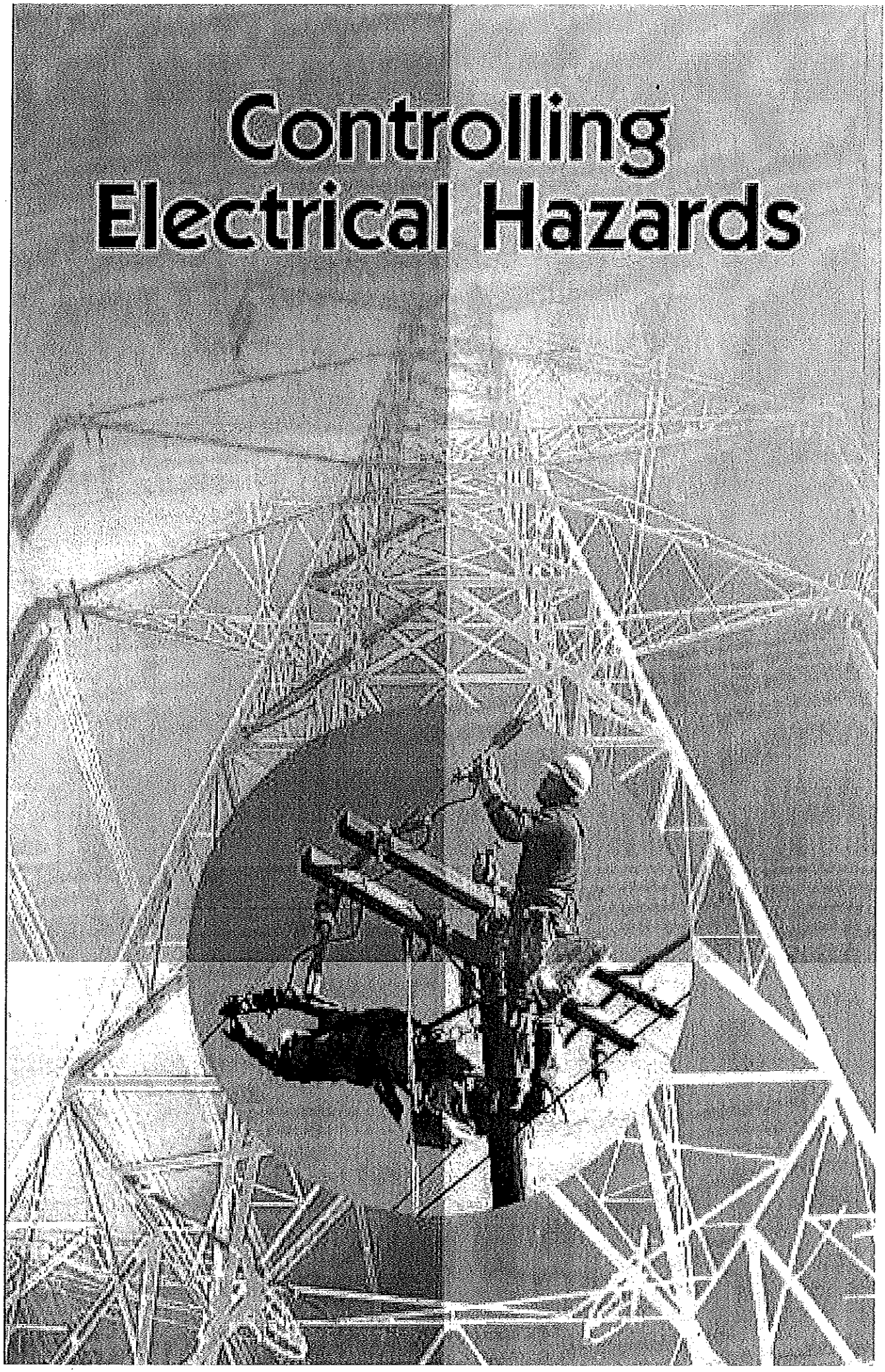
Controlling Electrical Hazards



ELECTRICAL

INTRODUCTION

Electricity has become an essential of modern life, both at home and on the job. Some employees work with electricity directly, as is the case with engineers, electricians, or people who do wiring, such as overhead lines, cable harnesses, or circuit assemblies. Others, such as office workers and salespeople, work with it indirectly. As a source of power, electricity is accepted without much thought to the hazards encountered. Perhaps because it has become such a familiar part of our surroundings, it often is not treated with the respect it deserves.

OSHA's electrical standards address the government's concern that electricity has long been recognized as a serious workplace hazard, exposing employees to such dangers as electric shock, electrocution, fires and explosions. The objective of the standards is to minimize such potential hazards by specifying *design* characteristics of safety in use of electrical equipment and systems.

OSHA's electrical standards were carefully developed to cover only those parts of any electrical system that an employee would normally use or contact. The exposed and/or operating elements of an electrical installation - lighting equipment, motors, machines, appliances, switches, controls, enclosures, etc. - must be so constructed and installed as to minimize electrical dangers to people in any workplace.

The OSHA electrical standards were based on the National Fire Protection Association's standard NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*, and the NFPA 70 Committee derived Part I of their document from the 1978 edition of the *National Electrical Code* (NEC). The standards extracted from the NEC were those considered to most directly apply to employee safety and least likely to change with each new edition of the NEC. OSHA's electrical standards are performance oriented; therefore they contain few direct references to the NEC. However, the NEC contains specific information as to how the required performance can be obtained.

This discussion does not cover OSHA's Electrical Safety-Related Work Practices Standard, which contains requirements for working on or near energized and de-energized electrical equipment, the use of personal protective equipment, and the safe use of electrical equipment.

This discussion covers requirements in OSHA's Design Safety Standards for Electrical Systems that are frequently overlooked and may present serious hazards. The reader is encouraged to consult the complete text of OSHA's electrical standards for all of OSHA's requirements.

EXAMINATION, INSTALLATION AND USE OF EQUIPMENT

Examination

Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees[1]. Safety of equipment shall be determined using the following considerations:

- Suitability for installation and use in conformity with the provisions of this subpart. Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.
- Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.
- Electrical insulation.
- Heating effects under conditions of use.
- Arcing effects.
- Classification by type, size, voltage, current capacity, and specific use.
- Other factors which contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.

Installation and Use

Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.

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[1] Note that this requirement is, in effect, an electrical "general duty clause" similar to Section 5(a)(1) of the OSH Act: "each employer shall furnish . . . a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

IDENTIFICATION OF DISCONNECTING MEANS AND CIRCUITS

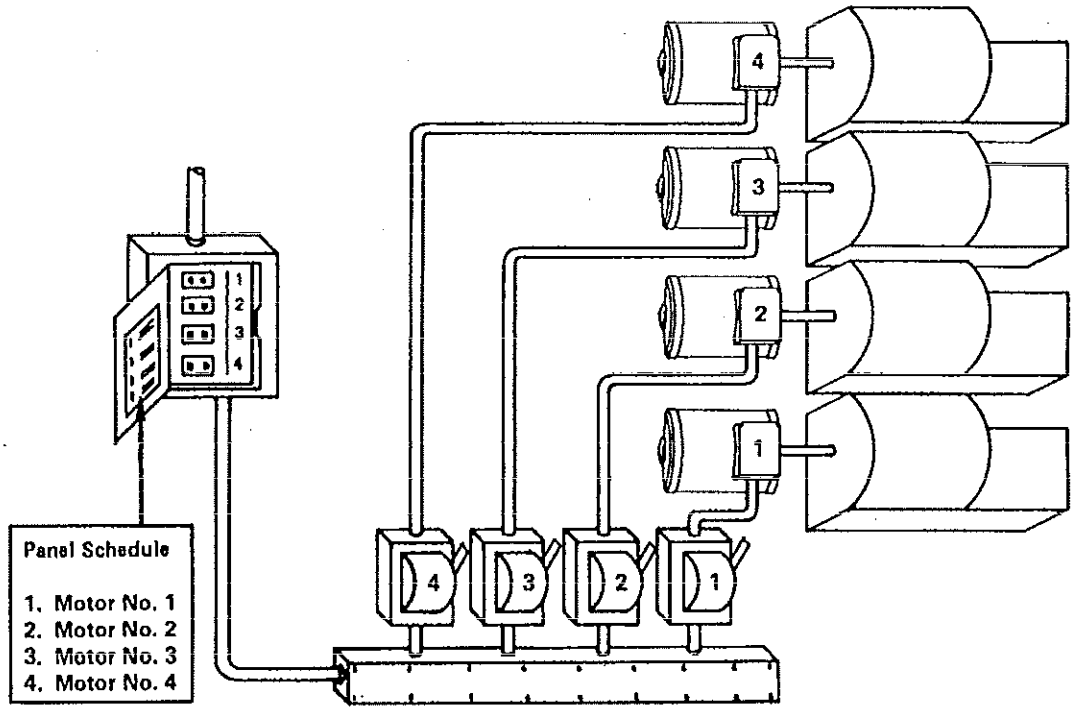
Each disconnecting means required by this subpart for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. These markings shall be of sufficient durability to withstand the environment involved.

A disconnecting means is a switch that is used to disconnect the conductors of a circuit from the source of electric current. Disconnect switches are important because they enable a circuit to be opened, stopping the flow of electricity, and thus can effectively protect workers and equipment.

Each disconnect switch or overcurrent device required for a service, feeder, or branch circuit must be clearly labeled to indicate the circuit's function, and the label or marking should be located at the point where the circuit originates. For example, on a panel that controls several motors or on a motor control center, each disconnect must be clearly marked to indicate the motor to which each circuit is connected. In the figure below, the Number 2 circuit breaker in the panel box supplies current only to disconnect Number 2, which in turn controls the current to motor Number 2. This current to motor Number 2 can be shut off by the Number 2 circuit breaker or the Number 2 disconnect.

If the purpose of the circuit is obvious, no identification of the disconnect is required.

All labels and markings must be durable enough to withstand weather, chemicals, heat, corrosion, or any other environment to which they may be exposed.



Motor No. 1 is Controlled by Disconnect No. 1 and Circuit Breaker No. 1

NOTE: As shown in diagram, the purposes of these disconnecting switches are clearly evident. In such cases identification may be omitted. In the actual installation however, the motors may not be within sight of the disconnects or arranged in such a way that the purpose is not evident and identification would be required.

Each Disconnect and Circuit Requires Identification

WORKING SPACE ABOUT ELECTRIC EQUIPMENT

Note that this particular section is concerned with the safety of a *person qualified to work on the equipment* (presumably an electrician). Obviously, the hazard must be treated in a different way if the person will remove guards and enclosures and actually work on the live parts. Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

Clear Spaces

Working space required by this subpart may not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.

GUARDING OF LIVE PARTS

It should be noted that the purpose of this requirement is to protect *any person* who may be in the vicinity of electrical equipment against accidental contact. These people are presumably not electricians working on the equipment, and are not qualified or trained to be in close proximity to live parts.

Except as required or permitted elsewhere in this subpart, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- By suitable permanent, substantial partitions or screens so arranged,that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them. It is good practice to use covers, screens or partitions which can only be removed by use of tools, so that unqualified persons are less likely to violate them.
- By location on a suitable balcony, gallery, or platform.
- By elevation of 8 feet or more above the floor or other working surface. Note that, although equipment elevated at least 8 feet is considered to be guarded, this may not be adequate if material being handled is likely to make contact with live parts.

In locations where electric equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

You should be constantly aware of hazards in your workplace. New work or changes may create a new hazard, or poor maintenance may allow reappearance of old ones.

