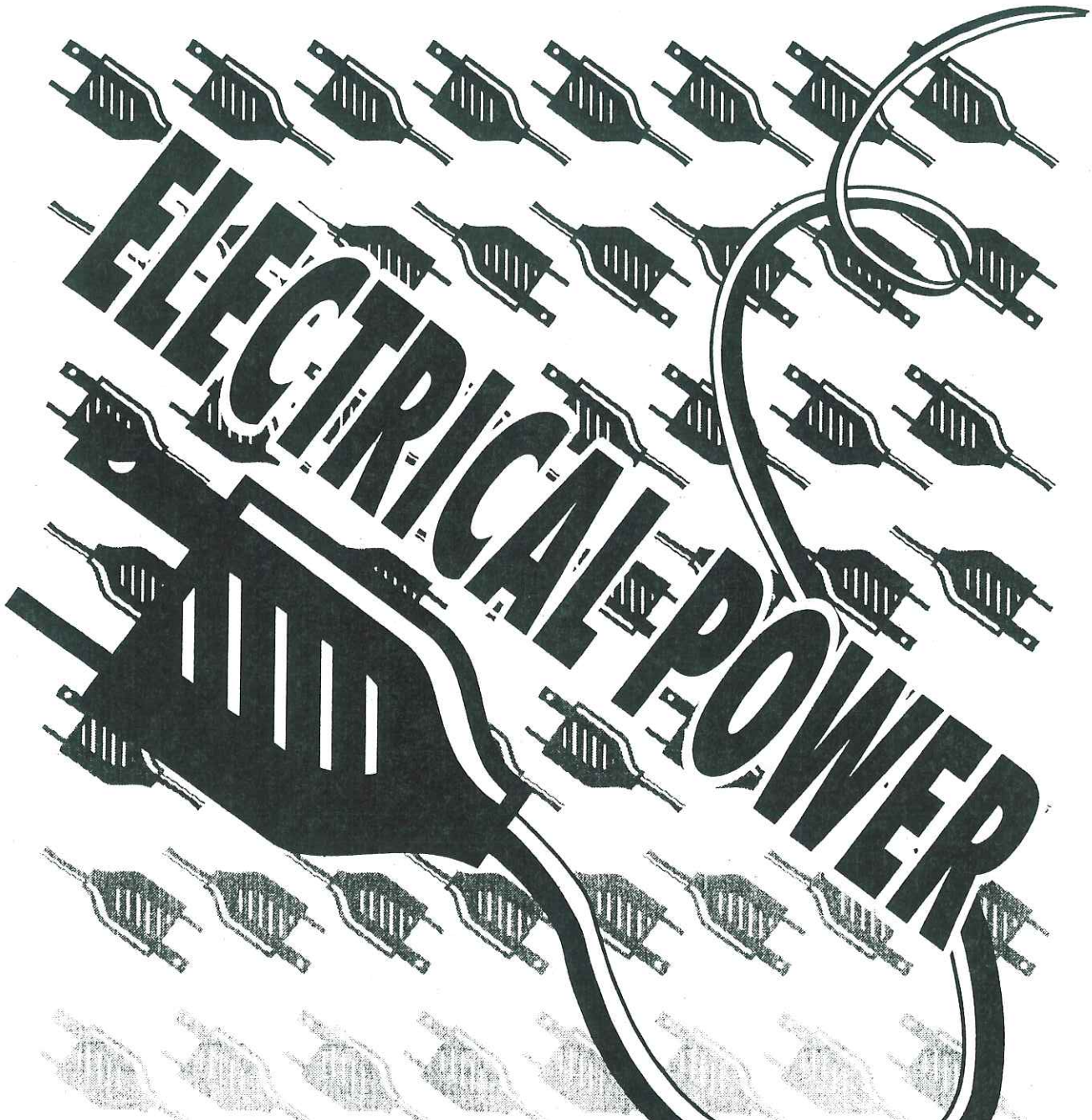


and Safety in Your Home

AMERICAN SOCIETY OF HOME INSPECTORS, INC.®

Electricity has become an indispensable fact of life in today's world. With it we control our comfort and many of the functions of daily life in our homes.

