Lesson 8: Connecting to the SEP

Once the wiring is in place in an agricultural structure, the next step is connecting the circuits to the service entrance panel. The SEP is the main distribution point for electrical power in the structure. Within the SEP, individual branch circuits link to the incoming power source, thus providing electrical power to the entire system.

SEP Parts

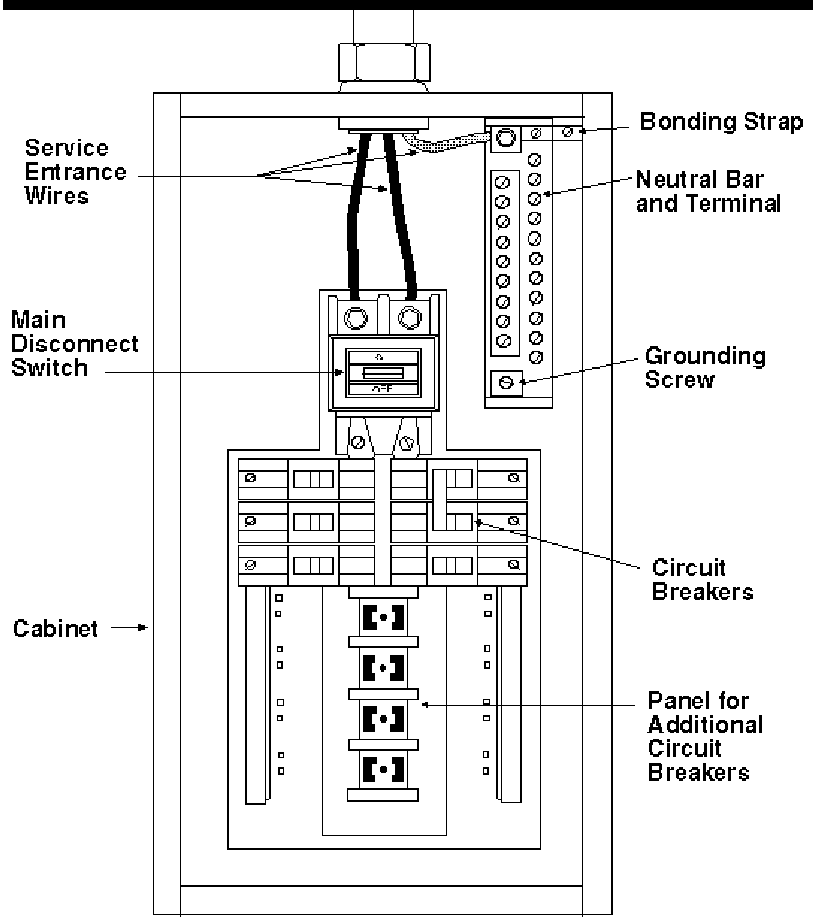
The parts of the SEP are housed within the service entrance cabinet, as shown in Figure 8.1. The main disconnect switch is a large amperage breaker used to disconnect the power coming into the structure from the individual circuits. This safety device can be shut off for electrical repairs or emergencies.

Also within the box is a panel with banks, or rows, of sockets designed to accept either circuit breakers or fuses. Generally, some of these sockets will remain open for expansion purposes. The circuit breakers or fuses provide overcurrent protection for the circuits.

Other components of the SEP ground the system. The neutral bar is a specialized bar with terminal screws placed in it to make connections between neutral wires and ground wires. The grounding screw is the point where the ground wire connects to the neutral bar to ground the SEP cabinet. The cabinet can also be grounded using a flexible bonding strap.

Good Wiring Practices

When making the connections in the SEP, following proper wiring procedures is important.



One of the biggest concerns involving the SEP is the buildup of heat and the overheating of wires within the panel. Several wiring procedures can reduce the likelihood of overheating. One way to reduce heat buildup is by wiring neatly and keeping wiring orderly within the cabinet. The SEP cabinet should not have excessive wire in it, so wire runs in the SEP should be kept as straight and direct as possible. Wires should not be bent during wiring, because the constriction of wires can cause insulation damage as well as overheating.

Other good practices should be followed as well. Tight connections without excessive bare wire showing should be made at the terminal screws. The neutral bar should be placed in a convenient location in the SEP box to make direct wire runs easier. Wires should be cut to the exact length necessary, removing any excess wire from the box.

