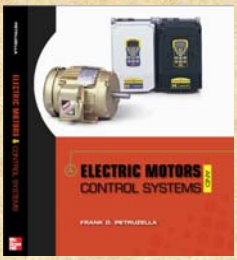


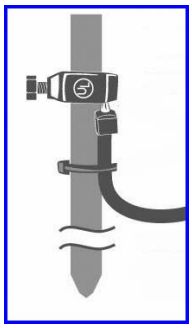
Chapter 1

Safety in the Workplace

PART 2 Grounding—Lockout—Codes

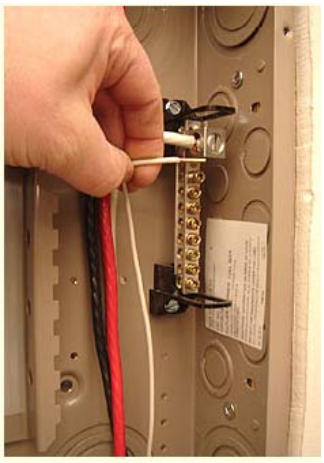
GROUNDING AND BONDING

Proper *grounding practices* protect people from the hazards of electric shock and ensure the correct operation of overcurrent protection devices.



Grounding **is the intentional connection of a current-carrying conductor to the earth in order to:**

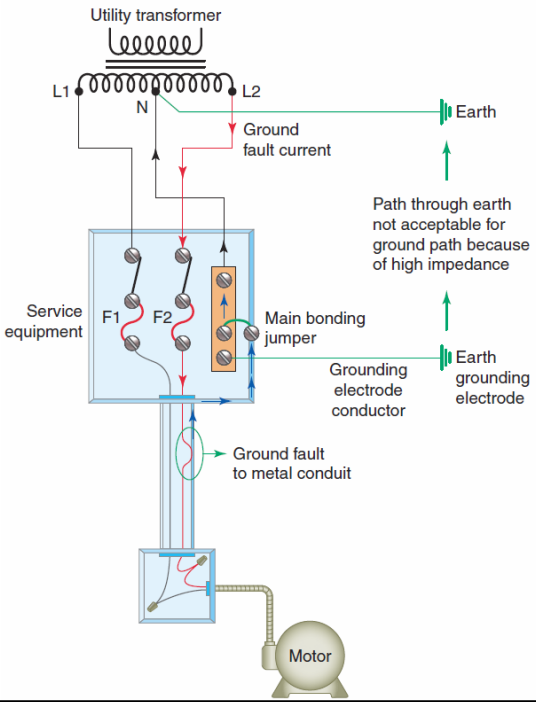
- **limit the voltage surges caused by lightning, utility system operations, or accidental contact with higher-voltage lines.**
- **provide a ground reference that stabilizes the voltage under normal operating conditions.**
- **facilitate the operation of overcurrent devices such as circuit breakers, fuses, and relays under ground-fault conditions.**

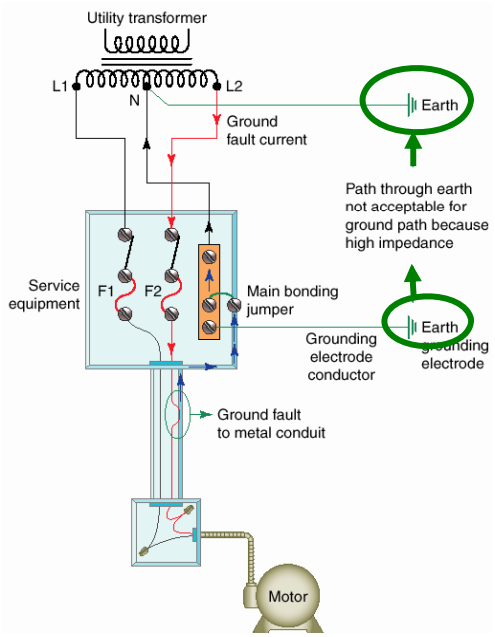


Bonding **is the permanent joining together of metal parts that aren't intended to carry current during normal operation in order to**

- **establish an effective path for fault current that facilitates the operation of overcurrent protective devices.**
- **minimize shock hazard to people by providing a low-impedance path to ground. Bonding limits the touch voltage when non–current-carrying metal parts are inadvertently energized by a ground fault**

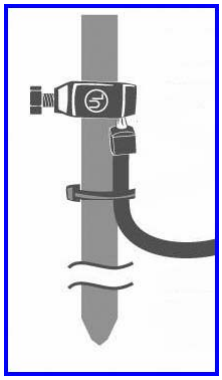
The Code requires all metal used in the construction of a wiring system to be bonded to, or connected to the ground system. The intent is to provide a low-impedance path back to the utility transformer in order to quickly clear faults.