Yet electricity also brings with it the potential for great danger. Inadequate wiring and improper installations can create serious, even lethal conditions. It is critically important for you, as a homeowner, to know enough about your electrical system to operate it safely.

UNDERSTANDING ELECTRICITY

Electricity results from the flow of electrons. The force, or pressure, that is needed to push electricity through wires is called **voltage**. The volume of electricity, or current, is called **amperage**. Just as the volume of water flowing through a pipe depends on its pressure and pipe's diameter, so the amount of electricity flowing through a wire depends on both the number of volts (pressure) and the number of **amperes** (volume) that can pass through it.

A home's electrical system most often originates at the **main service panel**. It is then divided into branches, called **circuits**, and connected by wires to wall outlets, appliances, and switches throughout the house.

The metals copper and aluminum carry electricity efficiently, and are called **conductors**. Materials that are not good conductors such as glass, rubber, plastic, ceramic, wood, and paper, are called **insulators**.

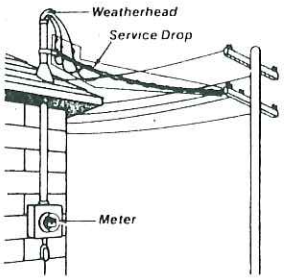
ELECTRICAL SERVICE

In order for an electrical system to be safe, it must be properly installed according to the requirements of the National Electrical Code® and any local regulations. Licensed electricians follow the Code when they install, repair, or improve electrical circuits inside a house.

As new materials and devices appear, however, the Code is periodically revised. Wiring which was in compliance with the Code when a home was built may no longer be up to modern standards. Your licensed electrician can tell you if upgrading your electrical system would be beneficial.

In older neighborhoods or rural areas, the utility company provides power to homes through overhead conductors called the **service drop**. In urban areas and newer neighborhoods the power comes to the house underground, and is called a **service lateral**.

In almost all areas the homeowner is responsible, through his or her electrical contractor, to maintain the wiring throughout the house up to the connections at the end of the service drop or service lateral.



Size of the Service:

The service voltage can usually be determined by counting the number of wires connected to the **service entrance**, the cable that carries the current from the service drop to the electrical equipment. Two wires mean 120 volt service, while three wires indicate the availability of both 120 volt and 240 volt service.* Voltage on a service lateral usually can be assumed to be 240 volts. While lights and most small appliances operate on 120 volts, heavy duty electrical appliances such as ranges, heat pumps, and clothes dryers require 240 volts.

The available amperage is determined by the size and the type of service entrance cable, and is something your electrician or ASHI inspector can identify for you.

With the heavy electrical demand of today's lifestyles, any service which provides less than 100 amps at 120/240 volts may be considered inadequate for the average family. A home equipped with an electric water heater, range, clothes dryer, and central air conditioning may require 150 amps. If, in addition, the house is heated by electricity, it should have, at a minimum, a 200 amp service, unless the dwelling is a small apartment or cottage.

If an electrical service has not been upgraded within the last 20-30 years, the chances are that the amount of power being supplied is inadequate. An inadequate service may have:

- fuses that blow or circuit breakers that trip often
- lights that flicker or dim when appliances are turned on
- a TV image that shrinks when a heavy appliance is turned on
- too many extension cords in use
- smoke coming from receptacles, switches, or devices.

The Electric Meter:

Electrical usage is measured in units call **watts**, which are equivalent to the number of volts times the number of amps. The utility company charges you according to the number of watts that are registered on the digital readout or dials of your **electric meter**. The meter itself, which belongs to the utility, may be located inside or outside the house.

Main Service Panel:

The **main service panel**, which is usually located on a wall close to the incoming cables, is the central command post of your electrical system. From here power is fed to the outlets and appliances throughout the house.

