

UNIT V - ELECTRICITY

Lesson 8: Connecting to the SEP

Competency/Objective: Identify procedures for connecting the drop wires and branch circuit wires to the SEP.

Study Questions

1. What are the parts of the SEP?
2. What are some good wiring practices to follow when wiring the panel?
3. What is the procedure for connecting the service entrance conductors to the SEP?
4. How is the ground system installed for the SEP?
5. How are circuit protectors selected and sized?
6. How are the 120-volt branch circuits connected to the SEP?
7. How are the 240-volt individual circuits connected to the SEP?
8. What is three-phase power, and when should its use be considered?

References

1. *Agricultural Structures (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1999, Unit V.
2. Transparency Masters
 - a) TM 8.1: SEP Parts
 - b) TM 8.2: Ground System
 - c) TM 8.3: Wired 120/240 V Panel
3. Activity Sheet
 - a) AS 8.1: Identifying SEP Components

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TEACHING PROCEDURES

A. *Review*

Lesson 7 described bringing electrical power in at the yard pole and then installing wiring from the yard pole to the service entrance, after which wire can be run to branch circuits and electrical fixtures. The next step is making the connections at the service entrance panel. Within the SEP, circuits are linked to the power source, providing electrical power to the entire system.

B. *Motivation*

Remove the cover from the SEP in the agriculture shop or building. Have students examine how the connections are made. Ask students if they can determine which circuits are 120 volts and which are 240 volts.

C. *Assignment*

D. *Supervised Study*

E. *Discussion*

1. The SEP distributes power throughout a structure. Ask students to list the components of an SEP. Use the SEP in the agriculture building to illustrate the different parts, or show students TM 8.1.

What are the parts of the SEP?

- a) Cabinet - houses the parts of the SEP
 - b) Main disconnect switch - large amperage breaker used to disconnect the power coming into the structure from the individual circuits
 - c) Panel with banks, or rows, of sockets designed to accept either circuit breakers or fuses
 - d) Circuit breakers or fuses - provide overcurrent protection for the circuits
 - e) Neutral bar - specialized bar with terminal screws placed in it to make connections between neutral wires and ground wires
 - f) Grounding screw - the point where the ground wire connects to the neutral bar
 - g) Bonding strap - ground the cabinet
2. Describe proper wiring procedures at the SEP.

What are some good wiring practices to follow when wiring the panel?

- a) Reducing overheating
 - 1) One way to reduce heat buildup is by wiring neatly and keeping wiring orderly within the cabinet.
 - 2) Keep wire runs in the SEP as straight and direct as possible.
 - 3) Wires should not be bent during wiring, because the constriction of wires can cause insulation damage as well as overheating.
 - b) Other good practices
 - 1) Make tight connections without excessive bare wire showing at the terminal screws.
 - 2) Place the neutral bar in a convenient location in the SEP box to make direct wire runs easier.
 - 3) Cut wires to the exact length necessary, removing any excess wire from the box.
3. Typically, three wires enter the SEP from the service drop, including two 120-volt hot conductors and one neutral conductor. Discuss the procedure for connecting the wires. Emphasize the importance of making secure connections.

What is the procedure for connecting the service entrance conductors to the SEP?

- a) Check to make sure that the power is shut off.
 - b) Connect the two hot conductors to the main disconnect switch.
 - 1) Cut the conductors to the proper length.
 - 2) Strip off enough insulation to make a good connection.
 - 3) Insert the bare ends of the wire into the connectors on the main disconnect.
 - 4) Tighten the holding screws securely onto the wires.
 - c) Using the same procedures, attach the neutral wire to the neutral bar.
 - d) Ground the SEP cabinet by attaching either the flexible bonding strap or the ground wire to the grounding screw.
4. Discuss the installation of ground systems and grounding electrodes. TM 8.2 illustrates one type of ground system.

How is the ground system installed for the SEP?

