

## UNIT V - ELECTRICITY

### Lesson 4: Grounding and GFCI Protection

**Competency/Objective:** Identify the importance of grounding and GFCI protection.

#### **Study Questions**

1. What is grounding, and why is it important?
2. What are the NEC requirements for grounding?
3. What are GFCIs?
4. What are the NEC requirements for GFCI use?
5. What are the types of GFCI units used in agriculture structures?

#### **References**

1. *Agricultural Structures (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1999, Unit V.
2. Transparency Masters
  - a) TM 4.1: A GFCI at Work
  - b) TM 4.2: Types of GFCIs
3. Activity Sheet
  - a) AS 4.1: Grounding and GFCIs



## UNIT V - ELECTRICITY

### Lesson 4: Grounding and GFCI Protection

#### TEACHING PROCEDURES

##### A. *Review*

The last lesson discussed the importance of properly selecting wire types and sizes for agricultural structures. This lesson, Lesson 4, focuses on the importance of grounding the electrical system. The grounding of a building's electrical system is a safety feature that helps to protect people and animals from receiving a shock by redirecting the electrical current. Ground fault circuit interrupters, or GCFIs, also provide a safety feature that helps protect against electrical shock.

##### B. *Motivation*

Ask students to think of electricity as a living entity that is continually searching for a means of completing its path. Electricity will always seek the path of least resistance to complete its circuit. What would happen if a person came in contact with a wire or piece of equipment that has a short? What can protect individuals from being shocked?

##### C. *Assignment*

##### D. *Supervised Study*

##### E. *Discussion*

1. Ask students to describe ways to prevent shock hazards, and list them on the board. How many are related to grounding? Ask students to define grounding. Why is it important?

#### **What is grounding, and why is it important?**

- a) Grounding
  - 1) Forms the connection between a piece of equipment or electrical appliance and the earth
  - 2) Provides electricity an alternate path back to its source
  - 3) Grounding point
    - (a) Typically established at or near the service entrance panel
    - (b) May consist of a metal rod driven into the ground that is connected directly to the service panel with a ground wire
    - (c) May also consist of a grounding wire attached to an established galvanized metal water pipe
  - 4) Connected to appliances and electrical equipment through a dedicated ground wire

- (a) Connected either to the equipment directly or to the electrical outlet receptacle
    - (b) Leads back to the ground connection at the service panel
  - b) Importance - prevention of electrical shock
    - 1) Provides a safety measure for channeling an electrical current that is out of the electrical circuit back to the earth at the source
    - 2) Directs the charge away from humans and livestock
- 2. The NEC has set forth guidelines related to correct procedures for safely installing a grounding system. Discuss NEC requirements for grounding.

### **What are the NEC requirements for grounding?**

- a) Three main purposes
    - 1) Grounding limits voltages in an electrical system due to lightning, line surges, or unintentional contact with higher voltage lines.
    - 2) It helps stabilize voltages within the system.
    - 3) It provides a path to facilitate the operation of overcurrent devices.
  - b) Regulations
    - 1) Proper grounding rods must be in place and connected to the electrical system prior to making the electrical connection to the power source.
    - 2) The ground rod conductor is to be connected at the point where the electrical service enters the service panel.
    - 3) All connections to the ground rod must be made at the service panel and the entrance point to the service panel, not on the individual circuits.
    - 4) The grounding electrode should be as near as practical to the service entrance.
- 3. Ask students whether a ground wire can provide all the protection needed for an electrical system. What would happen if the ground wire was faulty? Describe the uses of GFCIs. Show students TM 4.1 to illustrate how GFCIs work.

### **What are GFCIs?**

- a) GFCI (ground fault circuit interrupter) - device that interrupts the circuit to any electrical device when a fault current exceeds a predetermined level less than that required to operate the overcurrent protection device
- b) Primary function - to interrupt the flow of the current to prevent people and animals from being shocked
- c) Monitors the magnitude and time of electrical flow; interrupts abnormal electrical flows of 5/1000 amperes in 25/1000 of a second
- d) Work by sensing imbalances in electrical circuits caused by shorts or other faults
  - 1) When an imbalance occurs between the black “hot” wire and white “neutral” conductors, an uneven electrical load exists in the system.

