

ELECTRICAL



SAFETY WORKBOOK

A guide to understanding and maintaining your home's electrical system



A publication presented by the Electrical Safety Foundation International





What's Inside?

► *Everything you need to know*

Should You Do-It-Yourself?.....	Page 1
Is a Permit or Inspection Required?.....	Page 2
How Much Energy Does My Home Use?.....	Page 3
How Does My Electrical System Work?.....	Page 4
What's Inside My Service Panel?.....	Page 5-6
What Kind of Wiring System is in My Home?.....	Page 7
Does My Home Have Grounded Outlets?.....	Page 8
What is a Tamper-Resistant Outlet?.....	Page 9
What is a GFCI?.....	Page 10
What is Energy Efficient Lighting?.....	Page 11
How Do I Clean Up a Broken CFL?.....	Page 12



► *Electrical Safety Foundation International*

The Electrical Safety Foundation International (ESFI) is dedicated exclusively to promoting electrical safety. ESFI is a 501(c)(3) organization funded by electrical manufacturers, distributors, trade and labor associations, independent testing laboratories, utilities, and safety and consumer organizations.

ESFI proudly sponsors National Electrical Safety Month each May, and engages in public education campaigns throughout the year to prevent electrically related fatalities, injuries, and property damage.

ESFI has a collection of educational tools and resources that are available right at your fingertips. On our web site, you will find practical information and safety tips on a wide variety of topics, from holiday safety to protecting our communities from dangerous counterfeit electrical products. These materials are available to download at no cost and can be used to help you raise awareness in your community or organization about electrical dangers in the home and the workplace.

To learn more about ESFI and electrical safety, visit www.electrical-safety.org.

Should you Do-It-Yourself?

► *Know When to Call a Professional*

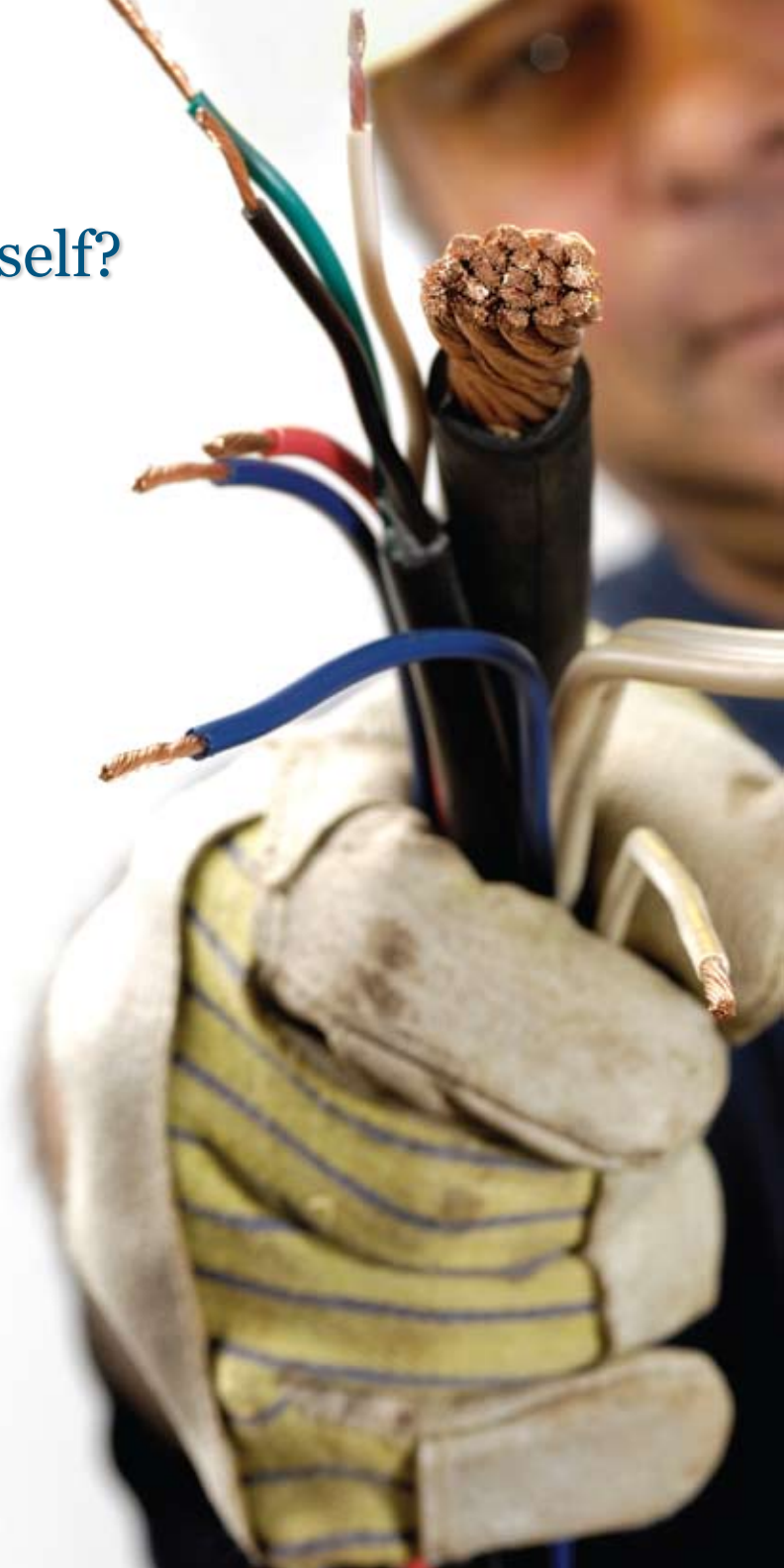
Safety should ALWAYS be the foremost concern for anyone who is working on or around electricity. It is critical to recognize and distinguish between those repairs that you are qualified to undertake and those that only a professional electrician should handle.