Connecting Service Entrance Conductors to the SEP

Service entrance conductors must be connected properly in the SEP. Typically, for 120/240-volt systems, three wires enter the SEP in a bundle of wire. They include two 120-volt hot conductors and one neutral conductor. Two wires make up 120-volt systems, one hot wire and one neutral wire.

The most important thing to do before connecting any wires is to check to make sure that the power is shut off. When the power is off, the two hot conductors, which consist of two black wires or one black and one red wire, are connected to the main disconnect switch. The conductors should be cut to the proper length so no excessive wire is in the cabinet. Then enough insulation is stripped off to make a good connection. The bare ends of the wire are inserted into the connectors on the main disconnect, and the holding screws are tightened securely onto the wires. Using the same procedures, the neutral wire is attached to the neutral bar. The SEP cabinet is then grounded by attaching either the flexible bonding strap or the ground wire to the grounding screw.

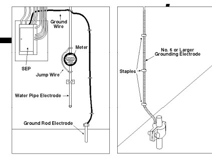
Installing the Ground System

Grounding involves connecting a ground wire from the neutral bar in the SEP to a grounding electrode or a ground system. The ground system, in which grounding electrodes are connected together, is the preferred method of grounding. A ground system is pictured in Figure 8.2.

Several different types of electrodes may make up ground systems. One alternative is a buried metal water pipe 10 feet or more in length, which must be supplemented by at least one other electrode. The grounded metal frame of the structure can also serve as an electrode. Another type of electrode consists of a concrete-enclosed electrode composed of either 20 or more feet of ½-inch reinforced steel or AWG 4 copper wire. The steel or wire is placed inside at least 2 inches of concrete located near the bottom of the foundation. It runs through the concrete into the ground, coming into direct contact with the earth. A buried AWG 2 or bigger wire that encircles the entire structure can also be a grounding electrode in a grounding system.

If none of these options for the ground system are available, a grounding electrode is used. Grounding electrodes can consist of underground metal piping or buried metal tanks, a ½-inch copper rod or _-inch metal or copper-clad rod, a ¾-inch galvanized steel pipe, or a buried metal plate at least 2 square feet in diameter.

The size of the ground wire is another important element of the ground system. The NEC has set the following guidelines for grounding conductors. If the service entrance conductor is AWG 2 or smaller, AWG 6 or 8 wire should be used for grounding. If the service entrance conductor is AWG 1 or 0, AWG 6 is the minimum size permitted for the ground wire. If the service entrance conductor is AWG 2/0 or 3/0, the ground wire should be a minimum of AWG 4. If wire larger than AWG 3/0 is used at the service entrance, AWG 2 must be used for the ground connection.



The ground wire must be installed properly. The wire is fastened to the surface over which it runs using special staples. The wire should be installed in a location that will minimize physical damage. Protection is typically provided by either tucking the ground wire behind the service conduit entering the structure or running the wire along wall studs. If AWG 8 or smaller wire is used for grounding, it must be protected with a conduit. However, larger wire sizes do not need this protection.

Selecting and Sizing Circuit Protection

As discussed in Lesson 2, the diameter of the conductors used in the wiring determines the maximum safe amperages. If more than the maximum amperage flows through the conductor, the temperature of the wire will increase. The heat can damage insulation and cause fires. To prevent this from happening, either fuses or circuit breakers are installed in the SEP in each branch circuit.

When planning the installation of the SEP, determining whether fuses or circuit breakers will be used is important. Most modern structures use circuit breakers because they are more convenient and easy to use. 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.

Correctly sized circuit protection devices must be installed. The main disconnect breaker determines the total electrical capacity of the SEP. These breakers are rated at 30, 40, 50, 60, 70, 90, 100, 125, 175, and 200 amps, with larger breakers available for industry purposes. The size of the service breaker will determine how much power is available; a 50-amp service breaker with 240 volts of power coming in will supply 12,000 (50×240) watts of power to the system.

Fuses and circuit breakers also have amperage ratings. Beginning at 15 amps, they increase by 5-amp increments up to 50 amps. Any overcurrent device used must have a amperage rating equal to or less than the rating for the conductor. For instance, an AWG 12 wire with an amperage of 20 amps would require an overcurrent device rated at 20 amps or less.