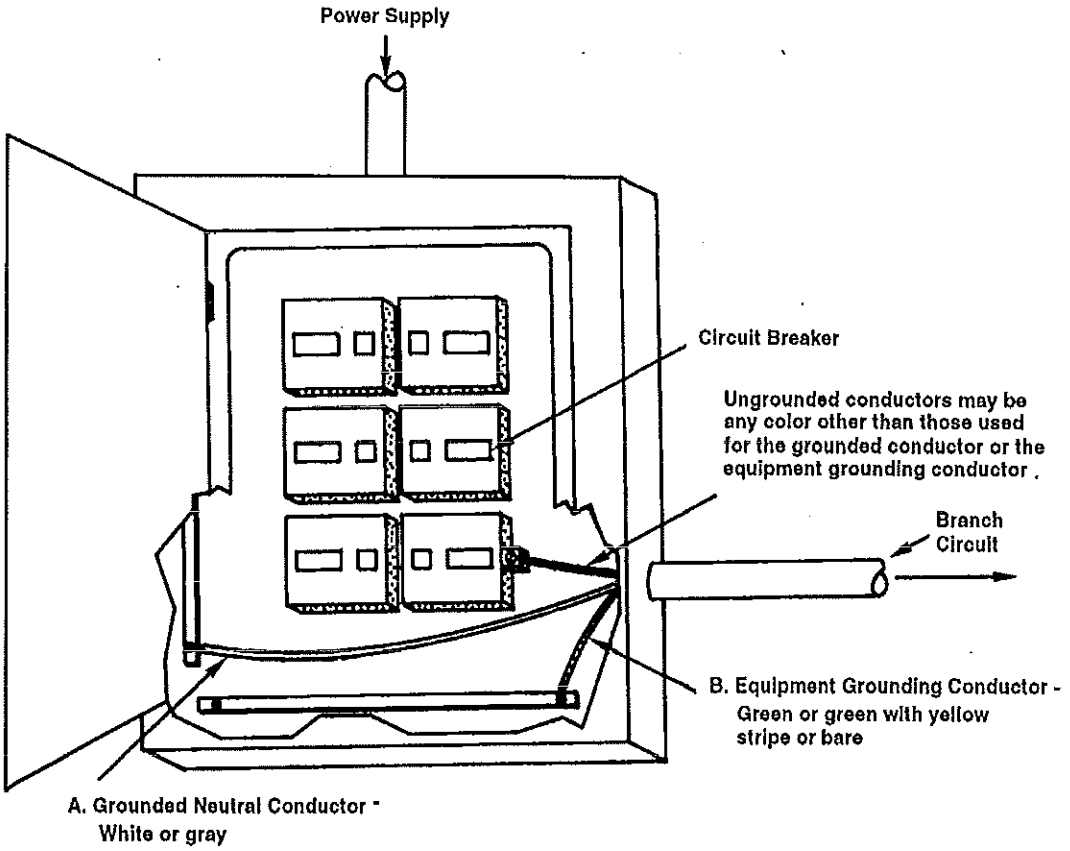
IDENTIFICATION OF CONDUCTORS

A conductor used as a grounded conductor shall be identifiable and distinguishable from all other conductors. A conductor used as an equipment grounding conductor shall be identifiable and distinguishable from all other conductors.

The grounded conductor is an energized circuit conductor that is connected to earth through the system ground. It is commonly referred to as the *neutral*. The equipment grounding conductor is not an energized conductor under normal conditions. The equipment grounding conductor acts as a safeguard against insulation failure or faults in the other circuit conductors. The equipment grounding conductor is energized *only* if there is a leak or fault in the normal current path, and it directs this current back to the source. Directing the fault current back to the source enables protective devices, such as circuit breakers or fuses, to operate thus preventing fires and reducing the hazard of electrical shocks.

The grounded and equipment grounding conductors of an electrical circuit must be marked or color coded in a way that allows employees to identify them and tell them apart from each other and from the other conductors in the circuit.

The figure below illustrates a distribution panelboard. One means by which each conductor's use is identified and made distinguishable from the other circuit conductors is the use of color coding. Acceptable color coding includes the method required by the *National Electrical Code*, Section 210-5. The Code states: "The grounded conductor of a branch circuit shall be identified by a continuous white or natural gray color." Also, "The equipment grounding conductor of a branch circuit shall be identified by a continuous green color or a continuous green color with one or more yellow stripes unless it is bare." Bare copper or aluminum wire is permitted for use as a grounding conductor.



A. The grounded conductor is identified and distinguished from other conductors by using white or gray color-coded insulated wires.

B. The equipment grounding conductor is identified and distinguished from other conductors by using green, or green with yellow stripe, color coding on wires, or run as a bare conductor.

Distribution Panelboard

POLARITY OF CONNECTIONS

No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.

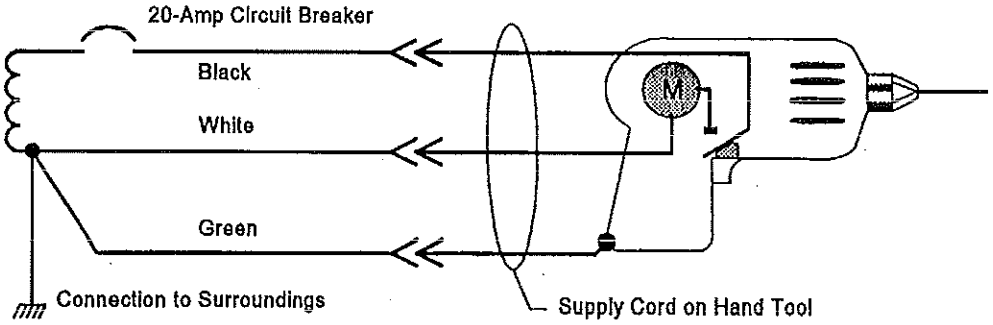
A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug may not be used for purposes other than grounding.

The above two subparagraphs dealing with polarity of connections and use of grounding terminals and devices address one potentially dangerous aspect of alternating current: many pieces of equipment will operate properly even though the supply wires are not connected in the order designated by design or the manufacturer. Improper connection of these conductors is most prevalent on the smaller branch circuit typically associated with standard 120 volt receptacle outlets, lighting fixtures and cord- and plug-connected equipment.

When plugs, receptacles, and connectors are used in an electrical branch circuit, correct polarity between the ungrounded (hot) conductor, the grounded (neutral) conductor, and the grounding conductor must be maintained.

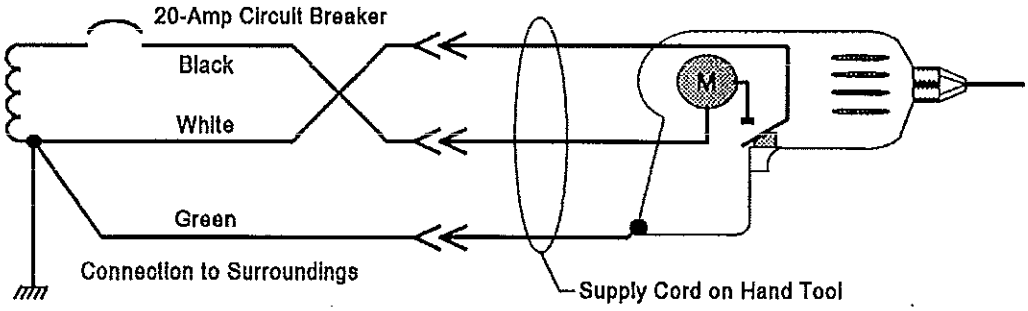
Reversed polarity is a condition when the identified circuit conductor (the grounded conductor or neutral) is incorrectly connected to the ungrounded or "hot" terminal of a plug, receptacle, or other type of connector.

The figure below shows the correct wiring for the common 120-volt outlet with a portable hand tool attached.



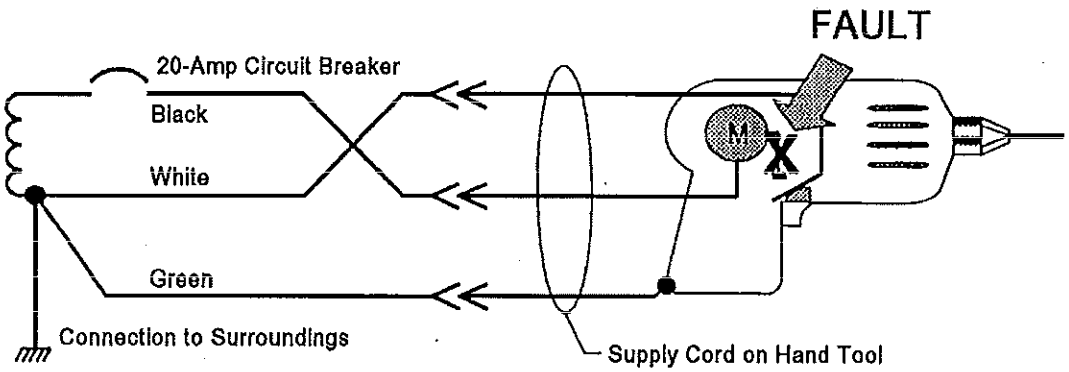
Typical 120 Volt Branch Circuit with Correct Wiring

Suppose now that the black (ungrounded) and white (grounded) conductors are reversed as shown in the figure below. This is the traditional *reversed polarity*. Although a shock hazard may not exist, there are other mechanical hazards that can occur.



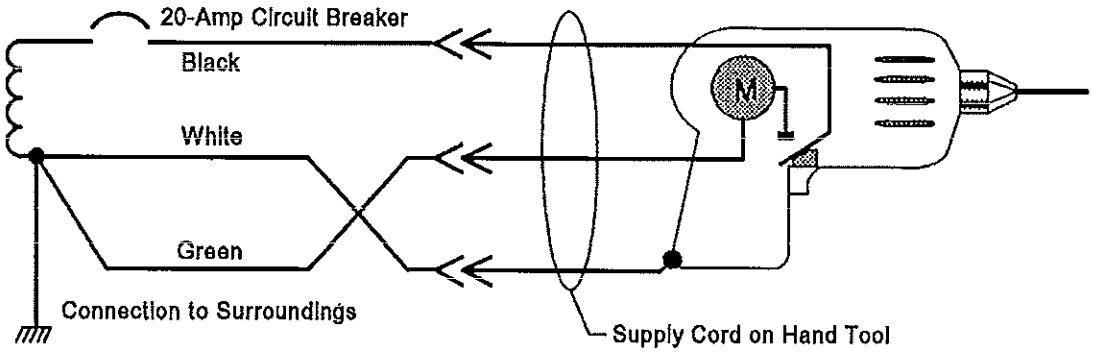
120 Volt Branch Circuit with Black and White Wires Reversed

For example, if an internal fault should occur in the wiring as shown in the figure below, the equipment would not stop when the switch is released or would start as soon as a person plugs the supply cord into the improperly wired outlet. This could result in serious injury.



120 Volt Branch Circuit with Black and White Wires Reversed
Internal Fault in Equipment Wiring

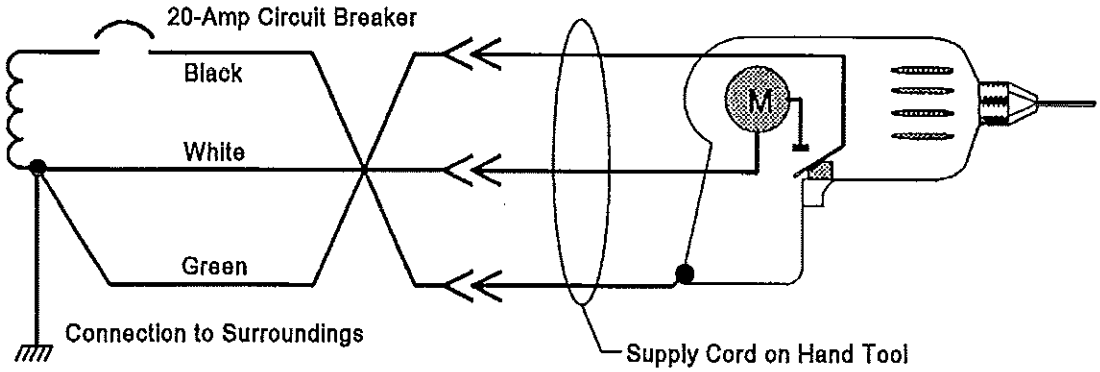
The figure below shows the white (grounded) and green (grounding) conductors reversed. Although it is not fitting, considering OSHA or code terminology, to call this *reversed polarity*, a hazard can still exist. In this case, due to the wiring error, the white wire is being used to provide equipment grounding. Under certain conditions, this could be dangerous.



