from line-to-ground faults that occur on the load side of the service disconnect. If the service consists of multiple disconnects all rated less that 1000 amps, then ground fault-protection is not required.

Where the overcurrent device has an adjustable trip setting the highest trip setting is the rating used. The maximum setting of the ground fault equipment is 1200 amps. There is no minimum setting. However, if the setting is too low nuisance tripping is likely.

Ground-fault protective devices must be installed according to the instructions and listing requirements and be tested on site when installed.

Question 30: Ground-fault protection of equipment is required on which of the following?

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

# Strip Shopping Center

## Question 31: Location of the 277/480 Volt Service.

Question ID#: 10312.0


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

## Question 32: Location of the 120/208 Volt Service.

Question ID#: 10313.0

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


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

Question 32: Where is the best location for the 120/208 Volt 3-phase service equipment?

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

## Question 33: The Rating of the 277/480 Volt Service.

Question ID#: 10314.0


***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.

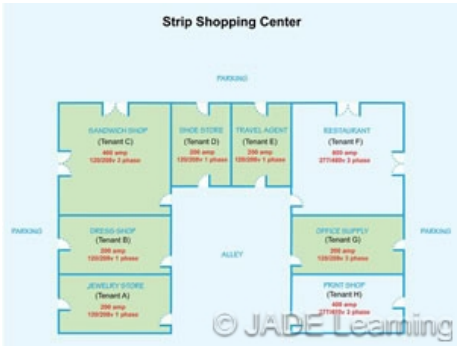
However, the equivalent rating of a service with multiple disconnecting means cannot be determined by adding up the rating of the individual disconnects. The rating of each service disconnect can be increased to the next standard size, so the sum total of the rating of each service disconnect may be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

Question 33: 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: 1000 amps.
B: 1100 amps.
C: 1600 amps.
D: 2000 amps.

## Question 34: The Rating of the 120/208 Volt Service.

Question ID#: 10315.0




***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.

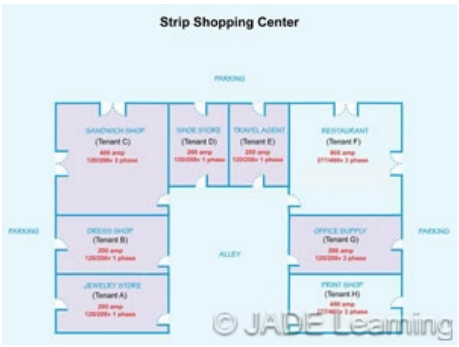
If the calculated load for a building is 375 amps, the service rating must be 400 amps. If a single service disconnect is used, a disconnect rated 400 amps is required. The service conductors must be large enough to carry the 375 amps of calculated load. If multiple disconnecting means are used the combined 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 34: 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: 1200 amps.
C: 1600 amps.
D: 2000 amps.

## Question 35: Ungrounded Conductors to Tenant Spaces A, B, D, E, G.

Question ID#: 10316.0




***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 underground conductors. The ungrounded conductors that supply the tenant spaces are selected from Table 310.15(B)(16).

Question 35: 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: 1/0 THW.
B: 2/0 THW.
C: 3/0 THW.
D: 4/0 THW.

## Question 36: Grounded Conductor to Tenant Spaces A, B, D, E, G.

Question ID#: 10317.0

The grounded conductor for any service must be large enough to carry the maximum unbalanced load.Â  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 thanÂ specified inÂ Table 250.102(C)(1).

The size of the grounded conductor must satisfy both conditions.


***Select the grounded conductor to carry the unbalanced load from each of the 200 ampÂ tenant spaces.***

Question 36: 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: #4 cu. THW.
B: #3 cu. THW.
C: #2 cu. THW.
D: #1 cu. THW.

## Question 37: Ungrounded Conductors to Tenant Space C (Sandwich Shop).

Question ID#: 10318.0


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

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

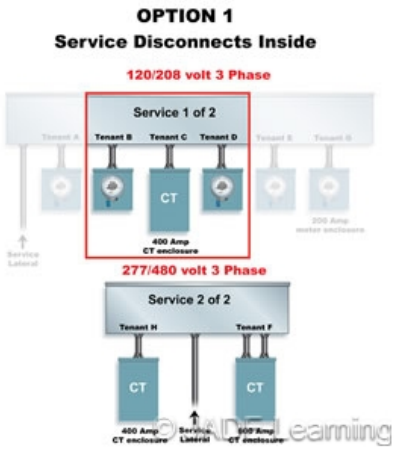
## Question 38: Grounded Conductor to Tenant Space C (Sandwich Shop).