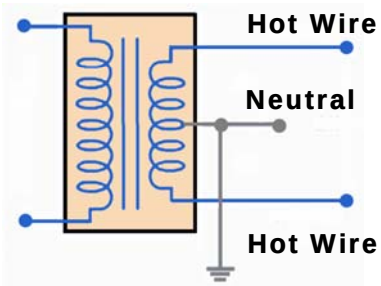
The earth is not considered as an effective ground-fault current path. The resistance of earth is so high that very little fault current returns to the electrical supply source through the earth.

Grounding **is accomplished by connecting the circuit to a metal underground water pipe, the metal frame of a building, a concrete-encased electrode, or a ground ring.**



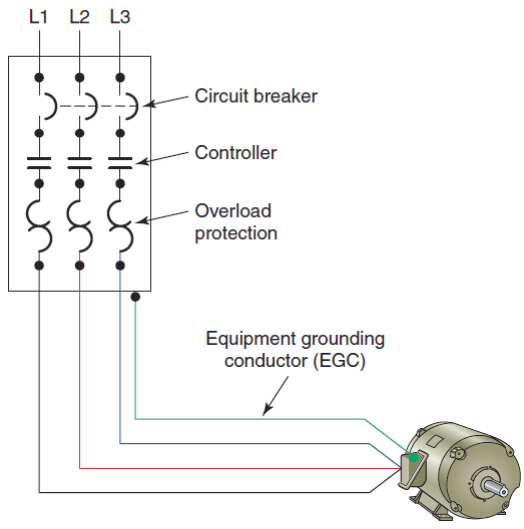
A grounding system has two distinct parts: system grounding and equipment grounding.

System grounding **is the electrical connection of one of the current carrying conductors of the electrical system to the ground.**



Equipment grounding **is the electrical connection of all the metal parts that do not carry current of all electrical equipment to the ground.**

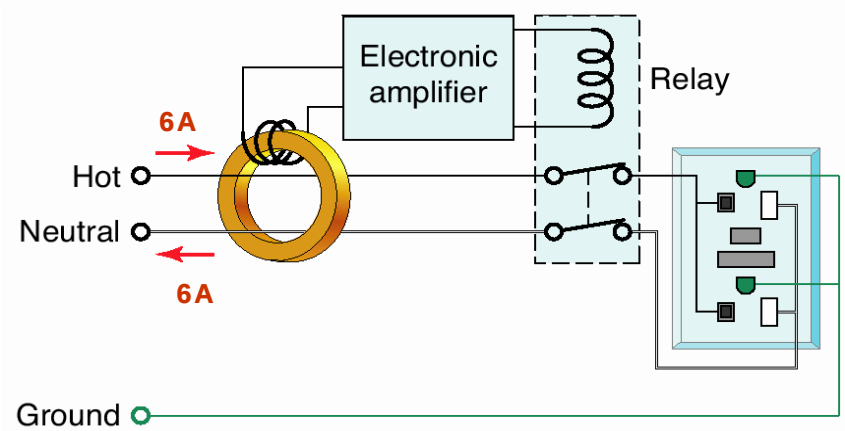
Equipment Grounding Conductor (EGC) **provides a low-impedance ground path between electrical equipment and enclosures within the distribution system.**



A *ground fault* is as an unintentional, electrically conducting connection between an ungrounded conductor of an electric circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth.

The *Ground-Fault Circuit Interrupter (GFCI)* is a device that can sense small ground fault currents. The GFCI is fast acting; the unit will shut off the current or interrupt the circuit within 1/40 second after its sensor detects a leakage as small as 5 mA.

The GFCI receptacle compares the amount of current in the ungrounded (hot) conductor with the amount of current in the grounded (neutral) conductor. Under normal operating conditions the two will be equal in value.



LOCKOUT AND TAGOUT

Electrical ***lockout*** is the process of removing the source of electrical power and installing a lock, which prevents the power from being turned "on".