- a) Involves connecting a ground wire from the neutral bar in the SEP to a grounding electrode or a ground system
 - 1) Several different types of electrodes may make up ground systems.
 - (a) Buried metal water pipe 10 feet or more in length, which must be supplemented by at least one other electrode
 - (b) Grounded metal frame of the structure
 - (c) Concrete-enclosed electrode

- (1) Composed of either 20 or more feet of ½-inch reinforced steel or AWG 4 copper wire
 - (2) Placed inside at least 2 inches of concrete located near the bottom of the foundation and in direct contact with the earth
 - (d) Buried AWG 2 or bigger wire that encircles the entire structure
 - 2) If none of these options for the ground system are available, a grounding electrode is used.
 - (a) Underground metal piping or buried metal tanks
 - (b) ½-inch copper rod or ½-inch metal or copper-clad rod
 - (c) ¾-inch galvanized steel pipe
 - (d) Buried metal plate at least 2 square feet in diameter
 - b) Size of the ground wire
 - 1) If the service entrance conductor is AWG 2 or smaller, AWG 6 or 8 wire should be used.
 - 2) If the service entrance conductor is AWG 1 or 0, AWG 6 is the minimum size permitted.
 - 3) If the service entrance conductor is AWG 2/0 or 3/0, the ground wire should be a minimum of AWG 4.
 - 4) If wire larger than AWG 3/0 is used at the service entrance, AWG 2 must be used for the ground connection.
 - c) Installation of the ground wire
 - 1) Fasten the wire to the surface over which it runs using special staples.
 - 2) Install the wire in a location that will minimize physical damage.
 - 3) Protection is typically provided by either tucking the grounding wire behind the service conduit entering the structure or running the wire along wall studs.
 - 4) If AWG 8 or smaller wire is used for grounding, protect it with a conduit.
- 5. Either circuit breakers or fuses are needed for overcurrent protection. Most structures being built have circuit breakers because they are easier to use. Discuss how circuit protectors are selected and sized.

How are circuit protectors selected and sized?

- a) Determining whether fuses or circuit breakers will be used is important.
- b) Other factors considered when selecting overcurrent devices are the wire size and amperage ratings, the electrical devices operated on the circuit, and the demand load of the circuit.
- c) Correctly sized circuit protection devices must be installed.
 - 1) Main disconnect breaker
 - (a) Determines the total electrical capacity of the SEP
 - (b) Rated at 30, 40, 50, 60, 70, 90, 100, 125, 175, and 200 amps, with larger breakers available for industry purposes
 - 2) Fuses and circuit breakers
 - (a) Begin at 15 amps and increase by 5-amp increments up to 50 amps.

- (b) Must have an amperage rating equal to or less than the rating for the conductor
- 6. Once the service wires have been connected into the SEP, the branch circuits can be connected. Describe the process of connecting 120-volt branch circuits. TM 8.3 can be used to illustrate the wiring.

How are the 120-volt branch circuits connected to the SEP?

- a) Planning the location of each circuit before beginning the installation is important.
 - b) Connect the neutral and ground circuit wires from the branch circuit to the neutral bar.
 - 1) Strip off enough insulation from the wires to make good contact with the neutral bar.
 - 2) Place each wire under a different screw on the neutral bar.
 - 3) Tighten the screws firmly.
 - c) Attach the hot wire.
 - 1) Strip off the insulation of the black wire.
 - 2) Insert the wire under the terminal screw of the circuit breaker, which should be screwed tight.
 - d) Insert the circuit breaker into the slot in the SEP panel.
7. Larger circuits that carry 240 volts use a double-pole circuit breaker for the connections at the SEP. Discuss how the circuits are connected, using TM 8.3 as an illustration. Hand out AS 8.1. To complete the activity sheet, contact a local electrician and obtain a SEP with breakers to use as a model. Wire the SEP as if it were actually in use. If possible, give the circuits sample labels, and ask students to identify their purpose.

How are the 240-volt individual circuits connected to the SEP?

- a) Connect the black circuit wire to one terminal screw of the double-pole breaker.
 - b) Connect the white circuit wire to the other terminal screw.
 - c) Attach the ground wire to the neutral bar.
8. Another type of power that can be supplied to agricultural structures is three-phase power, which is a form of alternating current. Describe three-phase power and its uses.

What is three-phase power, and when should its use be considered?

- a) Three-phase power
 - 1) Three-phase AC power utilizes three hot wires, each carrying electrical current at different stages of alternation.

- 2) Each wire peaks in amperage at a slightly different point in time.
- 3) By synchronizing the wave patterns of the three hot wires, a more consistent amperage is achieved.
- b) Uses
 - 1) Three-phase motors may be less expensive than single phase motors with the same horsepower.
 - 2) Three-phase power can also operate larger motors than standard single-phase power and will power those motors more efficiently.
- c) Limiting factors
 - 1) The cost of three-phase power is higher than that for single-phase power.
 - 2) The power company must install additional transformers.
 - 3) A more expensive meter is needed to monitor power usage.