Question ID#: 10319.0

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.



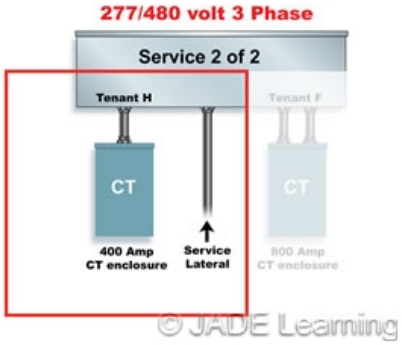

***The grounded conductor will carry the unbalanced load from the sandwich shop in tenant space C.***

Question 38: 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: 250 kcmil THW Cu.
B: 300 kcmil THW Cu.
C: 350 kcmil THW Cu.
D: 500 kcmil THW Cu.

## Question 39: Ungrounded Conductor to Tenant Space H (Print Shop).

Question ID#: 10320.0




***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 39: 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: 300 kcmil THW Cu.
B: 350 kcmil THW Cu.
C: 500 kcmil THW Cu.
D: 600 kcmil THW Cu.

## Question 40: Grounded Conductor to Tenant Space H (Print Shop).

Question ID#: 10321.0

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.

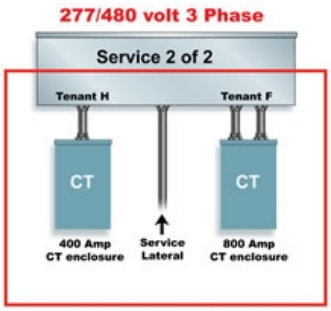

***Size the grounded conductor for the print shop to carry the unbalanced load.***

Question 40: 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: No. 1 THW cu.
B: 1/0 THW cu.
C: 2/0 THW cu.
D: 3/0 THW cu.

## Question 41: Ungrounded Conductor to Tenant Space F (Restaurant).

Question ID#: 10322.0




***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 41: 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: 2 sets of paralleled 500 kcmil THW conductors.
C: 2 sets of paralleled 4/0 THW conductors.
D: A single 600 kcmil THW conductor.

## Question 42: Grounded Conductors to Tenant Space F (Restaurant).

Question ID#: 10323.0

If the grounded conductor is to be routed with the phase conductors and the phase conductors are installed in parallel runs of conduit, the grounded conductors must also be installed in parallel.

However, the minimum size of the grounded conductor is based on the size of the phase conductors in each conduit, not the combined rating of the ungrounded conductors run to the Restaurant.

The grounded conductors must carry the unbalanced load for the Restaurant, but if the unbalanced load is small, the grounded conductor cannot be smaller than specified in Table 250.102(C)(1).

***The grounded conductors to the restaurant will be installed in parallel with one grounded conductor in each conduit.***

Question 42: The grounded conductor must be run in each parallel conduit and installed with the ungrounded conductors. It can be no smaller than specified in Table 250.102(C)(1), based on the size of the wire in each conduit. Refer to 250.24(C)(2). What are the minimum size grounded conductors installed in each of the two paralleled raceways to the 277/480 volt 800 amp tenant space F (Restaurant)?

A: One 1/0 with each parallel set.
B: One 2/0 with each parallel set.
C: One 3/0 with each parallel set.
D: One 4/0 with each parallel set.

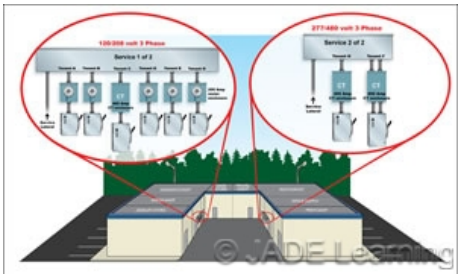
## Question 43: Location of the 120/208 Volt Service.

Question ID#: 10324.0

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.



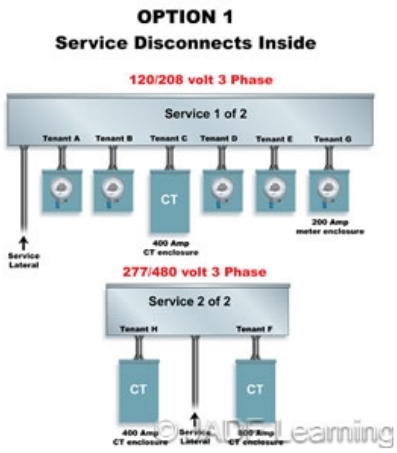

***The location of the service disconnecting means is an important Code requirement.***

Question 43: Which of the following is a code violation for the location of the 120/208 volt service for the strip shopping center?