White and Green Wires Reversed

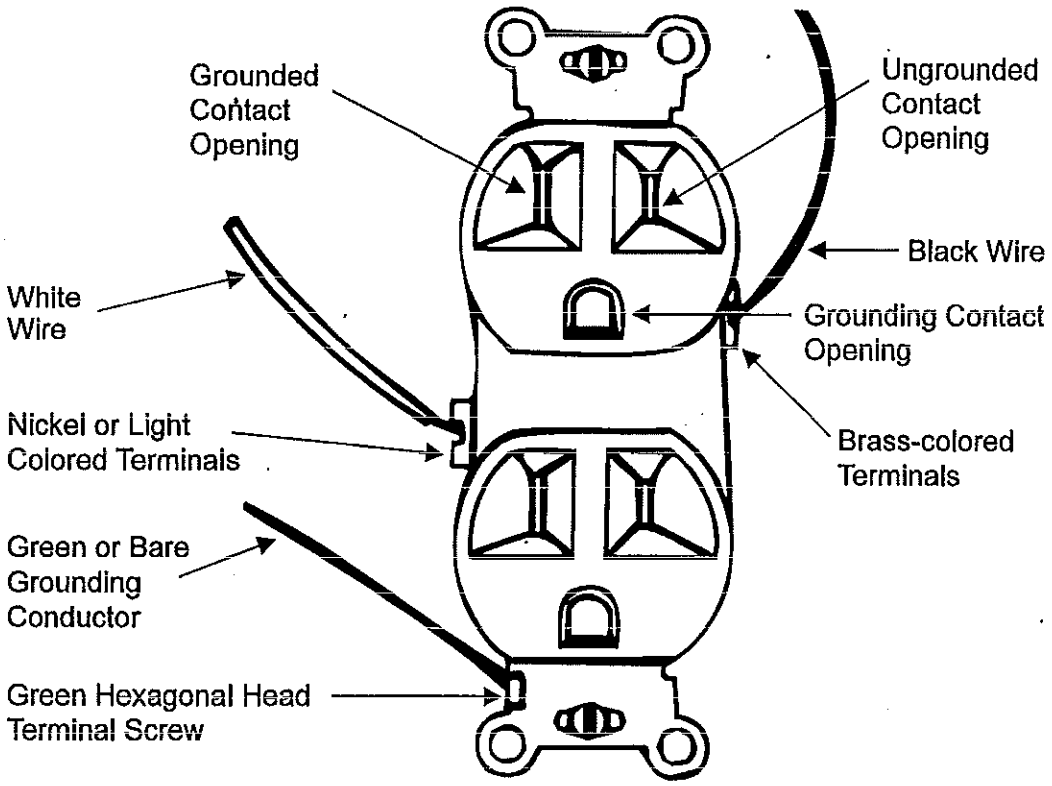
The figure below shows an *extremely* dangerous situation. In this example, the black (ungrounded) and green (grounding) conductors have been reversed. The metal case of the equipment is at 120 volts with reference to the surroundings. As soon as a person picks up the equipment and touches a conductive surface in their surrounding, they will receive a serious, or even deadly, shock.

Although the equipment will not work with this wiring error, it would not be unusual for a person to pick up the equipment before realizing this. The person may even attempt to troubleshoot the problem before unplugging the power cord.



Black and Green Wires Reversed

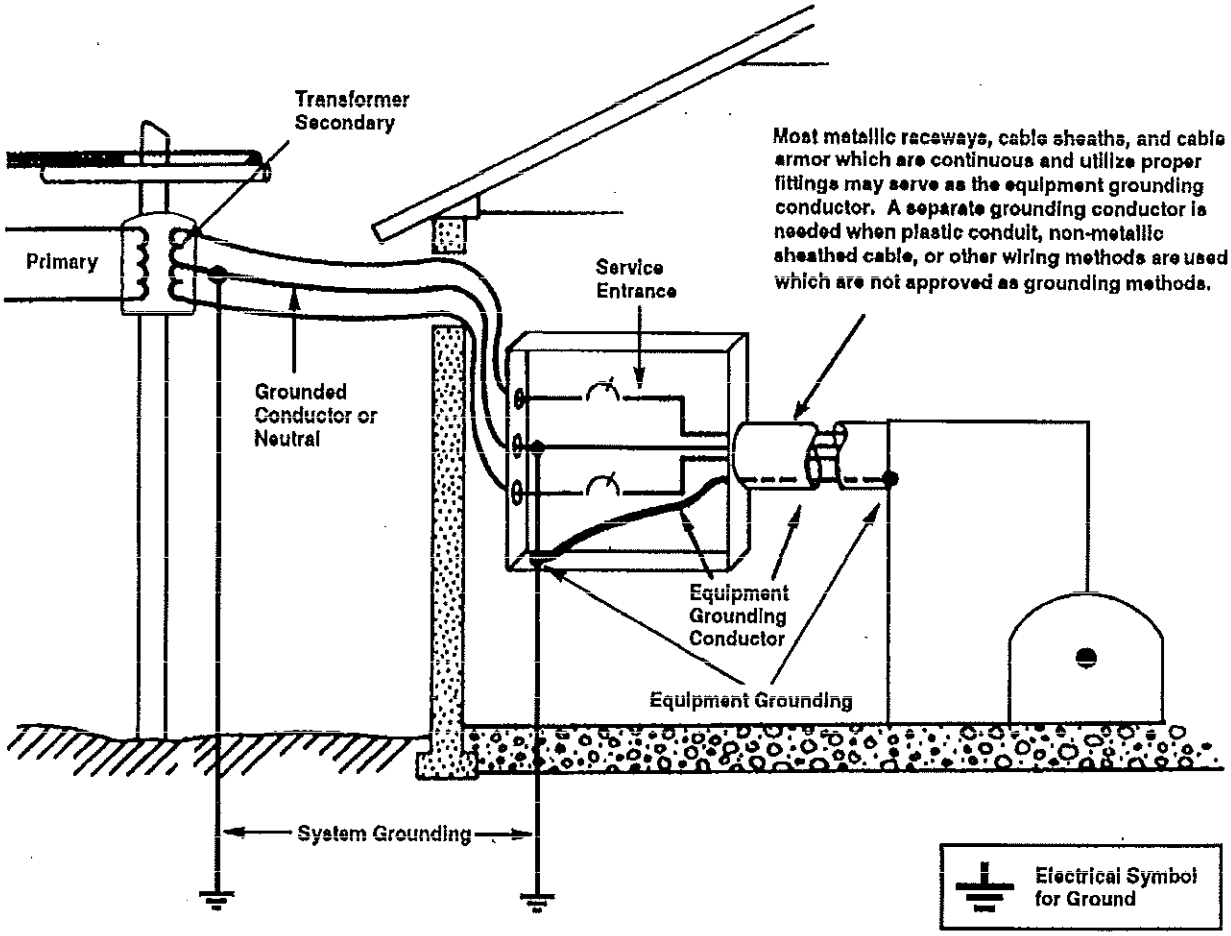
Correct polarity is achieved when the grounded conductor is connected to the corresponding grounded terminal and the ungrounded conductor is connected to the corresponding ungrounded terminal. The reverse of the designated polarity is prohibited. The figure below illustrates a duplex receptacle correctly wired. Terminals are designated and identified to avoid confusion. An easy way to remember the correct polarity is "white to light" - the white (grounded) wire should be connected to the light or nickel-colored terminal; "black to brass" - the black or multi-colored (ungrounded) wire should be connected to the brass terminal; and "green to green" - the green or bare (grounding) wire should be connected to the green hexagonal head terminal screw.



Duplex Receptacle Correctly Wired to Designated Terminals

GROUNDING

This section contains grounding requirements for systems, circuits, and equipment. Grounding electrical circuits and electrical equipment is required to protect employees against electrical shock, safeguard against fire, and protect against damage to electrical equipment. There are two kinds of grounding: (1) electrical circuit or system grounding, and (2) electrical equipment grounding. Electrical system grounding is accomplished when one conductor of the circuit is intentionally connected to earth. This is done to protect the circuit should lightning strike or other high voltage contact occur. Grounding a system also stabilizes the voltage in the system so "expected voltage levels" are not exceeded under normal conditions. The second kind of ground is equipment grounding. This is accomplished when all metal frames of equipment and enclosures containing electrical equipment or conductors are grounded by means of a permanent and continuous connection or bond. The equipment grounding conductor provides a path for dangerous fault current to return to the system ground at the supply source of the circuit should an insulation failure take place. If installed properly, the equipment grounding conductor is the current path that enables protective devices, such as circuit breakers and fuses, to operate when a fault occurs. The figure below illustrates both types of grounding.



SYSTEM AND EQUIPMENT GROUNDING

GROUNDING PATH

The path to ground from circuits, equipment, and enclosures shall be permanent and continuous.

This requirement was extracted from NEC 250-51, *Effective Grounding Path*, which is more complete and fundamental to the understanding of electrical safety. It states that the path to ground:

1. "shall be permanent and continuous." (If the path is installed in such a way that damage, corrosion, loosening, etc. may impair the continuity during the life of the installation, then shock and burn hazards will develop.)

2. "shall have capacity to conduct safely any fault current likely to be imposed on it." (Fault currents may be many times normal currents, and such high currents may melt or burn metal at points of poor conductivity. These high temperatures may be a hazard in themselves, and they may destroy the continuity of the ground-fault path.)

3. "shall have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit." (If the ground-fault path has a high impedance, there will be hazardous voltages whenever fault currents attempt to flow. Also, if the impedance is high, the fault current will be limited to some value so low that the fuse or circuit breaker will not operate promptly, if at all.)

It is important to remember the following regarding safe grounding paths:

1. The fault current in A-C circuits will be limited by the sum of resistance and reactance, and the only low-reactance path is that which closely follows the circuit conductors.

2. If a metallic raceway system is used, make sure that the metallic system is continuous and permanent.

3. In cases where a metallic raceway system is not used, provide a green or bare equipment-grounding conductor close to the supply conductors to assure that all enclosures are bonded together and to the source.

GROUNDING OF EQUIPMENT CONNECTED BY CORD AND PLUG

Under any of the conditions described below, exposed non-current-carrying metal parts of cord- and plug-connected equipment which may become energized shall be grounded.

a. If in a hazardous (classified) location.