Some electrical systems have a single switch, lever or handle called the **main disconnect** which can shut off all the power to the house in case of emergency, but the National Electrical Code® allows up to six disconnects to shut off all the power in a residence. It is essential that you know the type, number, location, and operation of the main disconnect(s) in the event of an emergency. A single disconnect will usually be located very close to the electric meter; multiple disconnects will nearly always be located on the panel.

Overload Protection:

When too much current flows through a wire, the wire gets hot, sometimes hot enough to destroy the insulation and cause a fire.

This situation, called an **overload**, may develop from a **short circuit**, where two bare wires are touching each other, or, more frequently, when too many appliances are being used on the same circuit at one time.

To prevent this from happening, the wires in a circuit are protected with safety devices which are designed to open, or disconnect, the circuit from its source when too much current is passing through them.

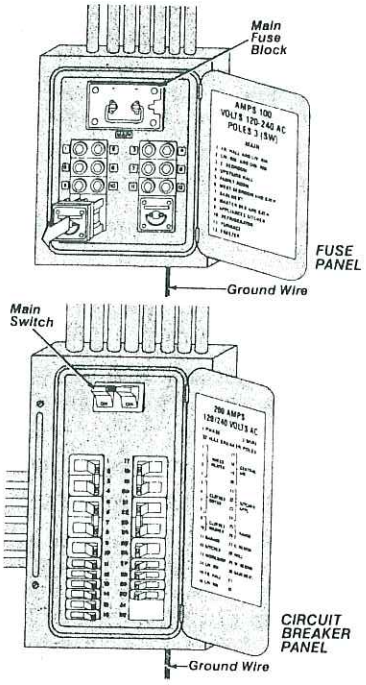
There are two kinds of over-current protective devices: **fuses**, which must be replaced if they blow, and **circuit breakers**, which can be simply reset.

Once the overload situation is remedied (e.g. by unplugging some of the devices, or by replacing worn insulation or defective appliances), circuit breakers can be reset by moving the switch from the "trip" position to "off" and then back to "on". Even if they are never tripped, all circuit breakers should be turned off and on at least once a year to prevent sticking due to corrosion buildup or mechanical failure of their moving parts.

Since blown fuses must be replaced, it helps always to have a supply of the correct sizes on hand.

A word about fuse and breaker size:

The National Electrical Code® specifies the maximum current or amperage which can be carried safely by each size and type of wire used in a home. Therefore, fuses and breakers must be the correct amperage in order to properly protect each circuit. In other words, if you blow a 15-amp fuse, it should be replaced only with a 15-amp fuse or a Type S (tamper-proof) 15-amp fuse and adapter. Larger size fuses would allow too much current to flow in the circuit, making it unsafe.



Service Ground:

Every electrical system must be **grounded** so that, in case of a faulty appliance, worn insulation, or a voltage surge caused by a lightning strike, the electricity will be harmlessly discharged into the earth, rather than into the house system or a person.

System grounding is achieved by connecting the neutral wires from all the electrical circuits to a metal strip in the main service panel called the **neutral bus bar**, which is in turn connected by a wire to a rod driven into the earth, or to the metal cold water supply pipe which goes into the earth.

ELECTRICAL CIRCUITS

Power Distribution:

If there are too few circuits, or their loads are not distributed properly throughout the house, there may be frequent overloads. This kind of service is unsatisfactory and can be a potential fire hazard.

A good way to evaluate your power distribution is to test and label the individual circuits in your home. Simply turn off the fuses or circuit breakers one by one and notice which outlets and appliances are affected. Then mark the circuits accordingly, either on the main service panel box or on a master list kept nearby.

After identifying the individual circuits, calculate the number of watts each one uses. Many electrical devices have the wattage stamped on their I.D. tag or **name plate**. If only the amperage is identified, multiply this by the voltage of the circuit to arrive at the wattage. **[Watts = Volts x Amps]** Be sure to add up the wattage ratings of **all** the light bulbs and appliances on each circuit.

No 15-amp circuit (at 120 volts) should carry more than 1,500 watts. For a 20-amp circuit, the maximum is 2,000 watts. Heavy duty appliances are almost always wired for 240 volts and each must be on a separate circuit with its own fuse or breaker.