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

## Question 44: Conduit Installation to Tenant Spaces.

Question ID#: 10325.0




***If the service disconnects are located in each tenant space, the ungrounded conductors in each conduit do not have overcurrent protection.***

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, 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 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.

Question 44: If the service disconnects are located in each tenant space, how should the conduit to each tenant space be installed?

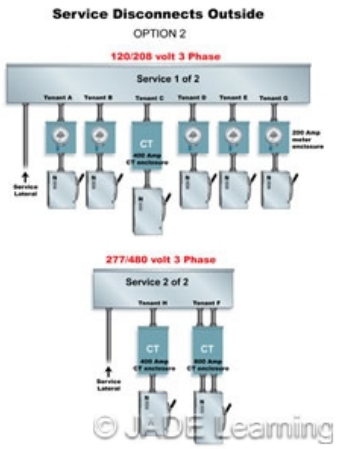
A: Through the ceiling joists.
B: Under the 4-inch concrete slab.
C: Through the outside wall and overhead to each tenant space.
D: Through the outside wall and interior wall.

## Question 45: Location of Service Disconnects.

Question ID#: 10326.0

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.




***The disconnects are located in the tenant spaces.***

Question 45: 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: Locating the service disconnect for each tenant indoors within space controlled by that tenant.
B: Grouping all of the service disconnects together outside the building.
C: Grouping some of the service disconnects together outdoors and installing other service disconnects indoors in space controlled by that tenant.
D: 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.

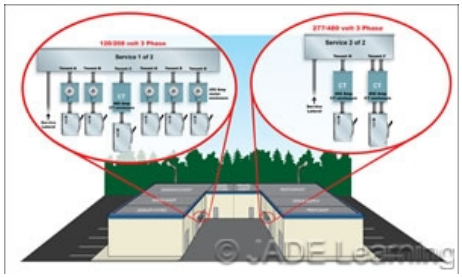
## Question 46: Two Services.

Question ID#: 10327.0

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 mutiple-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.




***This multi-tenant building has two separate services.***

Question 46: Why are two services permitted for this building?

A: Because the owner has requested two services.
B: Because the building has more than 3000 amps of load.
C: Because there are two different voltages.
D: Because it is a new building.

## Question 47: House Load Panel.

Question ID#: 10328.0


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

A: 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.
B: 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.
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: Supply the house panel from one of the tenant panels.

## Question 48: Identifying Service Location.

Question ID#: 10329.0

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.***


***Separate services must be individually identified.***

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

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

## Question 49: Installing the Services.

Question ID#: 10330.0


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

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

## Question 50: Ground-Fault Protection.

Question ID#: 10331.0

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.


***Ground-fault protection may be required for some services.***

Question 50: 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: 3000 amps.
B: 2000 amps.
C: 1200 amps.
D: 1000 amps.

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

**OR Installing Services (2014 NEC) Course# 104 4 Code Related Credit Hours $55.00**

| | | |
|---|---|---|
| **1.) A B C D** | **18.) A B C D** | **35.) A B C D** |
| **2.) A B C D** | **19.) A B C D** | **36.) A B C D** |
| **3.) A B C D** | **20.) A B C D** | **37.) A B C D** |
| **4.) A B C D** | **21.) A B C D** | **38.) A B C D** |
| **5.) A B C D** | **22.) A B C D** | **39.) A B C D** |
| **6.) A B C D** | **23.) A B C D** | **40.) A B C D** |
| **7.) A B C D** | **24.) A B C D** | **41.) A B C D** |
| **8.) A B C D** | **25.) A B C D** | **42.) A B C D** |
| **9.) A B C D** | **26.) A B C D** | **43.) A B C D** |
| **10.) A B C D** | **27.) A B C D** | **44.) A B C D** |
| **11.) A B C D** | **28.) A B C D** | **45.) A B C D** |
| **12.) A B C D** | **29.) A B C D** | **46.) A B C D** |
| **13.) A B C D** | **30.) A B C D** | **47.) A B C D** |
| **14.) A B C D** | **31.) A B C D** | **48.) A B C D** |
| **15.) A B C D** | **32.) A B C D** | **49.) A B C D** |
| **16.) A B C D** | **33.) A B C D** | **50.) A B C D** |
| **17.) A B C D** | **34.) A B C D** | |

**Email answer sheet to: registrar@jadelearning.com**

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