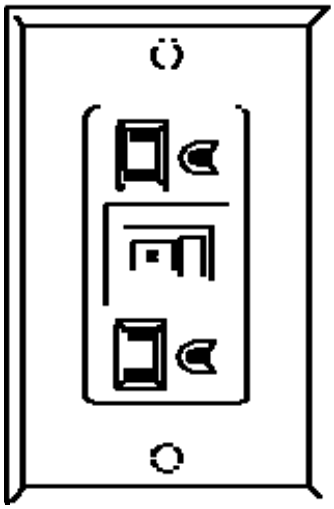
CompWest
WORKERS' COMPENSATION WITH CARE™

LOSS CONTROL GUIDE

Loss Control: Activities to Prevent Accidents or Reduce the Cost of Accidents in the Workplace

U.S. Department of Labor
Occupational Safety & Health Administration



GROUND-FAULT CIRCUIT-INTERRUPTERS

Introduction

In most cases, *insulation* and *grounding* are used to prevent injury from electrical wiring systems or equipment. However, there are instances when these recognized methods do not provide the degree of protection required. To help appreciate this, let's consider a few examples of where ground fault circuit interrupters would provide additional protection.

- Many portable hand tools, such as electric drills, are now manufactured with non-metallic cases. If approved, we refer to such tools as *double insulated*. Although this design method assists in reducing the risk from grounding deficiencies, a shock hazard can still exist. In many cases, persons must use such electrical equipment where there is considerable moisture or wetness. Although the person is *insulated* from the electrical wiring and components, there is still the possibility that water can enter the tool housing. Ordinary water is a conductor of electricity. Therefore, if the water contacts energized parts, a path will be provided from inside the housing to the outside, bypassing the *double insulation*. When a person holding a hand tool under these conditions touches another conductive surface in their work environment, an electric shock will result.

- Double-insulated equipment or equipment with non-metallic housings, that does not require grounding under the National Electrical Code, is frequently used around sinks or in situations where the equipment could be dropped into water. Frequently, the initial human response is to grab for the equipment. If a person's hand is placed in the water and another portion of their body is in contact with a conductive surface, a serious or deadly electric shock can occur.

- In construction work and regular factory maintenance work, it is frequently necessary to use extension cord sets with portable equipment. These cords are regularly exposed to physical damage. Although safe work procedures require adequate protection, it is not possible to prevent all damage. Frequently, the damage is only to the insulation, exposing energized conductors. It is not unusual for a person to handle the cord often with the possibility of contacting the exposed wires while holding a metal case tool or while in contact with other conductive surfaces. The amount of current which flows under such conditions will be enough to cause serious human response. This can result in falls or other physical injury and in many cases death.

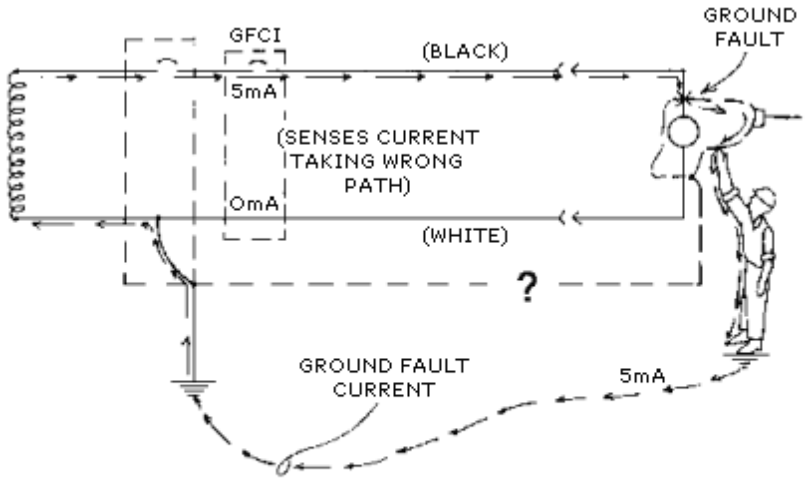
Since neither *insulation* (double insulation) nor *grounding* can provide protection under these conditions, it is necessary to use other protective measures. One acceptable method is a ground fault circuit interrupter, commonly referred to as a GFCI.