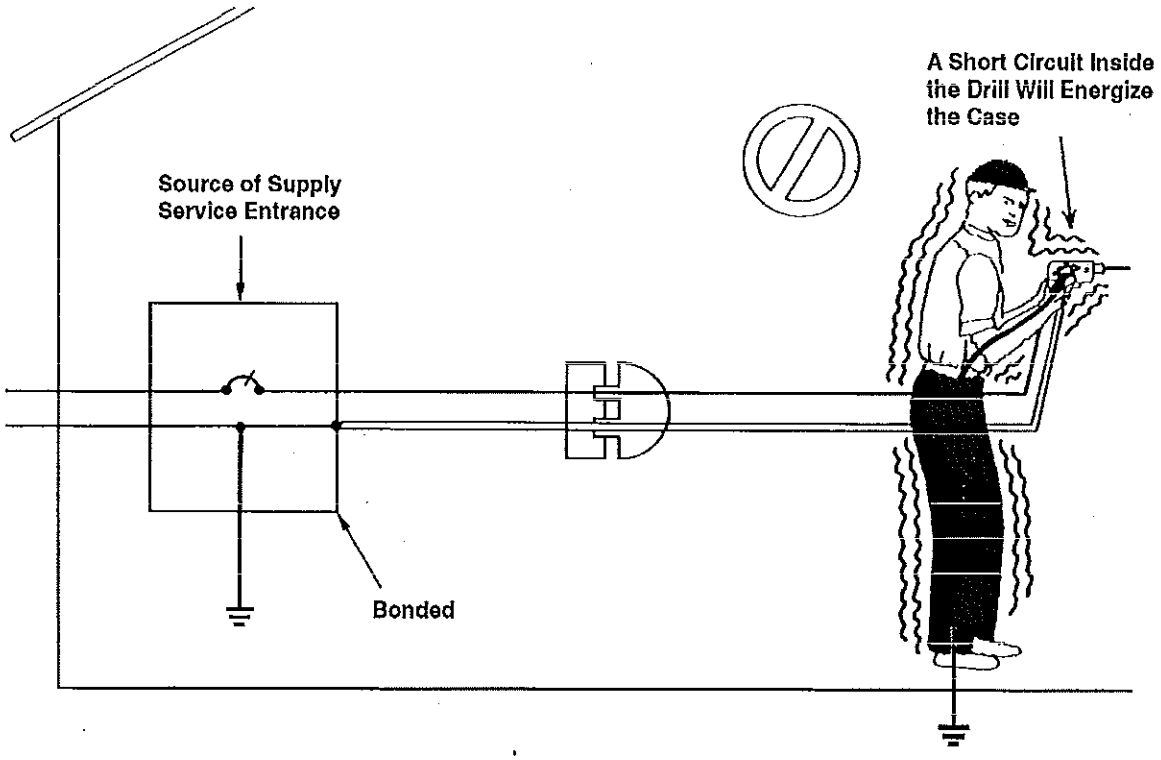
b. If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.

c. If the equipment is of the following types:

- Refrigerators, freezers, and air conditioners;
- Clothes-washing, clothes-drying and dishwashing machines, sump pumps, and electrical aquarium equipment;
- Hand-held motor-operated tools;
- Motor-operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers;
- Cord- and plug-connected appliances used in damp or wet locations or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers;
- Portable and mobile X-ray and associated equipment;
- Tools likely to be used in wet and conductive locations; and
- Portable hand lamps.

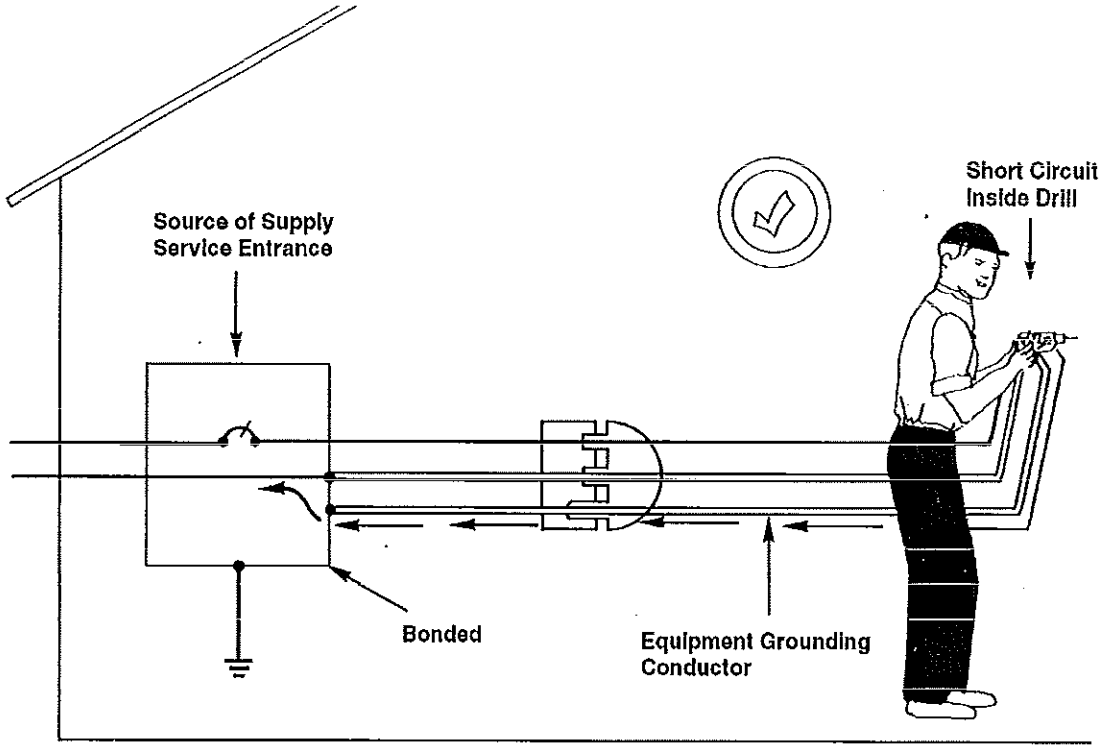
Under the conditions described above, exposed non-current-carrying metal parts of cord- and plug-connected equipment must be grounded. Grounding metal parts is not required where the equipment is supplied through an isolating transformer with an ungrounded secondary of not over 50 volts or if portable tools are protected by an approved system of double insulation. To ground cord- and plug-connected equipment, a third wire is commonly provided in the cord set and a third prong in the plug. The third wire serves as an equipment grounding conductor which is connected to the metal housing of a portable tool and a metal grounding bus inside the service entrance equipment. The service entrance equipment is located at the entrance point of the electric supply for a building or plant and contains, or serves other panelboards which contain, branch circuit protective devices such as fuses and circuit breakers. The third wire provides a path for fault current should an insulation failure occur. In this manner, dangerous fault current will be directed back to the source, the service entrance, and will enable circuit breakers or fuses to operate, thus opening the circuit and stopping the current flow.

The figure below illustrates the potential shock hazard that exists when no third wire, grounding conductor, is used. If a fault occurs, most of the current will follow the path of least resistance. If the worker provides a path to ground as shown, some portion of the current will flow away from the grounded white conductor (neutral) and return to ground through the worker. The severity of the shock received will depend on the amount of current that flows through the worker.



CORD- AND PLUG-CONNECTED EQUIPMENT
WITHOUT A GROUNDING CONDUCTOR

The figure below illustrates the advantage of a properly connected grounded conductor. It should be noted that properly bonded conduit and associated metal enclosures can also serve as a grounding conductor.

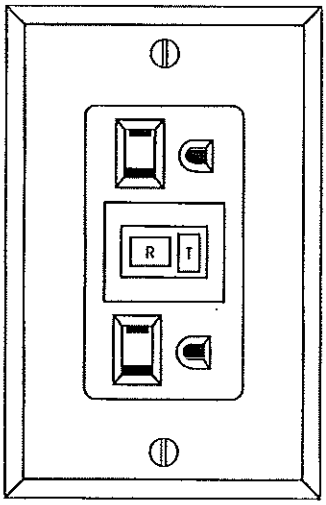


CORD- AND PLUG-CONNECTED EQUIPMENT
WITH A GROUNDING CONDUCTOR

Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.

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.

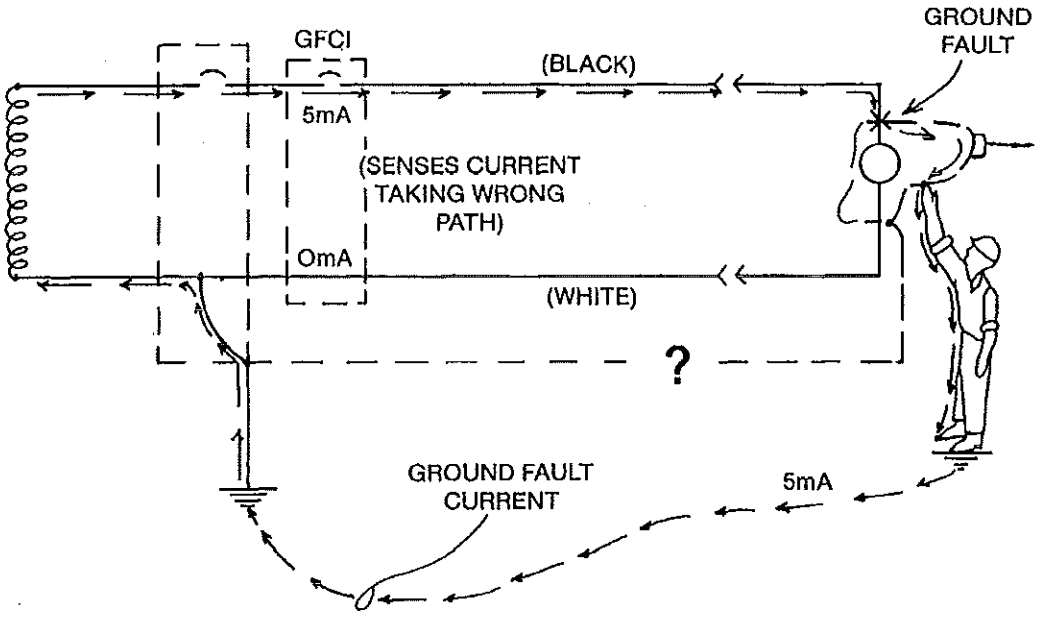
Since neither *insulation* (double insulation) nor *grounding* can provide protection under these conditions, it is necessary to use other protective measures. One acceptable method is a ground fault circuit interrupter, commonly referred to as a GFCI.

How Ground-Fault Circuit-Interrupters Work

A ground-fault circuit-interrupter is not an overcurrent 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 panelboard 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.

CABINETS, BOXES, AND FITTINGS

Conductors Entering Boxes, Cabinets, or Fittings

Since conductors can be damaged if they rub against the sharp edges of cabinets, boxes, or fittings, they must be protected from damage where they enter. To protect the conductors, some type of clamp or rubber grommet must be used. The device used must close the hole through which the conductor passes as well as provide protection from abrasion. If the conductor is in a conduit and the conduit fits tightly in the opening, additional sealing is not required.

The knockouts in cabinets, boxes, and fittings should be removed only if conductors are to be run through them. However, if a knockout is missing or if there is another hole in the box, the hole or opening must be closed.

Covers and Canopies

All pull boxes, junction boxes, and fittings shall be provided with covers approved for the purpose. If metal covers are used, they shall be grounded. In completed installations, each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

FLEXIBLE CORDS AND CABLES

This standard for safe use of flexible cords is one of the most frequently violated electrical standards, particularly in smaller plants. There is a definite need and place for cords, but there is also a temptation to misuse them because they seem to offer a quick and easy way to carry electricity to where it is needed. The basic problem is that flexible cords in general are more vulnerable than the fixed wiring of the building. Therefore, cords should not be used if one of the recognized wiring methods could be used instead.

Use of Flexible Cords and Cables

Flexible cords and cables shall be approved and suitable for conditions of use and location. The standard lists specific situations in which flexible cords may be used. Flexible cords and cables shall be used only for:

a. Pendants (a lampholder or cord-connector body suspended by a length of cord properly secured and terminated directly above the suspended device);

b. Wiring of fixtures;

c. Connection of portable lamps or appliances;

d. Elevator cables;

e. Wiring of cranes and hoists (where flexibility is necessary);

f. Connection of stationary equipment to facilitate their frequent interchange (equipment which is not normally moved from place to place, but might be on occasion);

g. Prevention of the transmission of noise or vibration. (In some cases vibration might fatigue fixed wiring and result in a situation more hazardous than flexible cord.)

h. Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair (e.g. water coolers, exhaust fans);

i. Data processing cables approved as a part of the data processing system.

Note that all of the above situations involve conditions where flexibility is necessary. Unless specifically permitted by one of these situations, flexible cords and cables may not be used:

a. As a substitute for the fixed wiring of the structure;

b. Where run through holes in walls, ceilings, or floors;

c. Where run through doorways, windows, or similar openings;

d. Where attached to building surfaces; or

e. Where concealed behind building walls, ceilings, or floors.