Connecting 120-Volt Branch Circuits to the SEP

Once the service wires have been connected to the SEP, the branch circuits and circuit breakers can be installed and connected. Planning the location of each circuit before beginning the installation is important. The first step in making the connections is to connect the neutral and ground circuit wires from the branch circuit to the neutral bar. These connections are made by stripping off enough insulation from the wires to make good contact with the neutral bar and then placing each wire under a different screw on the neutral bar, as shown in Figure 8.3. The screws should be tightened firmly. Next, the hot wire is attached by stripping off the insulation of the black wire and inserting the wire under the terminal screw of the circuit breaker, which should be screwed tight. Finally, the circuit breaker is inserted into the slot in the SEP board.

Connecting 240-Volt Individual Circuits to the SEP

Larger circuits that carry 240 volts utilize a special double-pole circuit breaker in the SEP. It has two connections because the circuit has two hot wires. To connect the wires, the black circuit wire is first connected to one terminal screw of the double-pole breaker. The white circuit wire is then connected to the other terminal screw. Finally, the ground wire is attached to the neutral bar. Figure 8.3 illustrates this type of circuit.

Three-Phase Power

Another type of power supplied to agricultural structures is three-phase power, a form of alternating current. Single-phase alternating current provides power in a wave-like pattern, with periods of high amperage and low amperage as the current changes the direction of flow. Three-phase AC power utilizes three hot wires, each carrying electrical current at different stages of alternation; each wire peaks in amperage at a slightly different point in time. By synchronizing the wave patterns of the three hot wires, a more consistent amperage is achieved.

Three-phase power may be useful in some situations. Three-phase motors may be less expensive than single phase motors with the same horsepower. Three-phase power can also operate larger motors than standard single-phase power and will power those motors more efficiently.

Some limiting factors affect the use of three-phase power. The cost of three-phase power is higher than that for single-phase power because of the additional hot wire required. The power company must install additional transformers, which are devices used by power companies to raise or lower the voltage of alternating current for use in the home or business. A more expensive meter is needed to monitor power usage.

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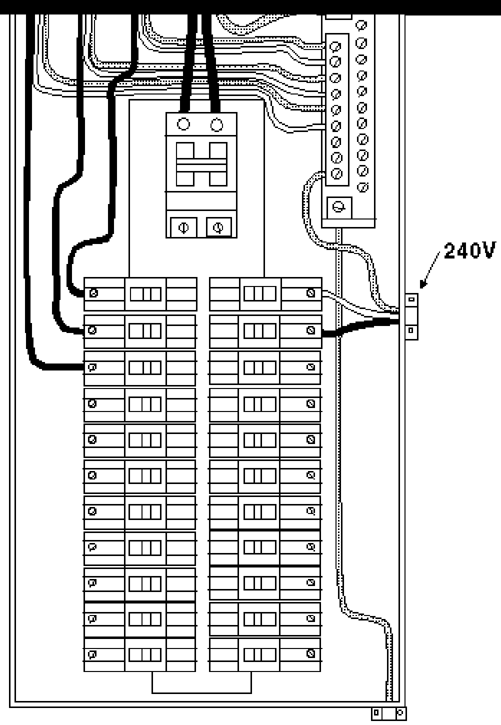

If three-phase power is desirable, it may be installed if it is not already available, or a phase converter may be used. A phase converter is a specialized device that allows a three-phase motor to operate using single-phase power. Phase converters can be very expensive, so an analysis of power needs should be conducted to determine if the investment is necessary.

Three-phase power is different from single-phase power in terms of wiring. Typically, the wire sizes are similar, but virtually all three-phase power circuits are hard wired, which means that three-phase outlets do not exist. Machines that require three-phase power do not have a plug at the end of a cable. Instead, the wires coming out of the machine are connected directly to the wires at the breaker box. This practice prevents single-phase machines from being plugged into three-phase outlets, which would burn out the motor.

Summary

The SEP is the point from which power is routed throughout an agricultural structure. A properly installed SEP is critical to providing an efficient electrical system for the structure. Wiring the service entrance conductors and the circuits properly is vital. The SEP should also be grounded correctly. The SEP houses individual circuit protection in the form of overcurrent devices, which should be carefully selected and installed to meet the needs of the structure. If three-phase power is to be used, it should also be installed with care.

Credits

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Richter, H.P., and W. C. Schwann. *Wiring Simplified*. 38th ed. Somerset, Wis.: Park Publishing, Inc., 1996.