F. ***Other Activities***

G. ***Conclusion***

The service entrance panel provides power to all the circuits in an agricultural structure. The SEP houses individual circuit protection in the form of overcurrent devices and provides a centralized location for power control for the entire electrical system.

H. ***Answers to Activity Sheet***

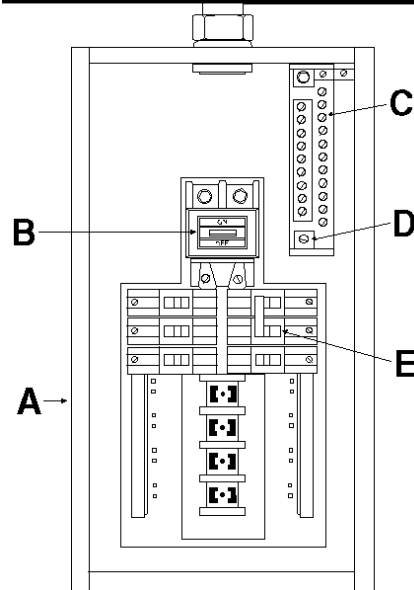
I. ***Answers to Evaluation***

- 1. c
- 2. a
- 3. d
- 4. e
- 5. b
- 6. 30 amps or less
- 7. In a location that will minimize physical damage
- 8. To remove any excess wire from the box
- 9. Three-phase motors may be less expensive than single phase motors with the same horsepower, and three-phase power can also operate larger motors and will power those motors more efficiently.
- 10. Answers will vary, but the wires should be drawn and labeled appropriately.

EVALUATION

Write the letter in the blank next to the _____ name of the SEP part pictured.

1. Main disconnect switch
2. Circuit breaker
3. Neutral bar
4. Grounding screw
5. Cabinet



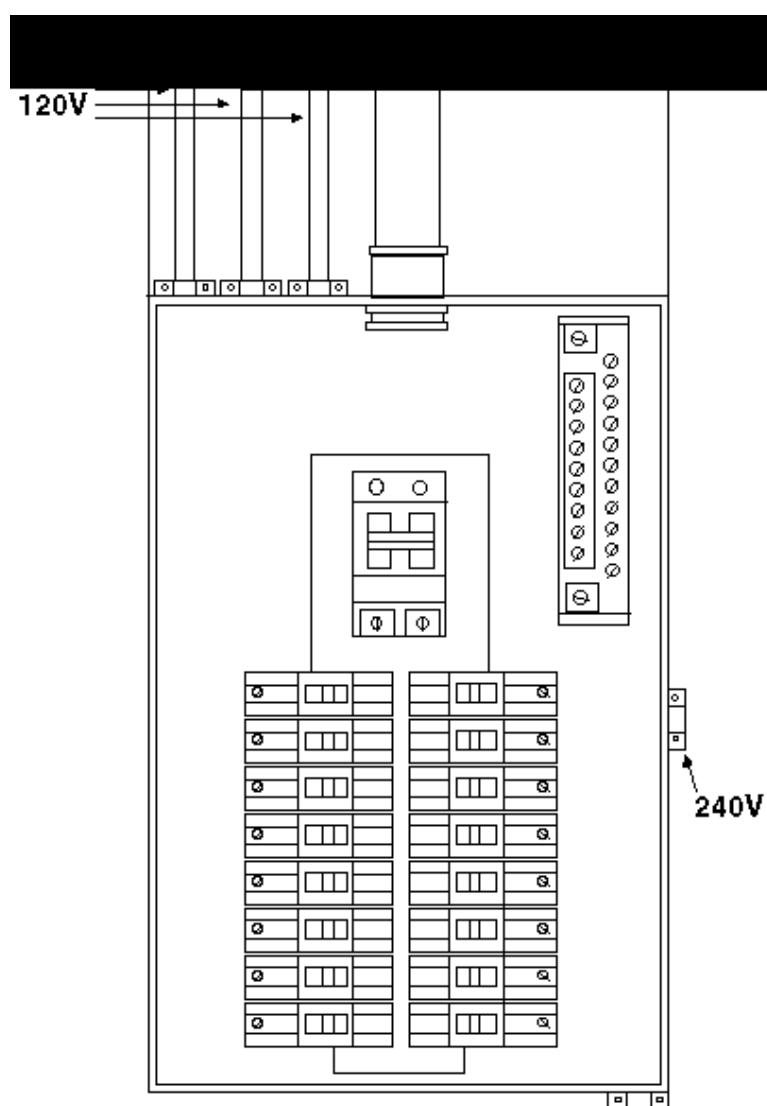
Complete the following short answer questions.