Electrical ***tagout*** is the process of placing a danger tag on the source of electrical power, which indicates that the equipment may not be operated until the danger tag is removed.

Lockout **means achieving a zero state of energy. It's essential for all *interlocking or dependent systems* to also be deactivated and de-energized.**

The *danger tag* has the same importance and purpose as a lock and is used alone only when a lock does not fit the disconnect means. Danger tags are required to be securely attached at the disconnect device with space provided for the worker's name, craft, and the procedure that is taking place.

BASIC STEPS IN A LOCKOUT PROCEDURE

Prepare For Machinery Shutdown: **Identify the location of all switches, power sources, controls, interlocks, and other devices that need to be locked out in order to isolate the system.**

Machinery Or Equipment Shutdown: **Stop all running equipment by using the controls at or near the machine.**

Machinery Or Equipment Isolation: Disconnect the switch (Do not operate if the switch is still under load). Stand clear of the box and face away while operating the switch with the left hand (if the switch is on the right side of the box).

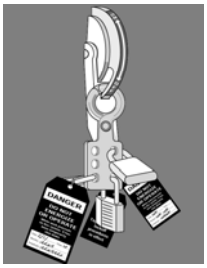
Lockout And Tagout Application:

- Lock the disconnect switch in the OFF position.
- Some switch boxes contain fuses, and these should be removed as part of the lockout process.
- Use a tamper-proof lock with one key, which is kept by the individual who owns the lock.
- Tag the lock with the signature of the individual performing the repair and the date and time of the repair.
- There may be several locks and tags on the disconnect switch if more than one person is working on the machinery.

Release Of Stored Energy: All sources of energy that have the potential to unexpectedly startup, energize, or release must be identified and locked, blocked, or released.

Verify the isolation: Use a voltage test to determine that voltage is present at the line side of the switch or breaker. When all phases of outlet are dead with the line side live, you can verify the isolation. Ensure that your voltmeter is working properly by performing the ***live-dead-live*** check before each use.

Lockout/Tagout Removal: **Remove tags and locks when the work is completed. Each individual must remove his or her own lock and tag. If there is more than one lock present, the person in charge of the work is the last to remove his or her lock. Before reconnecting the power, check that all guards are in place and that all tools, blocks, and braces used in the repair are removed. Make sure that all employees stand clear of the machinery.**

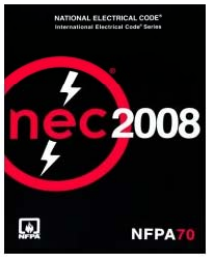


ELECTRICAL CODES AND STANDARDS

Occupational Safety and Health Administration *(OSHA)*

The purpose of *OSHA* is to assure safe and healthful working conditions for working men and women by authorizing enforcement of standards developed under the Act; by encouraging and assisting state governments to improve and expand their own occupational safety and health programs and by providing for research, information, education and training in the field of occupational health and safety.

National Electrical Code (NEC)



The *National Electrical Code (NEC)* is a minimum electrical safety standard; its primary purpose is directed at protection of persons and property from electrical hazards. Hazards of electrical shock, electrocution, and fires are some of the more serious consequences of noncompliance with minimum rules for safety.

Standards contained in the NEC are enforced by being incorporated into the different city and community ordinances that deal with electrical installations in residences, industrial plants, and commercial buildings.

An *Article* of the Code covers a specific subject.

Article 430 of the NEC covers motors and all associated branch circuits, overcurrent protection, overload and so on.