If the wattage used on an individual circuit exceeds the maximum, you should consult a licensed electrician about having that circuit rewired.

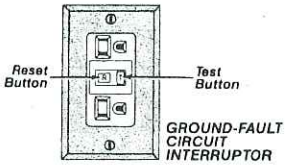
Outlets/Receptacles:

The modern, ideal arrangement of duplex receptacles, for safety and convenience, is one for every 12 feet of running wall space, or one on each wall of the average 10' by 12' room. No point on any wall should be further than 6' from an outlet. The reason for this placement is to avoid the use of extension cords, which can become worn, broken, or simply overheat and cause a fire. In the kitchen there should be 20-amp appliance outlets every two feet at the counters. Homes with fewer than this ideal number of outlets may require upgrading.

Modern homes are equipped with grounded three-hole receptacles. Appliances with three-prong plugs are thus safely grounded in three-hole receptacles. A three-prong appliance plug can be connected to a two-hole outlet by means of a properly installed grounding adapter.

Even if a system is properly grounded, minor faults in a circuit can cause dangerous shock to a person using an electrical appliance in a damp location or near water. For this reason, the National Electrical Code® now requires a **Ground-Fault Circuit Interruptor** (GFCI) to be connected to (a) every bathroom outlet, (b) at least one garage and one basement receptacle, (c) kitchen counter receptacles within 6 feet of the sink, and (d) all outdoor receptacles with direct access to the yard or a swimming pool.

The GFCI senses the flow of electricity through a circuit. If more current is flowing through the black ("hot") wire than the white ("neutral") wire, there is a current leakage. The GFCI, which can sense a ground leak of as little as .005 amps, will shut off the current in 1/40 of a second, which is fast enough to prevent injury.



If you do have Ground-Fault Circuit Interruptors, it is recommended that you test (and reset) them monthly. When you push the test button, the reset button should pop out, shutting off the circuit. If it doesn't, the breaker is not working properly. If you don't test them once a month, the breakers have a tendency to stick, and may not protect you when needed.

Further protection is provided in the electrical system by the use of **polarized** plugs and outlets. These ensure that the hot and neutral wires of an appliance connect to the hot and neutral wires inside the receptacle.

Polarized plugs have one prong wider than the other, so that the plug can only be inserted the correct way. Three-prong plugs are automatically polarized because the hot and neutral prongs are properly positioned in the outlet by the grounding plug.

Conductors:

Most electrical wire is made of copper. Nevertheless, some houses built or remodeled between the early 1950s and 1979 were wired with aluminum. Such wiring can be identified by the letters AL or the word ALUMINUM stamped on the plastic covering or cable. In some very early cases, the aluminum wiring was in a steel metal jacket, and therefore must be carefully examined to verify that it is aluminum.

Aluminum wiring can be hazardous because of its tendency to oxidize and its incompatibility with fittings designed for other metals used in the electrical system. Improper connections can create electrical resistance, which may in turn cause overheating and fire.

A house with aluminum wiring may not need to be completely rewired, but may require "pigtailing" of each wire with copper, the only method approved by the Consumer Products Safety Commission.

Warning signs of unsafe aluminum wiring include:

- unusually warm or warped outlet and switch cover plates
- smoke or sparks coming from outlets and switches
- strange odors in the area of outlets and switches
- periodic flickering of lights
- untraceable problems with plug-in lights and appliances.

Only a licensed electrician should be allowed to evaluate and repair these potentially dangerous situations.

Cabling:

Modern electrical cables are usually composed of two, three or four insulated wires enclosed in a metallic (called armored) jacket, or in a non-metallic plastic or cloth jacket.

In older homes, the conductors are sometimes not enclosed in jackets, but run singly, supported on porcelain fittings or behind

special wood molding. This is called knob-and-tube-wiring. Sections of the system may be visible in an unfinished basement or attic or the molding may be seen on finished walls and ceilings.