6. If AWG 12 wire with a rating of 30 amps is used for a circuit, what size circuit breaker should be used?
7. Where should the ground wire be installed?

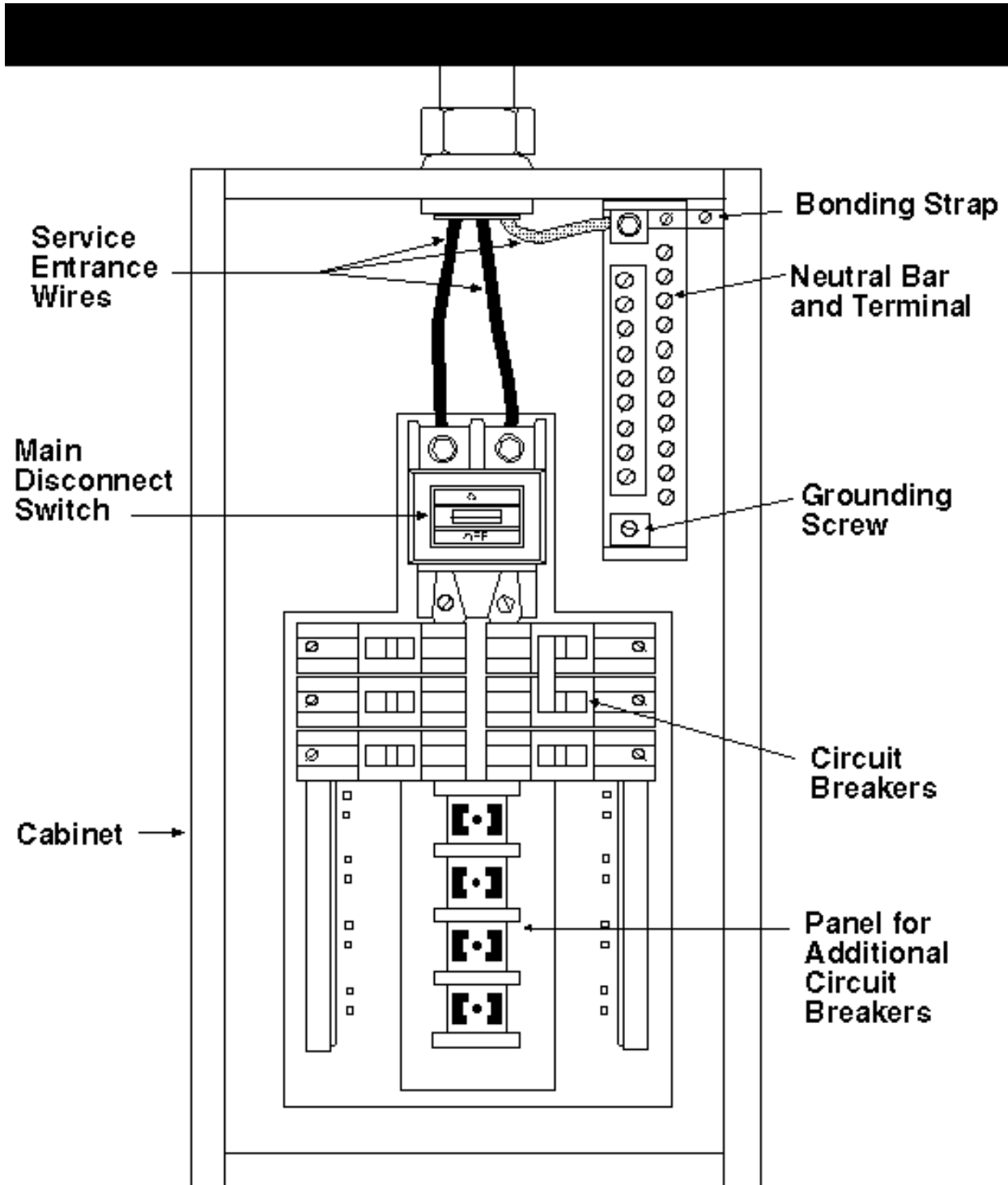
8. When wiring the SEP panel, why should wires be cut to the exact length necessary?
9. What are two reasons three-phase power might be used?
- a.
 - b.