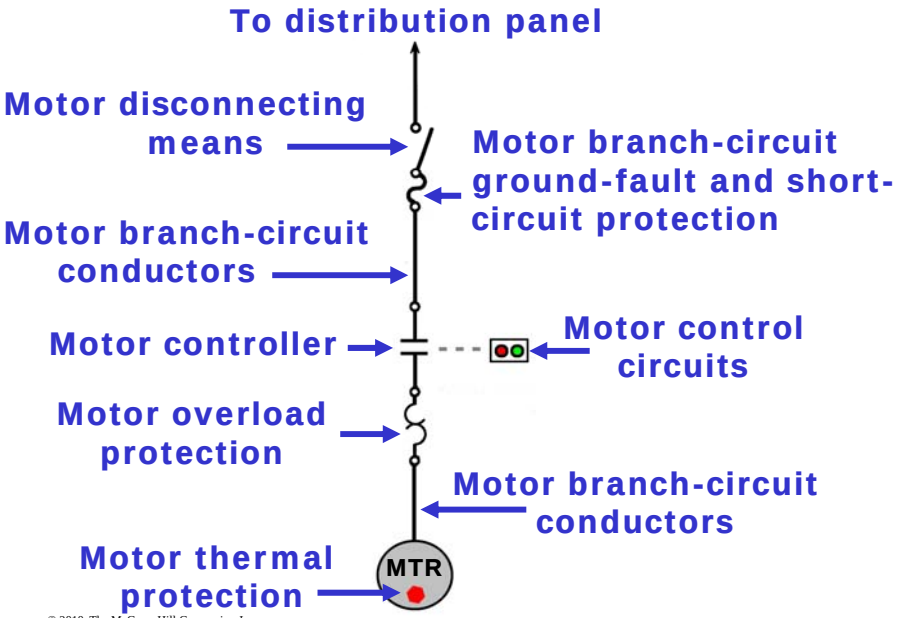
The installation of motor-control centers is covered in **Article 408**.

Air-conditioning equipment is covered in **Article 440**.

Each Code rule is called a *Code Section*.

For example, the rule that requires a motor disconnecting means be mounted within sight of the motor and driven machinery is contained in Section **430.102 (B).** "In sight" is defined by the Code as visible and not more than 50 feet distance (**Article 100** - definitions)

Code Motor Terminology



Article 500 of the Code refers to hazardous areas. Such areas are dangerous from any standpoint and each has its unique problems that require special methods for taking care of the electrical systems installed in these places.

Explosion-proof apparatus, dust ignition-proof equipment, and purged and pressurized equipment are examples of protection techniques that can be used in certain hazardous (classified) locations.

National Fire Protection Association (NFPA)

The National Fire Protection Association (NFPA) develops codes governing construction practices in the building and electrical trades. It is the world's largest and most influential fire safety organization.

NFPA has published almost 300 codes and standards, including the National Electrical Code!

Classes of fires are categorized by NFPA according to the kind of material that is burning.

Class A **fires are those fueled by materials that, when they burn, leave a residue in the form of ash, such as paper, wood, cloth, rubber, and certain plastics.**

Class B **fires involve flammable liquids and gasses, such as gasoline, paint thinner, kitchen grease, propane, and acetylene.**

Class C **fires involve energized electrical wiring or equipment such as motors and panel boxes.**

Class D **fires involve combustible metals such as magnesium, titanium, zirconium, sodium, and potassium**

Nationally Recognized Testing Laboratory

Article 100 of the NEC definitions the terms *Labeled* and *Listed* which are both are related with product evaluation.

Labeled or listed **indicates the piece of electrical equipment or material has been tested and evaluated for the purpose for which it is intended to be used.**

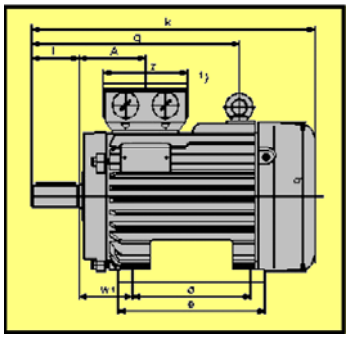
Any modification of a piece of electrical equipment in the field may void the label or listing.

A *Nationally Recognized Testing Laboratory* must test electrical products for conformity to national codes and standards before they can be listed or labeled.

The biggest and best-known testing laboratory is *Underwriters' Laboratories*, identified with the UL logo.

National Electrical Manufacturers Association

NEMA standards **provide practical information concerning the rating, testing, performance, and manufacture of motors and frame sizes.**



International Electrotechnical Commission (IEC)

The IEC is a *European based* standards organization made up of national committees from over 60 countries.

Dimensionally, IEC standards are expressed in metric units.

NEMA standards tend to be more conservative---- allowing more room for design interpretation, as has been U.S. practice. Conversely, IEC standards tend to be more specific, more categorized --- some say more precise--- designed with less overload capacity.

The Institute of Electrical and Electronics Engineers (IEEE)

The IEEE is a technical professional association which primary goal is to foster and establish technical developments and advancements in electrical and electronic standards.