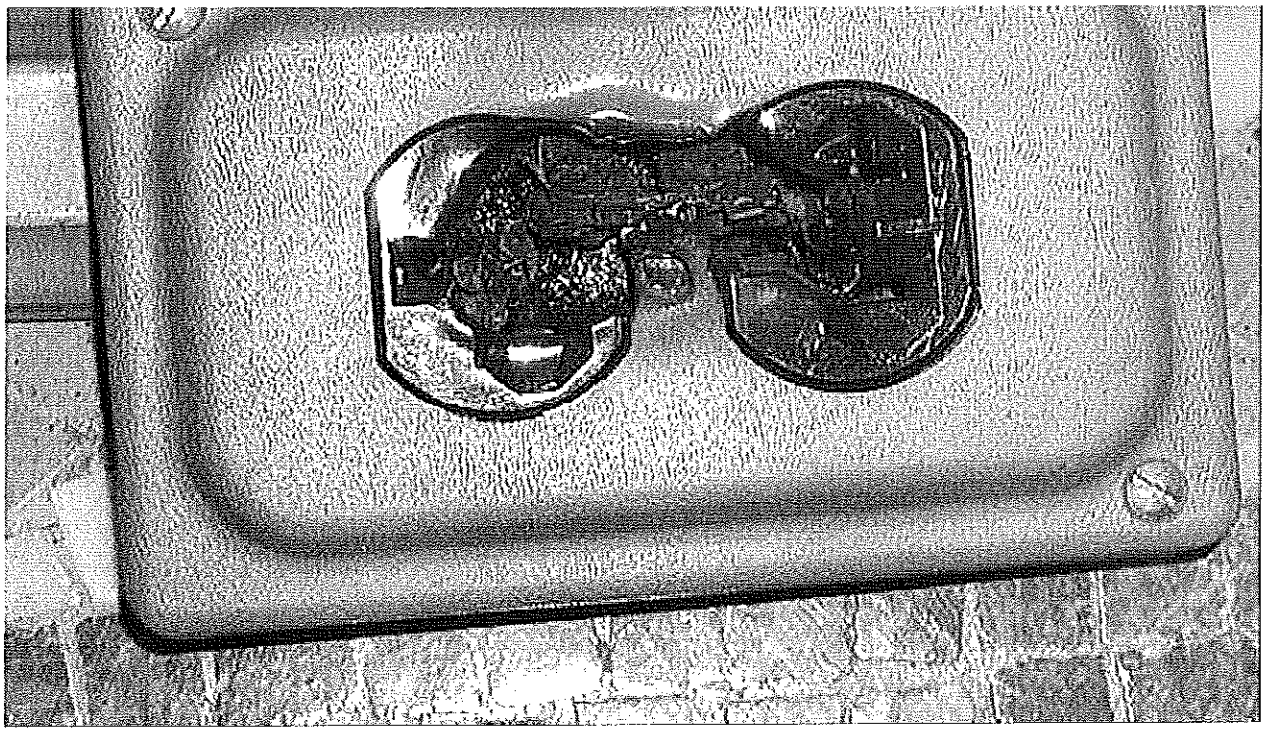
There is usually not much question about use of the short length of cord which is furnished as part of an approved appliance or tool; there is usually no question about an extension cord used temporarily to permit use of the appliance or tool in its intended manner at some distance from a fixed outlet; but there are questions when the usage is not obviously temporary, and when the cord is extended to some distant outlet in order to avoid providing a fixed outlet where needed.

Flexible cord used in violation of this standard is likely to be damaged by activities in the area; by door or window edges; by staples or fastenings; by abrasion from adjacent materials; or simply by aging. If the conductors become partially exposed over a period of time, there will be danger of shocks, burns, or fire.

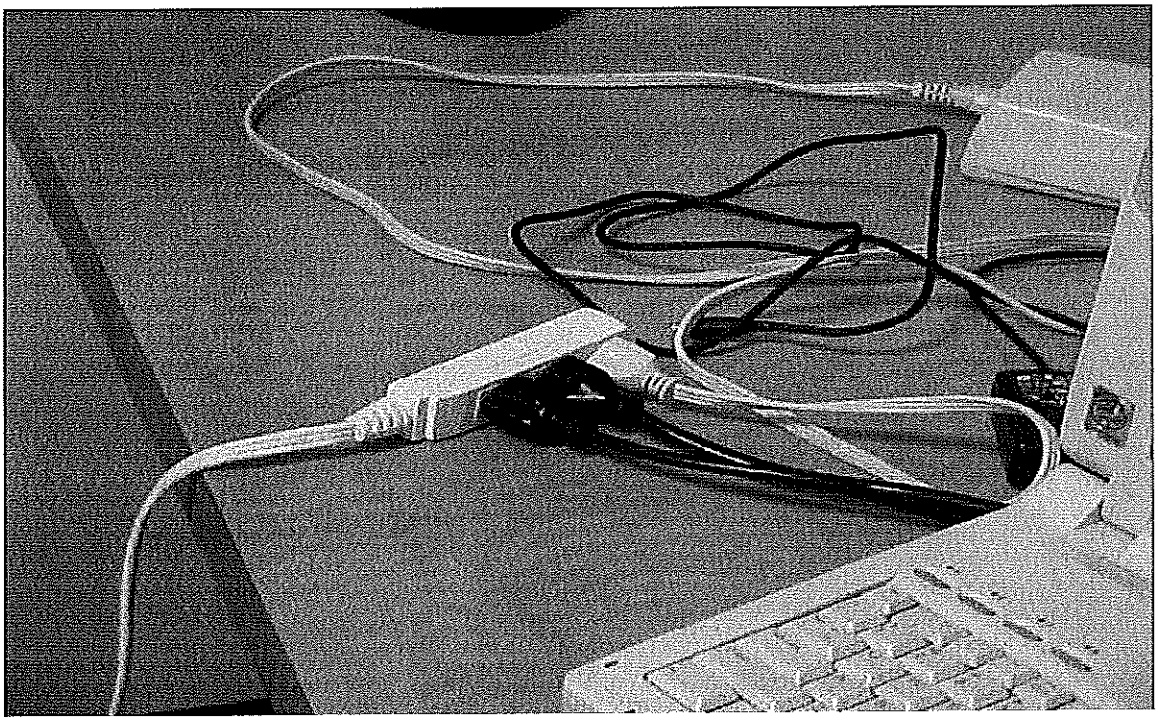
Identification, Splices and Terminations

Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords, No. 12 or larger, may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

Flexible cords shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.



Melted plug in overloaded socket



Misuse of power strip leading to overloading

Standard Interpretations

03/03/1992 - Contractor shop-made extension cords.

Standard Interpretations - Table of Contents

• **Standard Number:** 1910.305(a)(2); 1926.405(a)(2)

March 3, 1992

MEMORANDUM FOR: CHARLES CULVER, Director
Office of Construction and Engineering

THROUGH: LEO CAREY, Director Office of Field Programs

FROM: PATRICIA K. CLARK, Director Directorate of Compliance Programs

SUBJECT: Interpretation on Contractor Shop-made Extension Cords.

This is in response to your November 13 memorandum requesting an interpretation of OSHA requirements pertaining to shop-made extension cords. I apologize for the delay in responding to you.

Normally, equipment must be approved as an assembly by a nationally recognized testing laboratory before it would be acceptable under the General Industry or Construction Electrical Standards (Part 1910, Subpart S and Part 1926, Subpart K, respectively). In the case of cord sets used in construction, it is common for them to be assembled in the field by electrical contractors. It should be noted that OSHA interprets cord sets as being temporary wiring extensions of the branch circuit. As such, temporary electrical power and lighting wiring methods, as specifically modified in 1926.405(a)(2) and 1910.305(a)(2), may be of a class less than that required for a permanent installation. Thus, temporary electrical power and lighting installations are permitted during the period of construction, remodeling, maintenance, repair or demolition of buildings, structures, equipment or similar activities. In addition, temporary wiring must be removed immediately upon completion of construction or purpose for which the wiring was installed. When the temporary wiring consists of shop-made cord sets, self- fabricated lighting installations, emergency or experimental wiring etc., as permitted by 1926.405(a)(2) and 1910.305(a)(2) to be assembled and installed at the work site using approved parts, the requirement for listing by a nationally recognized test laboratory does not apply. If a factory manufactured temporary wiring assembly, such as ready-made extension cords, temporary lighting strings (UL-1088), "on-the-spot" emergency lighting, etc., is desired, then the prefabricated temporary wiring assembly to be installed must be of a type that a nationally recognized testing laboratory accepts, certifies, lists, labels or determines to be safe.

In regard to electrical contractors assembling cord sets at construction sites, the practice is acceptable provided the assembled cord sets are constructed in a manner equivalent to those that are factory-assembled and approved. (The same approach applies to the General Industry Electrical Standards. However, your question pertained to construction, so the remaining references are to Subpart K of Part 1926.) Criteria for determining whether shop-made cord

sets meet existing electrical standards include:

1. All components must be approved for the purpose by a nationally recognized testing laboratory (1926.403(a)). Individual components must be compatible for use with the other components of the completed assembly.

2. The cord set must meet all applicable requirements of Subpart K. For example, the assembly must be marked appropriately (1926.403(g)); boxes intended for use in a permanent installation may not be used (1926.403(b)(1)(i)); cords must be connected to devices and fittings so as to provide strain relief (1926.405(g)(2)(iv)); cords passing through holes in enclosures must be protected by bushings or fittings designed for the purpose (1926.405(g)(2)(v)- fittings designed to fasten cables to metal boxes are not acceptable); and no grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity (1926.404(a)(2)).

3. The cord set must be assembled by a qualified person.

4. The wiring of the completed assembly must be checked before the cord set is first used. For example, the following, or equivalent, tests should be performed:

(a) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

(b) Each receptacle and attachment plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

Standard Interpretations - Table of Contents

Back to Top www.osha.gov www

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Standard Interpretations

06/17/1992 - Acceptable job-made extension cords.

Standard Interpretations - Table of Contents

• **Standard Number:** 1910.305(a)(2)

June 17, 1992

MEMORANDUM FOR: LINDA R. ANKU
REGIONAL ADMINISTRATOR

FROM: PATRICIA K. CLARK, DIRECTOR
DIRECTORATE OF COMPLIANCE PROGRAMS

SUBJECT: Acceptable Job-Made Extension Cords

This is in reference to your memorandum of June 12, 1991 to your area directors and district supervisors on the subject of extension cords acceptable for use (copy attached). We believe your interpretation is unduly restrictive and that it does not accurately reflect the requirements of the applicable standards. We have prepared the following analysis, which indicates that shop-made extension cords and other temporary wiring is acceptable in certain circumstances. It is not required in all circumstances that an extension cord be approved as an assembly.

Analysis

Normally, electrical equipment must be approved as an assembly by a nationally recognized testing laboratory to be acceptable under the General Industry or Construction Electrical Standards (Part 1910, Subpart S and Part 1926, Subpart K, respectively).

However, it is also true that cord sets, assembled in the field by qualified persons, are appropriately used in both general industry and in the construction industry, under limited circumstances. Such cord sets are considered to be temporary wiring extensions of the branch circuit.

Temporary electrical power and lighting wiring methods, as specified in 1910.305(a)(2) and 1926.405(a)(2), may be of a class less than that required for a permanent installation. Thus, temporary electrical power and lighting installations are permitted during the period of construction, remodeling, maintenance, repair or demolition of buildings, structures and equipment or similar activities. Such temporary wiring must be removed immediately upon completion of the work for which the wiring was installed.

When the temporary wiring consists of shop-made cord sets, etc., using approved parts, as permitted by 1910.305(a)(2) and 1926.405(a)(2) the requirements for listing by a nationally recognized testing laboratory do not apply.

The practice of assembling electrical extension cords is considered to be in compliance with OSHA standards provided the assembled cord sets are assembled in a manner equivalent to

those that are factory-assembled and approved. Criteria for determining whether shop-made cord sets meet existing electrical standards include:

1. All components must be approved for the purpose by a nationally recognized testing laboratory (1910.303(a)) and (1926.403(a)). Individual components must be compatible for use with the other components of the completed assembly.