On the diagram of the SEP, draw the wiring for the connections listed and label the conductors (hot, neutral, ground, etc.).

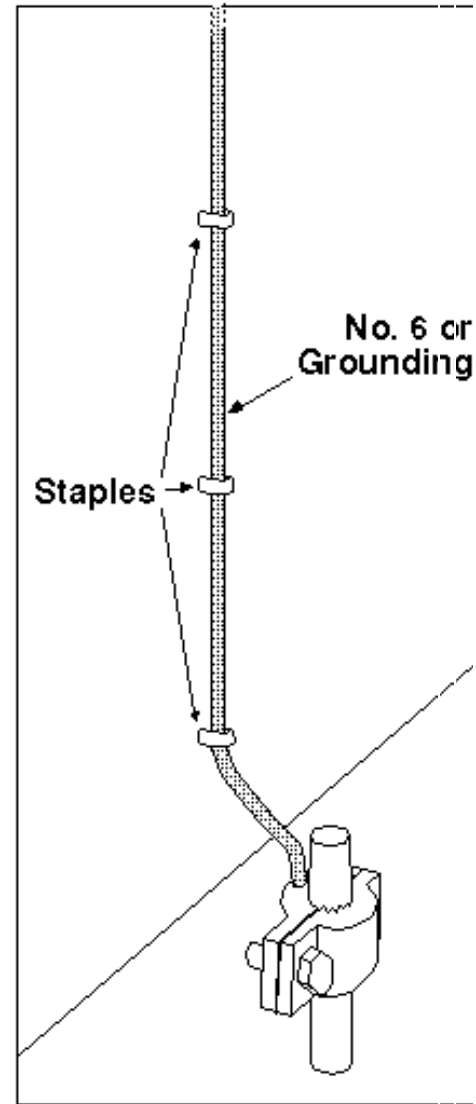
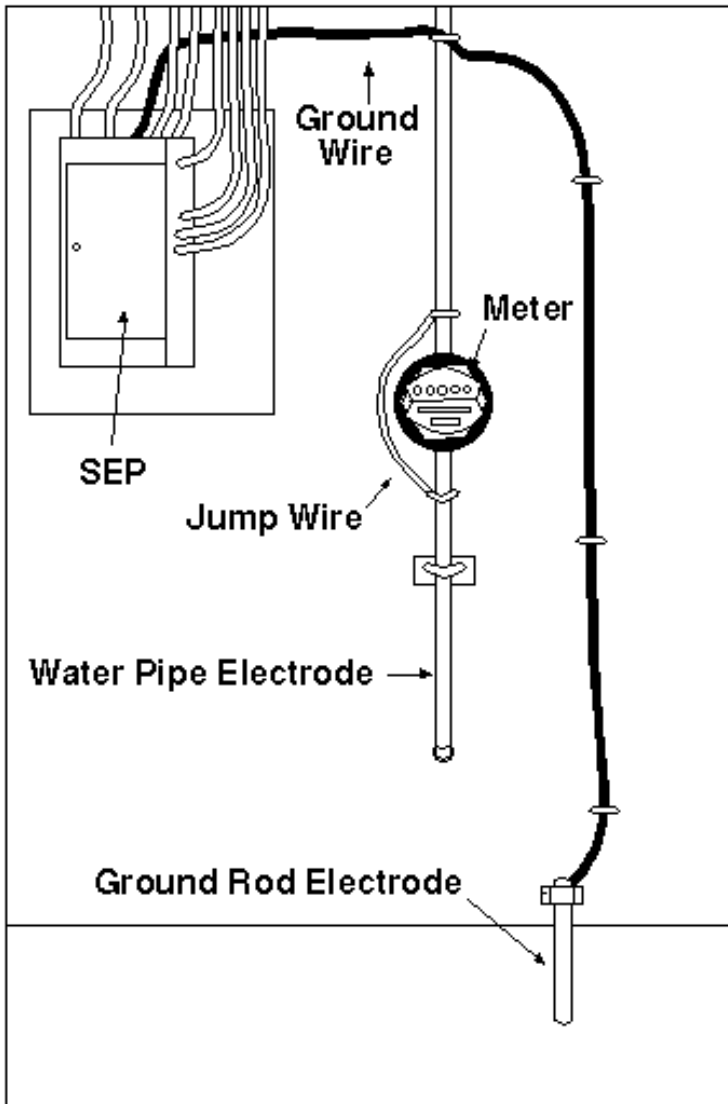
10. • Service entrance conductors
- 120-volt branch circuit
 - 240-volt branch circuit