How Ground-Fault Circuit-Interrupters Work

A ground-fault circuit-interrupter is *not* an over-current device like a fuse or circuit breaker. GFCI's are designed to sense an imbalance in current flow over the normal path.

The GFCI contains a special sensor that monitors the strength of the magnetic field around each wire in the circuit when current is flowing. The magnetic field around a wire is directly proportional to the amount of current flow, thus the circuitry can accurately translate the magnetic information into current flow.

If the current flowing in the *black (ungrounded) wire* is within 5 (plus or minus 1) milliamperes (mA) of the current flowing in the *white (grounded) wire* at any given instant, the circuitry considers the situation normal. All the current is flowing in the normal path. If, however, the current flow in the two wires differs by more than 5 mA, the GFCI will quickly open the circuit. This is illustrated in the figure below.



HOW THE GFCI PROTECTS PEOPLE

(BY OPENING THE CIRCUIT WHEN CURRENT FLOWS THROUGH A GROUND-FAULT PATH)

Note that the GFCI will open the circuit if 5 mA or more of current returns to the service entrance by any path other than the intended white (grounded) conductor. If the equipment grounding conductor is properly installed and maintained, this will happen *as soon as the faulty tool is plugged in.* If by chance this grounding conductor is not intact and of low-impedance, the GFCI may not trip out *until a person provides a path.* In this case, the person will receive a shock, but the GFCI should trip out so quickly that the shock will not be harmful.

Types of Ground-Fault Circuit-Interrupters

There are several types of GFCI's available, with some variations to each type. Although all types will provide ground-fault protection, the specific application may dictate one type over another.

- **Circuit-Breaker Type**
  The circuit-breaker type includes the functions of a standard circuit breaker with the additional

functions of a GFCI. It is installed in a panel board and can protect an entire branch circuit with multiple outlets. It is a direct replacement for a standard circuit breaker of the same rating.

- **Receptacle Type**
  The receptacle style GFCI incorporates within one device one or more receptacle outlets, protected by the GFCI. Such devices are becoming very popular because of their low cost. Most are of the duplex receptacle configuration and can provide GFCI protection for additional non-GFCI type receptacles connected "down stream" from the GFCI unit.

- **Permanently Mounted Type**
  The permanently mounted types are mounted in an enclosure and designed to be permanently wired to the supply. Frequently they are used around large commercial swimming pools or similar wet locations.

- **Portable Type**
  Several styles of portable GFCI's are available. The portable types are designed to be easily transported from one location to another. They usually contain one or more integral receptacle outlets protected by the GFCI module. Some models are designed to plug into existing non-GFCI protected outlets, or in some cases, are connected with a cord and plug arrangement. The portable type also incorporate a no-voltage release device which will disconnect power to the outlets if any supply conductor is open. Units approved for use outdoors will be in enclosures suitable for the environment. If exposed to rain, they must be listed as rainproof.

- **Cord Connected Type**
  The power supply cord type GFCI consists of an attachment plug which incorporates the GFCI module. It provides protection for the cord and any equipment attached to the cord. The attachment plug has a non-standard appearance and is equipped with test and reset buttons. Like the portable type, it incorporates a no-voltage release device which will disconnect power to the load if any supply conductor is open.

Classes of Ground-Fault Circuit-Interrupters

Ground-Fault Circuit-Interrupters are divided into two classes: Class A and Class B. The Class A device is designed to trip when current flow, in other than the normal path, is 6 milliamperes or greater. The specification is 5 milliamperes ± 1 milliampere. The Class B device will trip when current flow, in other than the normal path, is 20 milliamperes or greater. Class B devices are approved for use on underwater swimming pool lighting installed prior to the adoption of the 1965 National Electrical Code.

Testing Ground-Fault Circuit-Interrupters

Due to the complexity of a GFCI, it is necessary to test the device on a regular basis. For permanently wired devices, a monthly test is recommended. Portable type GFCI's should be tested each time before use. GFCI's have a built-in test circuit which imposes an artificial ground fault on the load circuit to assure that the ground-fault protection is still functioning. Test and reset buttons are provided for testing.

http://www.osha.gov/SLTC/smallbusiness/sec14.html