2. The cord set must meet all applicable requirements of 1910 Subpart S and 1926 Subpart K. For example, the assembly must be marked appropriately (1910.303(e)) and (1926.405(g)(2)(iv)); boxing intended for use in a permanent installation may not be used (1910.303(b)(1)(i) and 1926.403(b)(1)(i)); cords must be connected to devices and fittings so as to provide strain relief (1910.305(g)(2) (iii) and 1926.405(g)(2)(iv)); cords passing through holes in enclosures must be protected by bushings or fittings designed for the purpose (1926.405(g)(2)(v)- fittings designed to fasten cables to metal boxes are not acceptable); and no grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity (1910.304(a)(2)) and (1926.404(a)(2)).

3. The cord set must be assembled by a qualified person.

4. The wiring of the completed assembly must be inspected by a qualified person before the cord set is used initially. For example, the following checks and tests, or equivalent, should be performed:

(a) Determine that all equipment grounding conductors are electrically continuous.

(b) Test all equipment grounding conductors for electrical continuity.

(c) Determine that each equipment grounding conductor is connected to its proper terminal.

(d) Test each receptacle and attachment plug to ensure correct attachment of the equipment grounding conductor.

If you have further questions on this matter, please contact the Office of General Industry Compliance Assistance [at (202) 693-1850].

Standard Interpretations - Table of Contents

Back to Top www.osha.gov www

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Standard Interpretations

05/19/2003 - Repair requirements for the cord plug (attachment plug) of double-insulated tools.

Standard Interpretations - Table of Contents

- **Standard Number:** 1926.302; 1926.302(a); 1926.302(a)(1); 1926.403; 1926.403(a); 1926.404; 1926.404(b)(1)(iii)(C); 1926.404(f)(7)(iv); 1926.404(f)(3); 1926.404(f)(7); 1926.405(g)(2)(iii); 1926.449

May 19, 2003

Barry Cole, Executive Vice President
Miller Safety Consulting, Inc.
5750 Pecos Street, Suite 6
Denver, CO 80221

Re: Whether an after-market (non-original) cord plug may be used to repair a double insulated electric hand tool; whether a non-current carrying metal strain-relief for a replacement cord plug must be grounded; Subpart K, §§1926.302(a); 1926.403(a); 1926.404(b)(1)(iii)(C) and (f)(7)(iv); attachment plug repairs

Dear Mr. Cole:

This is in response to your letter of December 24, 2002. On August 31, 2001, you asked OSHA some questions regarding repairs to the cord plug (attachment plug) of double-insulated tools under OSHA's construction electrical standards. We responded to those questions in a letter to you dated December 17, 2002. In your current letter, you ask us to reconsider our answer to one of those questions.

Previous letter
In our December 17, 2002, letter, we paraphrased one of your questions as follows:

> Question (1): This question is posed with respect to hand power tools that are NOT designed for use in hazardous environments. Is it permissible to replace the plug of a double-insulated electric hand tool with after-market parts? Is it permissible to repair the (external) power cord?

In our answer, in applying 29 CFR 1926.302(a)(1), 1926.403(a), and 1926.449, we stated that it was not permissible to open the body of a double-insulated tool to make a repair, since

that would vitiate the testing laboratory's approval of the tool as double-insulated. Specifically, in that portion of our answer, we stated:

> **Repair of double insulated tools**
>
> With respect to double insulated tools, competently made repairs to external parts of the tool, using parts that are at least equivalent to those used in the original tool, are permitted. For example, as long as the replacement plug is an approved item, has a capacity that meets or exceeds the original, and is properly installed, its use for repair is permitted.
>
> **However, repairs that require opening the body of a double insulated tool are not permitted under §1926.403(a) because opening the tool body would vitiate the approval of the tool (opening a double insulated tool may have deleterious effects on its double-insulation characteristics). For example, complete replacement of the power cord on a double insulated drill typically requires opening the body of the tool. Therefore, such a replacement would not be permitted under §1926.403 (a).** [Underlining added.]

In your current letter, you object to our conclusion that opening the body of a tool to make a repair would violate §1926.403(a) (see the portion of the answer underlined above). You assert that opening the tool body to make a repair does not, in fact, vitiate an Underwriter's Laboratory (UL) approval of the tool, and state that manufacturers supply replacement parts and instructions on how to make such repairs.

There are numerous nationally recognized testing laboratories; we are not in a position to survey them all to determine whether opening a tool that they have approved as double insulated would vitiate their approval. However, we agree that, if opening the tool body does not vitiate the testing laboratory's approval of the tool as double-insulated equipment, then opening the tool body would not, in itself, violate §1926.403(a). Therefore, we are modifying the underlined portion of our December 17, 2002, answer as follows:

> *Repairs that require opening the body of a double insulated tool are permitted under §1926.403(a) if opening the tool body is consistent with the terms of the testing laboratory's approval of the tool as double-insulated. For example, if the terms of the testing laboratory's approval permits a competent repair technician or facility to open the body of the tool to replace the power cord on a double insulated drill, such a repair would be permitted under §1926.403(a).*

To avoid confusion, we are retracting our December 17, 2002, letter and reissuing our response with the above modification, as follows:

Question (1): *This question is posed with respect to hand power tools that are NOT designed for use in hazardous environments. Is it permissible to replace the plug of a double-insulated electric hand tool with after-market parts? Is it permissible to repair the (external) power cord?*

Answer: It is permissible to replace the plug under certain conditions. OSHA's construction industry standards addressing grounding electric (power-operated) hand tools are in 29 CFR 1926.302(a). Section 1926.302(a)(1) states:

> Electric power operated tools shall either be of the approved double-insulated type or grounded in accordance with Subpart K of this part [§§1926.400-1926.449].

As you know, double-insulated tools have two-prong attachment plugs instead of a grounding (third) prong.

In addition, in 29 Part CFR 1926 Subpart K, §1926.403(a) requires all electric equipment,

including double-insulated tools, to be approved. "Approved" is defined in §1926.449 as being "acceptable," which (for purposes of this question) is defined as "accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a qualified testing laboratory...." A double-insulated electric hand tool with its original two-prong attachment plug that has been listed by a nationally recognized testing laboratory (NRTL) would comply with §1926.302(a). (1)

With regard to the applicable provisions in the OSHA standards for inspecting these tools, §1926.404(b)(1)(iii)(C) states:

> (C) Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. **Equipment found damaged or defective shall not be used until repaired.** [Emphasis added.]

You indicated that when these plugs are found to be damaged or the strain-relief is torn, you recommend that repairs be made, in accordance with §1926.404(b)(1)(iii)(C). Enclosed with your letter was a commercially available polarized attachment plug, which you state is UL-rated and has an appropriate capacity for a double insulated tool with a 12- to 18-gauge cord. The plug is specifically designed for installation as a replacement plug.

To satisfy the requirements of the OSHA standards, a repair would have to restore the tool to its "approved" condition in accordance with §1926.403(a). Tools, such as the double-insulated ones you address, are approved as complete factory-produced entities. The approval is for the tool as a whole -- its design, capacity, materials and construction. This provision precludes the use of an approved tool if its characteristics are materially altered. Also, it requires that the repair not compromise the integrity of the double-insulated construction.

Repair of double insulated tools

With respect to double insulated tools, competently made repairs to external parts of the tool, using parts that are at least equivalent to those used in the original tool, are permitted. For example, as long as the replacement plug is an approved item, has a capacity that meets or exceeds the original, and is properly installed, its use for repair is permitted.

Repairs that require opening the body of a double insulated tool are permitted under §1926.403(a) if opening the tool body is consistent with the terms of the testing laboratory's approval of the tool as double-insulated. For example, if the terms of the testing laboratory's approval permits a competent repair technician or facility to open the body of the tool to replace the power cord on a double insulated drill, such a repair would be permitted under §1926.403(a).

In addition, the cord may be repaired by severing the cord above bad area and installing an appropriate replacement plug as described above. However, repair of a cord for a tool such as a typical electric drill by splicing is not permitted. Section 1926.405(g)(2)(iii) states:

> Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

This provision precludes the repair of flexible cords smaller than No.12 (the higher the number, the smaller the cord). Since hand power tools typically have flexible power cords smaller than No.12, those cords are not permitted to be spliced. Heavier cords -- those No. 12 or larger (that is, with a lower gauge number), may be repaired with a molded or vulcanized splice as long as the repair returns the cord to at least the equivalent of its original specifications.

Question (2): *Does the metal strain-relief (metal cord clamp) of a replacement attachment plug on a double-insulated tool have to be grounded under §1926.404(f)(3) and (7) (or other standard)?*

Answer: We address your grounding question with respect to use of a properly installed replacement plug with a metal sleeve for strain relief. The strain relief sleeve is designed to compress the end-cap rubber cover, which squeezes the outer protective sheath of the power cord. In this design, there is a thick layer of rubber between the metal sleeve and the power cord sheath.

For purposes of your question, the provision that would be most typically pertinent[(2)] is §1926.404(f)(7)(iv), which provides:

> (iv) Equipment connected by cord and plug. Under any of the conditions described in paragraphs (f)(7)(iv)(A) through (f)(7)(iv)(C) of this section, **exposed noncurrent-carrying metal parts of cord- and plug-connected equipment which may become energized shall be grounded:**
>
> (A) If in a hazardous (classified) location (see §1926.407).
> (B) If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.
> (C) If the equipment is one of the types listed in paragraphs (f)(7)(iv)(C)(1) through (f)(7)(iv)(C)(5) of this section. However, even though the equipment may be one of these types, it need not be grounded if it is exempted by paragraph (f)(7)(iv)(C)(6).
>
> (1) Hand held motor-operated tools;
> (2) Cord- and plug-connected equipment used in damp or wet locations or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers;
> (3) Portable and mobile X-ray and associated equipment;
> (4) Tools likely to be used in wet and/or conductive locations;
> (5) Portable hand lamps.
> (6) Tools likely to be used in wet and/or conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances protected by a system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes a system of double insulation. [Emphasis added.]

If the original double-insulated tool plug is replaced with the type of replacement plug described above, and the power cord is in good condition, then under §1926.404(f)(7)(iv) the metal strain relief clamp would not be required to be grounded because there is virtually no likelihood that the metal clamp may become energized.

If you need additional information, please contact us by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Compliance Assistance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.

Sincerely,

Russell B. Swanson, Director
Directorate of Construction

---

[1] Section 1926.404(f)(7)(iv)(6) requires that double insulated tools be "distinctively marked to indicate that the tool or appliance utilizes a system of double insulation." [Back to Text]

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[2] There are a number of provisions that address grounding, including the grounding of portable and vehicle-mounted generators [§1926.404(f)(3)], and the grounding of supports, enclosures, and equipment [§1926.404(f)(7)]. There are additional references to non-current-carrying metal parts in §1926.404(f)(8) and (11). [Back to Text]

Standard Interpretations - Table of Contents

Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Standard Interpretations

12/16/1998 - Using electrical tape to repair minor damage to the outer jacket of an extension cord.

Standard Interpretations - Table of Contents

- **Standard Number:** 1926.403(a); 1926.403(e); 1926.405(g)(2)(iii); 1926.416(e)(1)

OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

December 16, 1998

Mr. Dennis Vance
Safety Specialist
711 Low Gap Road
Princeton, WV 24740

Re: 1926.403(e); 1926.405(g)(2)(iii); 1926.416(e)(1).

Dear Mr. Vance:

This is in response to your letter of March 20, and your follow-up letter of October 9, concerning the use of electrical tape to repair minor damage (abrasions and cuts of limited depth) on the outer jacket of an extension cord. We apologize for the lateness of this reply.

Generally, electrical tape may be used to cover superficial damage to cord jackets

You ask whether there is any prohibition against putting electrical tape over these kinds of abrasions and nicks when there is no damage beyond the jacket — the conductors have not been scraped or exposed and the insulation inside the jacket has not been displaced or compressed.