While knob-and-tube wiring is not inherently dangerous, it is old, and its insulation may no longer be intact. Much of it will be concealed behind walls, ceilings, and insulation, where its condition cannot be completely evaluated. It is also not a grounded system, and is therefore more hazardous than others, especially in kitchens, bathrooms, and garages, as well as near pools, outdoor outlets, and indoor outlets.

If you have knob-and-tube wiring it would be wise to have the system inspected and repaired by a licensed electrician. If necessary, it should be replaced.

SAFETY RULES

With this basic understanding of electricity and electrical systems, it is easy to realize why the following safety rules are so important:

1. Never work with or near electricity when hands or feet are damp.
2. Never remove service panel covers.
3. Don't use outlet multiplier plugs to connect lamps and appliances whose amperage totals more than the capacity of the circuit.
4. Avoid using extension cords whenever possible. Never run them across hallways or doorways, under carpeting or furniture, or through walls. Never staple them in place.
5. Never replace blown fuses with larger amp fuses.
6. Don't cut the grounding (3rd) prong off a plug to fit it into a two-hole receptacle.
7. Keep electrical appliances (e.g. hair dryers, radios, shavers) away from bath tubs, sinks, and showers.
8. Don't pull cords out of receptacles by the wire. Hold by the plug and pull.
9. Replace worn or frayed lamp and appliance wires.
10. Don't try to extinguish small electrical fires with water. Use baking soda or a Type "C" household halon extinguisher which is rated for electrical fires.
11. All electrical work done in a house should be inspected and approved by the local authorities.
12. Always disconnect a circuit before making repairs on it or installing a light fixture.
13. When in doubt, call a licensed electrician.

Homeowners should be prepared for electrical repairs if any of the following danger signs are observed.

- Dangling wires, overuse of extension cords
- Unsupported cabling
- Overheated wires
- Open junction boxes
- Splices not enclosed in a metal or plastic box
- Heat emanating from switches, outlets, junction boxes, or service panels
- Wires past doorways, radiators, under carpets
- Dimming lights

Though many homeowners are knowledgeable and feel confident in handling electrical repairs, it's always safest to consult a licensed electrician and to hire one for all but the most basic jobs.

GLOSSARY

Ampere The unit of electrical current by which the volume of electricity is measured.

Circuit A branch of the main electrical system which brings electricity to appliances or to a room in the house via switches and outlets.

Circuit Breaker A switch that senses current overload on a circuit and automatically shuts it off to prevent overheating or overcurrent.

Conductor Any material which permits the flow of electrons.

Electricity The result of electrons flowing through a conductor.

Fuse A device located at the main service panel or subpanel, which protects each circuit from a current overload. Screw-in fuses are used in panel boxes and subpanels to protect 120 volt circuits up to 30 amps. Cartridge type fuses, held in clips are used to protect 240 volt circuits drawing 20 or more amps.

Ground A conductor that leads directly, or through other conductors, to the earth.

Ground-Fault Circuit Interrupter (GFCI) A device which automatically opens the circuit when it senses a current leak to ground. Designed to prevent personal injury when electrical equipment is operated, it is particularly helpful in a damp or wet environment.

Insulator Any material which inhibits the flow of electrons.

Main Service Panel The location from which incoming power is divided and fed throughout the house along a series of branch circuits.

Overload A condition caused when too much current flows through a conductor. Overloaded conductors overheat, and may cause fires.

Polarity The correct flow of electricity that is achieved when the hot and neutral wires of the power supply circuits are connected to the corresponding hot and neutral wires of an appliance.

Reversed Polarity A potentially hazardous situation in which the hot and neutral wires of a circuit are reversed at the outlet, thereby allowing an appliance to be incorrectly connected.

Service Entrance The cable that carries current from the utility company's service drop to the main disconnect.

Short Circuit The condition that exists when a live wire touches any grounded or neutral bare wire or metal (such as a switch plate cover) somewhere along the circuit.

Volt The unit of electrical force used to measure the "pressure" with which electricity is pushed through a conductor.

Watt The unit by which electrical power consumption is measured. It is calculated by multiplying the voltage in a circuit by the number of amps being used by the appliance or other load.

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