- 2) A ground fault current is present and seeking a return conductor to the source.
  - 3) A person or animal coming in contact with the fault current can provide this path.
  - 4) The GFCI prevents shocks by stopping the electrical flow.
4. The NEC has developed a set of guidelines that apply to the installation and use of GFCIs. Discuss the requirements of the NEC.

#### **What are the NEC requirements for GFCI use?**

Required for all outlet receptacles or any devices permanently wired into the electrical system that are installed in the locations listed

- a) Bathrooms
  - b) Garages and grade level portions of unfinished accessory buildings used for storage and work areas
  - c) Outdoors
  - d) Crawl spaces, where the crawl space is at or below ground level
  - e) Unfinished basements and areas not intended as habitable rooms and limited to storage areas, work areas, and the like
  - f) Kitchens, where the receptacles are installed to serve counter top surfaces
  - g) Indoor or outdoor swimming pools
  - h) Hot tubs
  - i) Portable signs
  - j) Any location using temporary power
5. Ask students to describe any GFCIs they have seen. Describe the four types of GFCIs available for homes and farms. TM 4.2 illustrates the different types. Point out that the use of a particular type of GFCI will be determined by the conditions of the structure. Have students complete AS 4.1.

#### **What are the types of GFCI units used in agriculture structures?**

- a) Circuit breaker
  - 1) Fixed, permanently installed
  - 2) Substitutes for a standard circuit breaker
  - 3) Controls the outlets within an entire circuit
- b) Plug-in
  - 1) Designed for use in existing electrical systems that do not have GFCI devices
  - 2) Plugs into a regular receptacle
  - 3) Protects only those appliances plugged into it
- c) Portable
  - 1) Has an extension cord and is portable
  - 2) Plugs into standard outlets
  - 3) Generally used for construction and short term circuit protection needs

- d) Outlet-type
  - 1) Permanently mounted in an outlet box
  - 2) Protects all the items plugged into it
  - 3) Widely used in the construction of new buildings

F. ***Other Activities***

Have students identify various locations of GFCIs in the school. In class discuss their findings. Discuss the reasons for having GFCIs in those locations. Were there any locations where GFCIs should have been installed but were not?

G. ***Conclusion***

Grounding and GFCIs are an important safety feature for electrical systems in agricultural structures. Because they are so important, the NEC requires their use to help protect humans and livestock from shocks from faulty or damaged wiring. They also work to protect the electrical system from hazardous overloads.

H. ***Answers to Evaluation***

- 1. d
- 2. c
- 3. a
- 4. a
- 5. b
- 6. Ground fault circuit interrupter
- 7. It provides a safety measure for channeling an electrical current that is out of the electrical circuit back to the earth at the source, directing the charge away from humans and livestock.
- 8. Answers may include any one of the following: grounding limits voltages in an electrical system due to lightning, line surges, or unintentional contact with higher voltage lines; it helps stabilize voltages within the system; and it provides a path to facilitate the operation of overcurrent devices.
- 9. At the point where the electrical service enters the service panel
- 10. Answers may include any three of the following: bathrooms; garages and grade level portions of unfinished accessory buildings used for storage and work areas; outdoors; crawl spaces, where the crawl space is at or below ground level; unfinished basements and areas not intended as habitable rooms and limited to storage areas, work areas, and the like; kitchens, where the receptacles are installed to serve counter top surfaces; swimming pools; hot tubs; portable signs; and any location using temporary power.