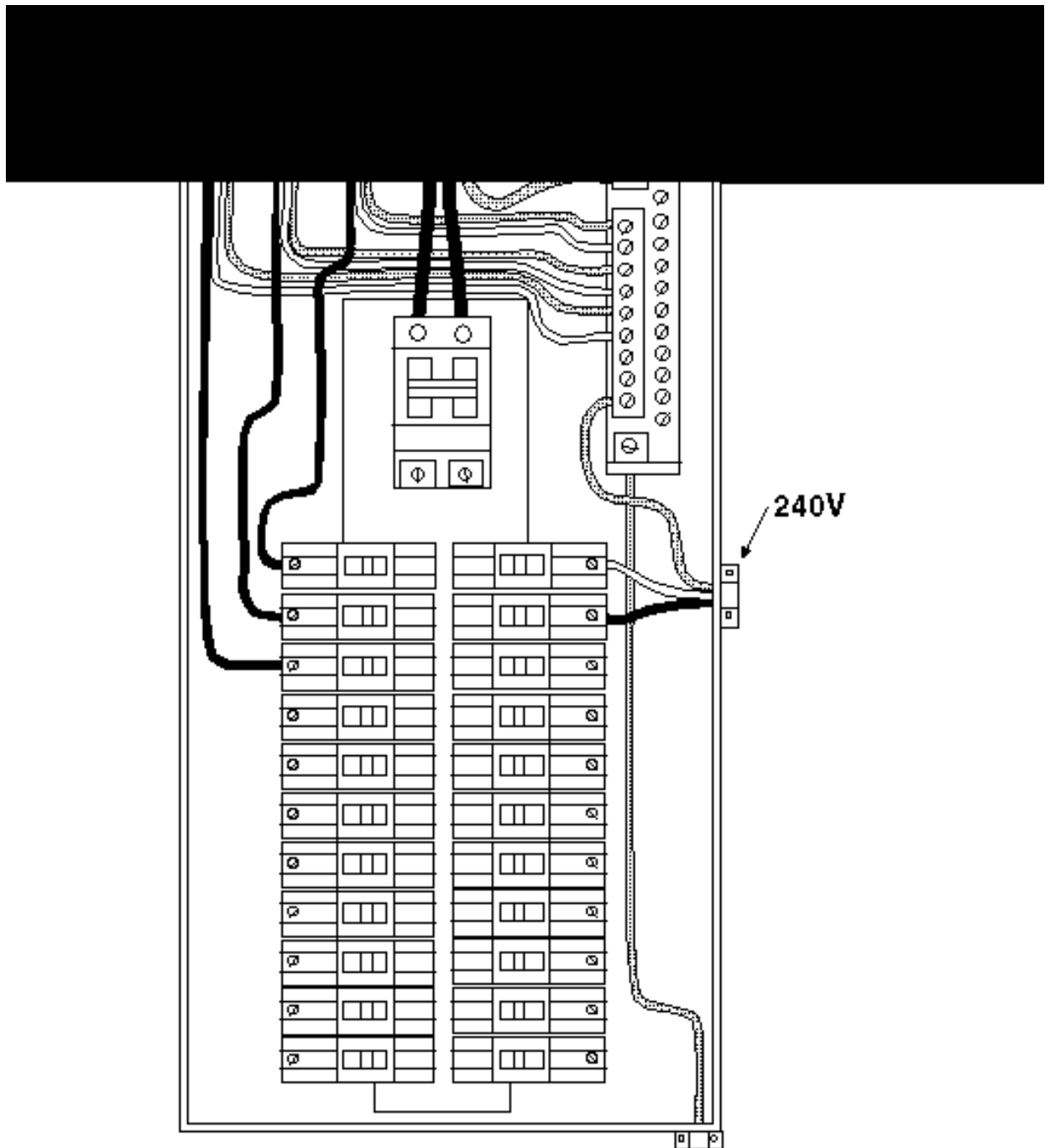
SEP Parts



Ground System



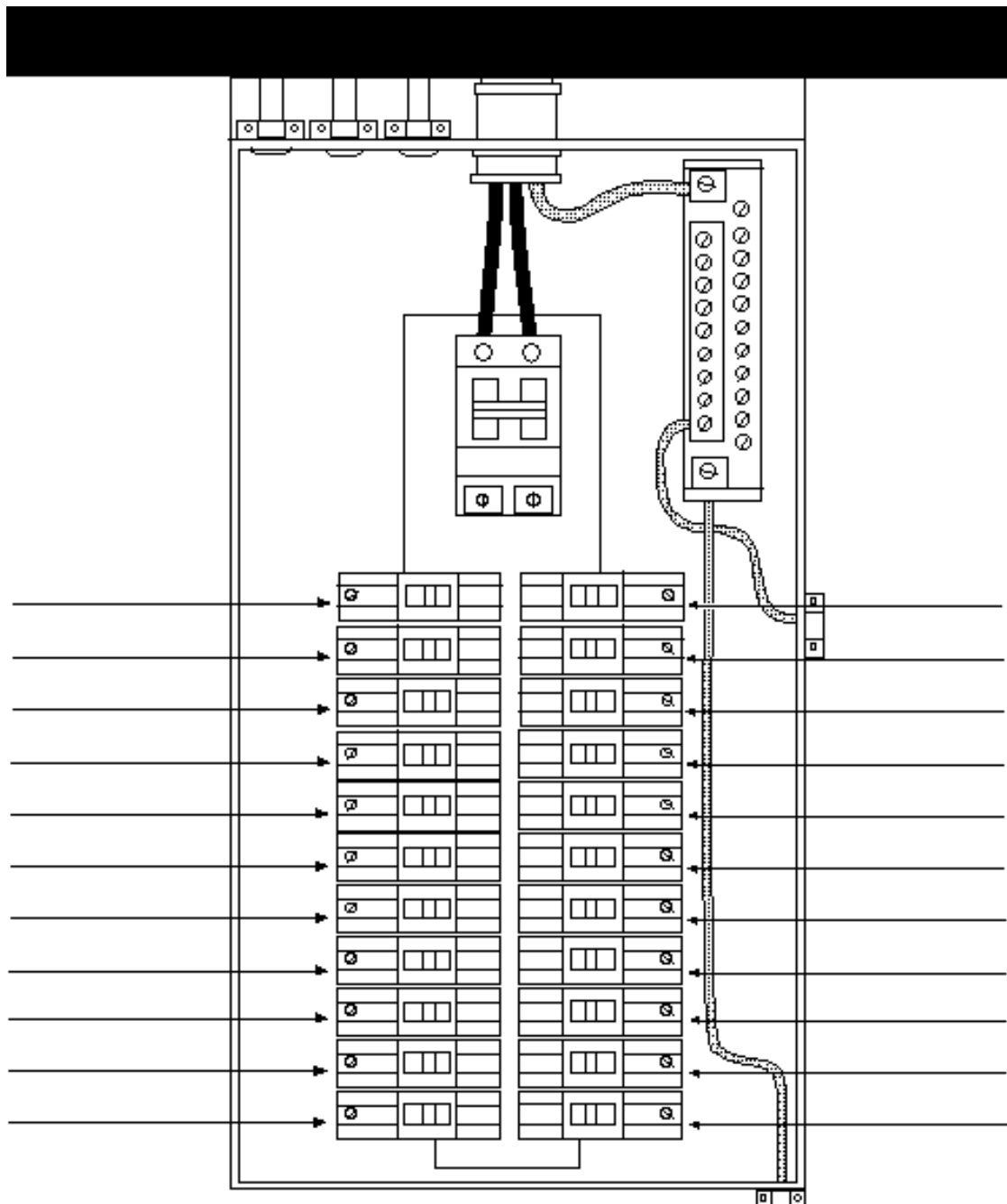
Wired 120/240 V Panel



Identifying SEP Components

Objective: Identify the components of a service entrance panel.

Using the model SEP provided by your instructor, label the wires and breakers installed within the panel. List the amperage ratings of each breaker and whether the circuit is 120 volts or 240 volts.



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