Section 1926.416(e)(1) provides that "worn or frayed electrical cords or cables shall not be used." Superficial nicks or abrasions — those that only slightly penetrate the outer jacket of a flexible cord, and do not permit the cord to bend more in that area than in the rest of the cord — do not normally render a cord "worn or frayed." Therefore, there is no need to repair or replace such a cord.

Recommendation against taping

While taping these incidental abrasions and cuts does not necessarily violate any OSHA standard, we recommend that employers not tape this type of damage for two reasons. First,

Section 1926.403(a) requires that "all electrical conductors and equipment shall be approved." This standard precludes the use of approved electrical conductors and equipment if their characteristics are significantly altered. Applying electrical tape that is too thick or applying too much of it could change the cord's original flexibility and lead to internal damage. Second, the depth of the abrasions and cuts cannot be monitored to see if they get worse without removing the tape.

It should also be kept in mind that the heavy-duty extension cords commonly used on construction sites are designed to withstand a hostile environment. Damage to an extension cord that is bad enough to consider taping may have caused damage beyond the jacket.

Tape may not be used to repair significant damage to cord jackets

Repair or replacement of a flexible cord (depending on its gauge) is required when the outer jacket is deeply penetrated (enough to cause that part of the cord to bend more than the undamaged part) or penetrated completely, or when the conductors or their insulation inside are damaged. Two provisions of the standard prohibit the repair of the jacket of a worn or frayed flexible cord with electrical tape. Section 1926.403(a) requires that the cord be approved. The original approval of the cord was based on the types of materials and construction used. As noted above, taping the cord can change the flexibility characteristics of the cord, which in turn can affect the amount of stress in the adjacent areas. This is of particular concern with respect to the grounding wire. Also, the jacket is designed both to prevent damage to the conductors and insulators inside and to further insulate the conductors. Taped repairs usually will not duplicate the cord's original characteristics; in most cases neither the jacket's strength nor flexibility characteristics will be restored. Therefore, tape repairs of the jacket may not be used to bring a worn or frayed flexible cord into compliance.

In addition, Section 1926.405(g)(2)(iii) states that "flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced." This standard precludes the repair of flexible cords smaller than No. 12.

MSHA has a different standard governing the repair of flexible cords

You point out in your letter that U.S. Department of Labor's Mine Safety and Health Administration (MSHA) permits the taping of damaged flexible cords in mines, which are, in many cases, very hazardous environments. The standard that applies in mines is different from the OSHA standard. The MSHA standard, located in volume 30 of the Code of Federal Regulations, Section 75.517, provides that "power wires and cables...shall be insulated adequately and fully protected."

A mine employer complies with this standard by "insulating adequately and fully protect[ing]" the cord. By its terms, this permits the use of cords as long as they are properly insulated and protected. Where that can be accomplished by the proper application of suitable electrical tape, the requirements of that standard are met. In contrast, the OSHA standard, which is based in large part on the National Electric Code, requires that the cords be "approved," and prohibits the repair of cords smaller than No. 12. Consequently, the use of tape to repair a worn or frayed cord is permitted under the MSHA standard but not under the OSHA standard.

If you require any further assistance, please do not hesitate to contact us [by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Guidance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.]

Sincerely,

Russell B. Swanson, Director

[Corrected 6/22/2007]

Standard Interpretations - Table of Contents

Back to Top www.osha.gov www

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Standard Interpretations

09/09/1997 - Clarification of the Electrical Standard as it applies to flexible power cords on appliances.

Standard Interpretations - Table of Contents

- **Standard Number:** 1910.303(a); 1910.305(g)(1); 1910.334(a)(2)

September 9, 1997

Mr. Kenneth J. Yotz
EMTS
919 St. Andrews Circle
Geneva, IL 60134-2995

Dear Mr. Yotz:

This is in response to your January 12 letter requesting clarification of the 29 CFR 1910 Subpart S - Electrical Standard as it applies to flexible power cords on appliances. Please, accept our apology for the delay in responding. Your questions, and our replies follow.

Question #1:

Can the original cord on an appliance, such as a fan, which is certified by a nationally recognized testing laboratory (NRTL) be replaced with a longer cord, perhaps 15-25 feet long, to reach an existing electrical outlet?

Reply:

Under paragraph 1910.303(a), electrical conductors and equipment are acceptable for use in the workplace only if approved. An electrical appliance which is certified by a NRTL is considered to be approved by the Occupational Safety and Health Administration (OSHA) as long as it is used in accordance with the condition(s) of NRTL certification. Replacing the existing cord (with a longer cord, perhaps 15-25 feet long) is a violation of the NRTL certification of the appliance. Flexible cords and cables may not be used as a substitute for the fixed wiring of a structure. A new receptacle, readily accessible to the fan, must be provided.

Use of an appliance with flexible cord and cable as short as possible plugged into a nearby receptacle promotes workplace safety by reducing the likelihood of being a tripping hazard and being damaged.

Question #2:

Would it make a difference if the appliance was cord and plug operated or if it is wired with a flexible cable directly into a junction box?

Reply:

Yes, cord and plug operated appliances which meet paragraph 1910.305(g) requirements may be-used. However, an appliance which is wired with a flexible cable directly into a junction box may not be used in workplaces. Paragraph 1910.305(g)(1)(iii)(A) prohibits such an installation to be used to substitute for fixed structural wiring.

Question #3:

Can electrical tape be used to cover minor nicks and abrasions in the outer jacket of a flexible cord? Under what circumstances, if any, may "electrical tape" be used to repair the outer cover of a flexible cord?

Reply:

Nicks and abrasions which do not penetrate completely through the outer jacket of a flexible cord are not considered a safety concern for which corrective action, that is, repair or replacement of the flexible cord, would be required. Repair or replacement of the flexible cord is required when the outer jacket is penetrated or the conductors or their insulation, inside are damaged. Flexible cord not less than No. 12 American Wire Gauge (AWG) may be repaired by splicing the conductors with a suitable vulcanized or molded splice. Please note that removing a damaged section of a flexible cord on an appliance and installing an attachment plug and a cord connection on the two ends would not be allowed. Such a repair would result in an extension cord between the flexible cord of the appliance and the installed building receptacle. Under paragraph 1910.305(a)(2)(i), this extension cord would be considered temporary wiring which is not permitted for workplace use.

Please note that flexible cord and cable should be visually inspected for external defects, such as insulation damage, and for indications of possible internal damage. Also, use of electrical tape to protect nicks or abrasions impedes visual inspection of the flexible cord. Flexible cords found damaged or defective must not be used until repaired.

We appreciate your interest in occupational safety and health. If we can be of further assistance, please contact the Office of General Industry Compliance Assistance [at (202) 693-1850].

Sincerely,

John B. Miles, Jr., Director
Directorate of Compliance Programs

Standard Interpretations - Table of Contents

Back to Top www.osha.gov www

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Standard Interpretations

04/15/1992 - Requirements for cord sets connected to permanent wiring.

Standard Interpretations - Table of Contents

- **Standard Number:** 1910.12(b); 1926.404(b)(1)

April 15, 1992

Mr. Robert L. Echols
Belco Electric, Inc.
3118 Marian Drive
Atlanta, Georgia 30340

Dear Mr. Echols:

This is in response to your January 31 letter requesting an interpretation of the application of Occupational Safety and Health Administration (OSHA) construction standards and whether temporary wiring requirements apply to cord sets connected to permanent wiring.

In regard to what constitutes a construction site or when OSHA construction standards apply, please be advised that part 1926 applies to all "construction work" which is defined in 29 CFR 1910.12(b) as "work for construction, alteration and/or repair, including painting and decorating." Therefore, OSHA construction standards would apply to the electrical installation referred to in your letter if construction, alteration or repair work is being performed. Whether or not the permanent wiring has been installed is not relevant to the applicability of the standard. The key factor is whether the activity being performed is construction work.

In regard to whether an extension cord, used to supply power between permanent wiring and a hand tool, is temporary wiring, please be advised that OSHA considers extension cords as temporary extensions of branch circuits and therefore GFCI's or an assured equipment grounding conductor program is normally required (1926.404(b)(1)).

However, if the area in which work is being performed is completed to the extent that the building finish has been applied and if employees are not exposed to contact with large grounded objects (such as metal ducts and structural steel and concrete, including flooring), the severe ground-fault hazards addressed by the standard would not be present. The Agency's policy is to treat this condition as de minimis (1926.404(b)(1)) in such areas, whether or not the electric power to tools in use is supplied by extension cord sets. This is based on the permanent nature of the electrical installations and the condition and maintenance of electrical tools and equipment used in general industry, as contrasted with the temporary wiring, which is frequently moved, and the rough use, abuse, and the relatively poorer condition and maintenance of electrical tools and equipment found on construction sites.

If we can be of any further assistance, please contact Mr. Roy F. Gurnham or Mr. Dale R. Cavanaugh of my staff in the Office of Construction and Maritime Compliance Assistance at (202) 523-8136.

Sincerely,

Patricia K. Clark, Director
Directorate of Compliance Programs

Standard Interpretations - Table of Contents

Back to Top www.osha.gov www

Contact Us | Freedom of Information Act | Customer Survey
Privacy and Security Statement | Disclaimers

Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Standard Interpretations

11/18/2002 - Compliance requirements for relocatable power taps or "power strips."

Standard Interpretations - Table of Contents

- **Standard Number:** 1910.303(b)(2); 1910.303; 1910.304(b)(2); 1910.304; 1910.305(g)(1); 1910.305

November 18, 2002

Wade R. Abnett, ASP
Senior Safety Engineer
Middle River Aircraft Systems
103 Chesapeake Park Plaza
Baltimore, MD 21220

Dear Mr. Abnett:

Thank you for your October 22, 2001 letter to the Occupational Safety and Health Administration (OSHA). This letter constitutes OSHA's interpretation only of the requirements discussed and may not be applicable to any questions not delineated within your original correspondence. You had concerns regarding an OSHA interpretation letter, "*The use of power strips*" addressed to Mr. Rick Cee, Chairperson, OSHA, Salt Lake City Technical Center, dated June 11, 1993. This letter has been removed from OSHA's website and is no longer considered current. We apologize for the delay in responding to your request.

Question: What is the current compliance status on the use of "power strips"?

Reply: "Power strips" (as they are most commonly referred to) "Surge/Spike Protectors" or "Portable Outlets," typically consist of several components, such as multiple electrical receptacles, on/off power switch, circuit breaker, and a grounded flexible power cord. One nationally recognized testing laboratory, Underwriters Laboratories (UL), refers to power strips as *Relocatable Power Taps (RPTs)* and, in its "*General Information for Electrical Equipment Directory*" (sometimes called the UL white book or UL Directory), describes RPTs as "*relocatable multiple outlet extensions of a branch circuit to supply laboratory equipment, home workshops, home movie lighting controls, musical instrumentation, and to provide outlet receptacles for computers, audio and video equipment and other equipment.*" Power strips may contain other electronic components intended to provide electrical noise filtering or surge protection. UL defines and lists such devices in UL 1283, *Standard for Electromagnetic Interference Filters* and UL 1449, *Transient Voltage Surge Suppressors (TVSS);* TVSSs are dual-listed by UL and meet the requirements of UL 1363, *Relocatable Power Taps.*

OSHA's standard at 29 CFR §1910.303(b)(2), Installation and use, requires that "*Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.*" Manufacturers and nationally recognized testing laboratories determine the proper uses for power strips. For example, the UL Directory contains instructions that require UL-listed RPTs to be directly connected to a permanently installed branch circuit receptacle; they are not to be series-connected to other RPTs or connected to extension cords. UL also specifies that RPTs are not intended for use at construction sites

and similar locations.

Power strips are designed for use with a number of low-powered loads, such as computers, peripherals, or audio/video components. Power loads are addressed by 29 CFR §1910.304(b)(2), *Outlet devices*: "*Outlet devices shall have an ampere rating not less than the load to be served.*" Power strips are not designed for high power loads such as space heaters, refrigerators and microwave ovens, which can easily exceed the recommended ampere ratings on many power strips. They must also meet the requirements of §1910.305 (g)(1), *Use of flexible cords and cables*. For example, the flexible power cord is not to be routed through walls, windows, ceilings, floors, or similar openings.