## Lesson 4: Grounding and GFCI Protection

Date \_\_\_\_\_

## EVALUATION

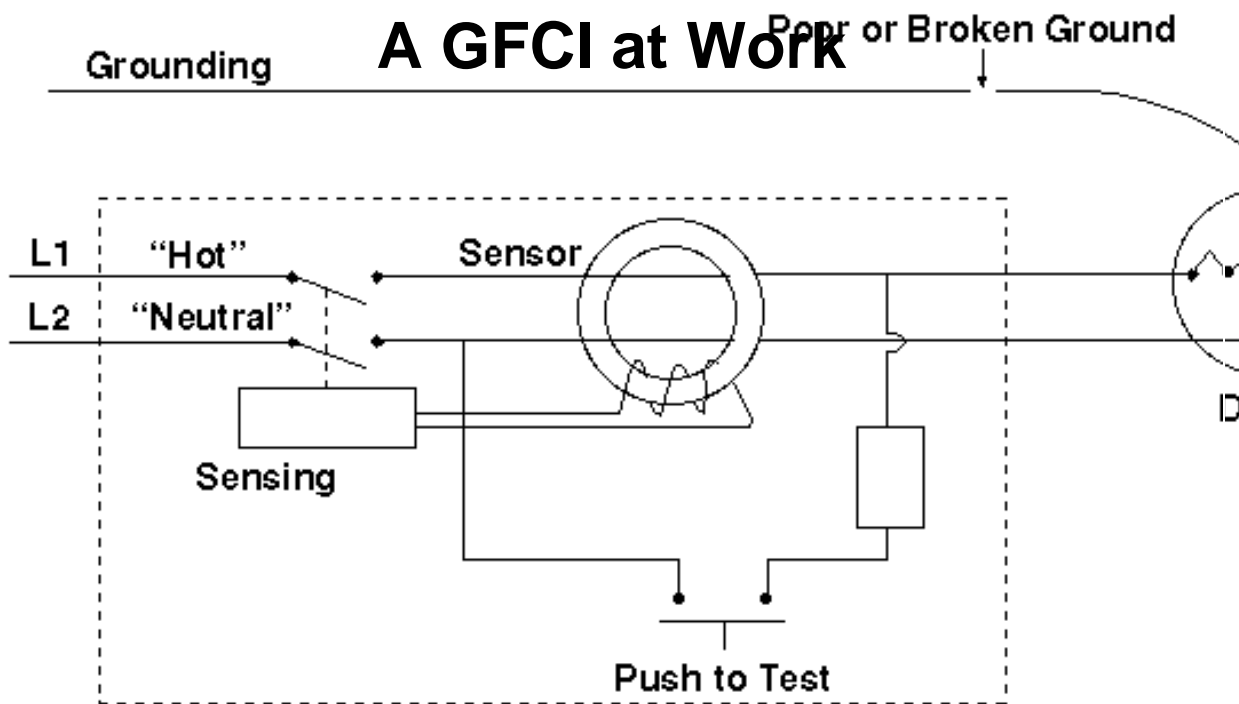
**Circle the letter that corresponds to the best answer.**

1. The outlet-type GFCI:
  - a. Controls the outlets within an entire circuit.
  - b. Has an extension cord.
  - c. Plugs into standard outlets.
  - d. Is permanently mounted in an outlet box.
2. The grounding electrode should be:
  - a. Close to all of the major appliances.
  - b. Connected to each of the individual circuits.
  - c. As near as practical to the service entrance.
  - d. Outside of the agricultural structure.
3. How does a GFCI work to prevent shocks?
  - a. By interrupting the flow of the current.
  - b. By serving as a path between electricity and its source.
  - c. By directing a charge into the ground.
  - d. By allowing electricity to escape out of the outlet.
4. The \_\_\_\_\_ ground fault has an extension cord attached to it.
  - a. Portable
  - b. Plug-in
  - c. Outlet-type
  - d. Circuit breaker
5. The \_\_\_\_\_ ground fault controls the outlets in an entire circuit.
  - a. Outlet-type
  - b. Circuit breaker
  - c. Plug-in
  - d. Portable

**Complete the following short answer questions.**

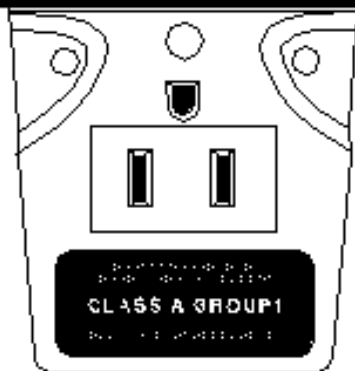
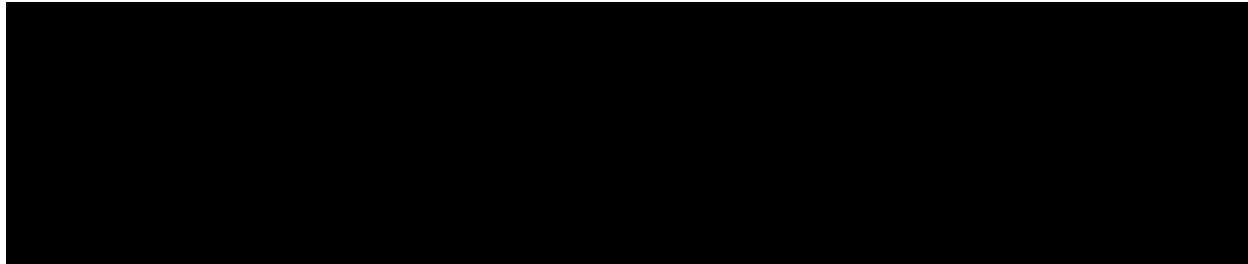


6. What does GFCI mean?
7. Why is grounding important in the prevention of electrical shock hazards?
8. What is one of the purposes of grounding, according to the NEC?
9. According to NEC regulations, where should the ground rod conductor be connected?
10. Where are three places the NEC requires that GFCIs be used?
  - a.
  - b.
  - c.

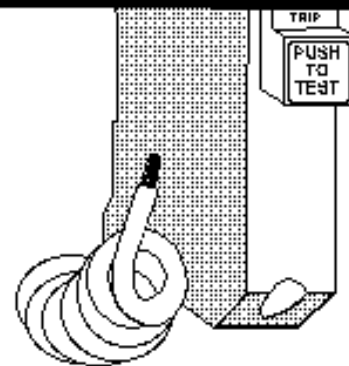




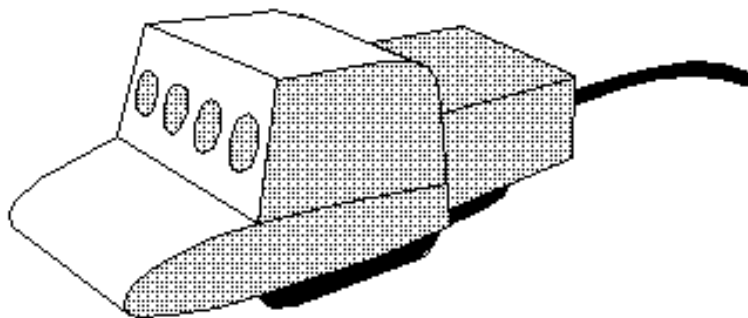
## Types of GFCIs



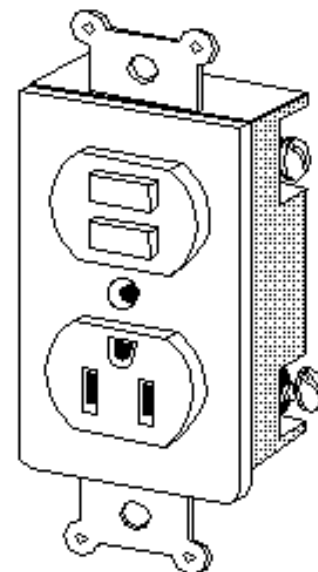
**Plug-In Ground Fault**



**Circuit Breaker Ground Fault**



**Portable Ground Fault**



**GFCI Outlet**



**Grounding and GFCIs**

**Objective:** Identify sources of electrical grounding and the location of GFCIs around the home and farm.

In the space below is a diagram of a simple machine shop. On the diagram, identify the ideal position for the electrical service panel (ESP), ground rods (GR), and installed GFCIs, using the abbreviations given.