Thank you for your interest in occupational safety and health. We hope you find this information helpful. OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information.

To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov/. If you have any further questions, please feel free to contact the Office of General Industry Enforcement at (202) 693-1850.

Sincerely,

Richard E. Fairfax, Director
Directorate of Enforcement Programs

Standard Interpretations - Table of Contents

Back to Top www.osha.gov www

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

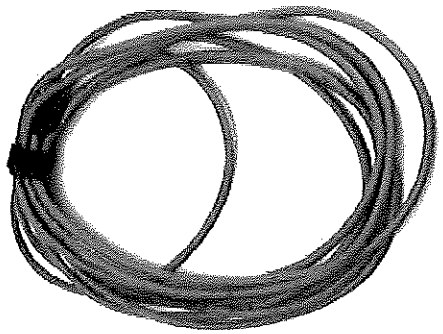
Underwriters Laboratories

Wiring Safety Tips

- Unplug appliances when not in use.
- Look for the UL Mark on all products. It means that samples of the product have been tested for safety.
- Make sure outlets are not overloaded.
- Check electrical wires and cords on appliances, tools, lamps, etc. to make sure they're not worn or frayed.
- Never run electrical wires or extension cords under carpets or heavy items.
- Never bunch electrical wires or extension cords behind a hot appliance.
- Use outlet plug covers to prevent children from inserting objects into outlets.
- Extension cords are meant for temporary use only.
    - Look for the UL Mark on extension cords that you purchase. The UL Mark means that representative samples of the cord have been tested for foreseeable safety hazards.
    - Store all cords indoors when not in use. Outdoor conditions can deteriorate a cord over time.
    - Never keep an extension cord plugged in when not in use. The cord will conduct electricity until it is unplugged from the outlet.
    - Most newer, indoor cords with more than one outlet have covers for the unused openings — use them. Children and pets face serious injury if they chew on unused outlets or stick sharp metal objects into the openings.
    - Do not use extension cords that are cut or damaged. Touching even a single exposed strand of wire can give you an electric shock or burn.

Product Safety Tips:

Extension Cords



Just because the first extension cord you find in your garage has the length to reach the outlet across the room, it doesn't mean it's the proper one to use for the task at hand. If a power tool is drawing more current than an extension cord can carry, it may cause the cord and tool to overheat and create a fire. Before using any extension cord to help power an electrical tool or appliance, the safety professionals at Underwriters Laboratories Inc. (UL) encourages consumers to ask themselves three important questions:

- **Will I use the cord indoors or outdoors?**
- **What is the total wattage rating of the appliances I'll use with the cord?**
- **How far is the nearest outlet from where I'll be working?**

Extension cords are labeled with valuable information as to the use, size and wattage rating of the cord. Cords are offered in many lengths and are marked with a size or "gauge." The gauge is based on the American Wire Gauge (AWG) System, in which the larger the wire, the smaller the AWG number. For example, a 12 gauge wire would be larger, and can power larger wattage appliances, than a 14 gauge wire.

Before deciding which extension cord to use, first carefully read the manufacturer's instructions for the power tools you will be using. These booklets contain important information about your tools and will provide instructions on their use. The booklets will also indicate whether the tools are suitable for use outdoors. Likewise, the first step in determining which extension cord you will need is to decide whether you will be using the appliance indoors or outdoors. Extension cords that can be used outdoors will be clearly marked "Suitable for Use with Outdoor Appliances." Never use an indoor extension cord outdoors; it could result in an electric shock or fire hazard.

To determine what size -- or gauge -- cord you will need, you will also have to determine how long you need the cord to be. A cord, based on its gauge, can power an appliance of a certain wattage only at specific distances. As the cord gets longer, the current carrying capacity of the cord gets lower. For example, a 16 gauge extension cord less than 50 feet in length can power a 1625 watt (W) appliance. A 16 gauge cord that is longer than 50 feet in length can only power an appliance up to 1250W.

All appliances indicate how much wattage is consumed when operated; that rating can be found on the appliance itself and often within the use and care booklet that accompanies the product. Other appliances will indicate power usage in amps, rather than watts. Quick tip: if your appliance indicates that it uses 5 amps at 125 volts, then its wattage rating is 625W (5x125).

If you are going to use the extension cord with two or more appliances, you must add together the wattage rating for all appliances used on the cord. The total of those wattage ratings will help you determine which gauge size you will need.

Follow these additional safety tips when using extension cords with any electrical appliance.

- Look for the UL Mark on extension cords you purchase. The UL Mark means that representative samples of the cord have been tested for foreseeable safety hazards.
- Store all cords indoors when not in use. Outdoor conditions can deteriorate a cord over time.
- Never keep an extension cord plugged in when not in use. The cord will still conduct electricity until it is unplugged from the outlet.
- Most newer, indoor cords with more than one outlet have covers for the unused openings - use them. Children and pets face serious injury if they chew on unused outlets or stick sharp metal objects into the openings.
- Do not use extension cords that are cut or damaged. Touching even a single exposed strand of wire can give you an electric shock or burn.

- Never file or cut the plug blades or grounding pin of an extension cord or appliance to plug it into an old outlet.
- As a safety feature, extension cords and most appliances have polarized plugs (one blade wider than the other). These special plugs are designed to prevent electric shock by properly aligning circuit conductors. If a plug does not fit, have a qualified electrician install a new outlet.

By using extension cords properly, you and your family can enjoy longer, safer use of your power tools and garden appliances.

Go the Distance On Extension Cord Safety

Underwriters Laboratories experts show how to avoid electrical shocks and fires

NORTHBROOK, Ill.; Spring 2005 - Extension cords let you go to great lengths for spring maintenance chores in and around your home. But extension cords also require you to go the distance on safety to avoid electrical shocks and fires when you're using power tools and garden equipment.

According to the Consumer Product Safety Commission, misused or damaged extension cords cause about 3,300 residential fires each year, killing 50 people and injuring 270 others.

"Extension cord safety begins with inspecting cords before you use them," says John Drengenberg, manager of Consumer Affairs at Underwriters Laboratories Inc. (UL), the not-for-profit product safety organization. "Do not use extension cords that are cut or damaged. Touching even a single, exposed strand of wire can give you an electric shock or burn."

Also, check the cord's plug to ensure that the blades and grounding pin are present. "Never file or cut the plug blades or grounding pin of an extension cord or an appliance to plug it into an old outlet," he says. "If an extension cord plug doesn't fit an outlet, have a qualified electrician replace the outlet."

Read the label when you're buying a new extension cord. "Labels carry valuable information about the use, size and wattage rating of the cord," he notes. "This can help you choose the right cord for the right job rather than overloading or misusing a cord. For example, outside extension cords are clearly labeled 'Suitable for Use with Outdoor Appliances.' Using an indoor extension cord outdoors could result in an electric shock or fire hazard."

Cords are marked with a size or gauge. "The larger the wire, the smaller the gauge number," he explains. "A 12-gauge wire is larger and can power larger wattage tools than a 14-gauge wire."

And, recognize that as the cord gets longer, the electric current carrying capacity of the cord gets lower. "That's probably not a problem if you're running a power tool inside your home, but it could be a factor if you're operating an electric lawn mower at the edge of a big lawn," Drengenberg points out.

Finally, UL safety experts offer these additional safety tips when using extension cords:

- Look for the UL Mark which means that representative samples of the cord have been tested for safety hazards.
- Store all cords indoors when not in use. Outdoor conditions can deteriorate a cord over time.
- Unplug an extension cord when it is not in use. The cord will still conduct electricity until it is unplugged from the outlet.

For more tips on the safe use of lawn mowers, ladders, power saws and home wiring, visit UL's Web site at *www.ul.com/consumers*.

About Underwriters Laboratories

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit product safety certification organization that has been testing products for more than 110 years. UL tests more than 18,850 types of products annually, and more than 19 billion UL Marks appear on products each year. Worldwide, UL's family of companies and its network of service providers include 58 laboratories, and testing and certification facilities.

Product Safety Tips:

GFCIs -- A SMALL INVESTMENT, A BIG LIFESAVER
UL Recommends Regular Testing of GFCIs

December 20, 2003: Underwriters Laboratories periodically revises requirements in its Standards for Safety to harmonize with international requirements, address code and safety issues, and accommodate new product developments as applicable. UL has adopted new and revised requirements for Ground-Fault Circuit-Interrupters (GFCIs) that become effective January 1, 2003. Among others, these requirements include enhanced requirements for immunity to voltage surges, resistance to moisture and corrosion, reverse line-load miswiring, and resistance to environmental noise. Though products meeting these revised requirements will soon enter the marketplace, they are not required to have any special markings to distinguish them from models made prior to January 1, 2003. Models of GFCIs Listed by UL that were manufactured and labeled prior to January 1, 2003 still may appear in the marketplace after January 1, 2003, and until such time as old stocks of GFCIs become exhausted.

Ground fault circuit interrupters (GFCI) can help prevent electrocution inside and outside the home. GFCIs are an effective means of protecting against electrical shock, however, they must be tested regularly -- UL recommends once a month -- to verify they are working properly.

"Ground faults" are often the result of damaged appliance cords or consumers who use electrical products in wet environments, such as bathrooms or swimming pool decks. By installing GFCIs in every home in the United States, the U.S. Product Safety Commission (CPSC) estimates that more than two-thirds of the approximately 300 electrocutions occurring each year could be prevented. The advantage of using GFCIs is that they detect even those amounts of electricity too small for your fuse or circuit breaker to activate and shut off the circuit.

Like all products, GFCIs can be damaged. GFCIs damaged by lightning or electrical surges may fail to provide adequate protection. A simple test once a month and after any violent thunderstorm should be conducted.

To properly test GFCI receptacles in your home:

- Push the "Reset" button located on the GFCI receptacle, first to assure normal GFCI operation.
- Plug a nightlight (with an "ON/OFF" switch) or other product (such as a lamp) into the GFCI receptacle and turn the product "ON."
- Push the "Test" button located on the GFCI receptacle. The nightlight or other product should go "OFF."
- Push the "Reset" button, again. The light or other product should go "ON" again.

If the light or other product remains "ON" when the "Test" button is pushed, the GFCI is not working properly or has been incorrectly installed (miswired). If your GFCI is not working properly, call a qualified, certified electrician who can assess the situation, rewire the GFCI if necessary or replace the device.

"GFCIs are proven lifesavers, however, consumers need to take a few minutes each month to do this simple test. By taking action, you can help protect your family from the risk of electric shock," says John Drengenberg, UL Consumer Affairs Manager.

Several types of GFCIs may be installed in/around your home. Look for the UL Mark on GFCIs when purchasing them or when specifying the product to your electrician.

Wall Receptacle GFCI -- This type of GFCI -- the most widely used -- fits into a standard outlet and protects against ground faults whenever an electrical product is plugged into the outlet. Wall receptacle GFCIs are most often installed in kitchens, bath and laundry rooms, and out-of-doors where water and electricity are most likely to be in close proximity.

Circuit Breaker GFCI -- In homes equipped with circuit breakers, this type of GFCI may be installed in a panel box to give protection to selected circuits. Circuit breaker GFCIs should also be checked monthly. Keep in mind that the test will disconnect power to all lights and appliances on the circuit.

Portable GFCI -- A portable GFCI requires no special knowledge or equipment to install. One type contains the GFCI circuitry in a self-contained enclosure with plug blades in the back and receptacle slots in the front. It can then be plugged into a receptacle, and the electrical products are plugged into the GFCI. Another type of portable GFCI is an extension cord combined with a GFCI. It adds flexibility in using receptacles that are not protected by GFCIs. Portable GFCIs should only be used on a temporary basis and should be tested prior to every use.

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit product safety certification organization that has been testing products for more than a century. More than 16 billion products bearing the UL Mark enter the marketplace every year.