► *Do-It-Yourself Safety Tips*

ESFI recommends that you always contact a qualified, licensed electrician to perform any electrical work in your home.

If you do decide to undertake a basic home electrical project, consider the following important safety tips:

- ✓ Always turn off the power to the circuit that you plan to work on by switching off the circuit breaker in the main service panel.
- ✓ Be sure to test wires before you touch them to make sure that the power has been turned off. Test from the black wires to both the grounded box and the white wires, and test from the white wires to the grounded box.
- ✓ Never touch plumbing or gas pipes when performing a do-it-yourself electrical project.
- ✓ Make sure that you are not standing on a damp floor.
- ✓ Be sure to unplug any lamp or appliance before working on it.
- ✓ Take an active role in understanding the condition of your current electrical system, its capacity, limitations, and potential hazards.



Is a permit or inspection required?

► *Electrical Permits & Inspections*

Many state and local laws require that a permit be obtained prior to the installation of electrical wiring or devices, and that an inspection be performed to ensure that the work was performed safely and meets applicable code requirements.

Projects that require a permit include:

- ☑ Adding or extending a new circuit and/or wiring for central air conditioning, a swimming pool, or a hot tub
- ☑ Installing and/or adding a receptacle or light fixture where one did not already exist
- ☑ Installing and/or adding a new electrical panel
- ☑ Restoring electrical service after an interruption caused by a hazardous condition
- ☑ Wiring or re-wiring any new structure such as a house, garage or shed

Permits are generally not mandated for minor repairs, but work must comply with the version of the *National Electrical Code* that is recognized by the state or city in which you live.

Projects that do not require a permit may include:

- ☑ Replacing a receptacle where one already exists
- ☑ Replacing a faulty circuit breaker with the same size/type
- ☑ Replacing or changing a light fixture
- ☑ Installing a phone or coax cable for cable television

If you hire an electrician or contractor to perform work at your home, be sure to confirm that he/she has obtained the appropriate permits, and request an inspection once the work is complete. This protects your family against risk of electrocution and electrical fires—and it is the law!

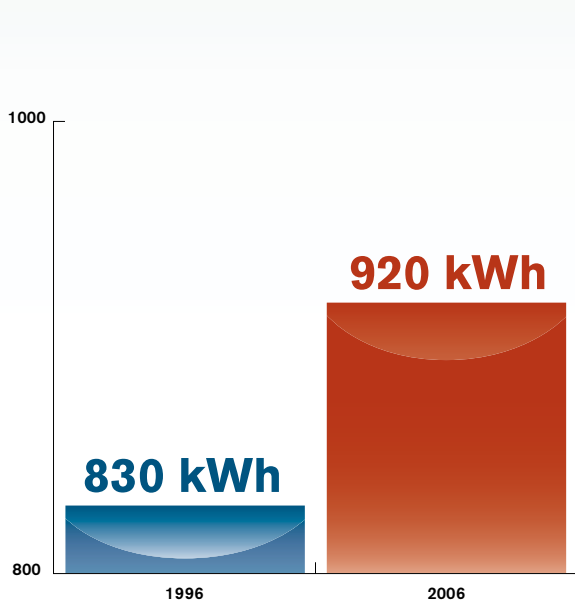


How much energy does my home use?

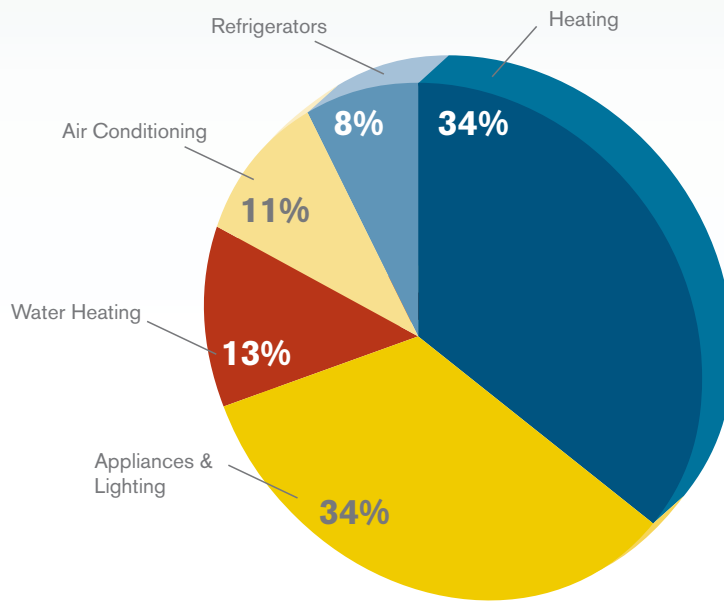
► *Energy Distribution*

Electricity plays an integral role in how our homes operate. Whether watching TV, turning on the air conditioner, or charging a cell phone, we rely on our home's electrical system to provide us with power when and where we need it.

Today, we expect more from our homes than ever before. As the number of appliances we use continues to grow, so does our energy consumption. You can help manage the demands placed on your electrical system and keep it in safe working condition by understanding the basics of how electricity is distributed around your home.



Average Monthly Energy Consumption



Average Home Energy Distribution



How does my electrical system work?

► *Your Home Electrical System*

Electricity enters your home through a service head from a series of outdoor power lines or an underground connection. A typical service head consists of two 120-volt wires and one neutral wire that deliver power to lights and appliances around the home.

Each year, 400 people are electrocuted in their own home or yard.

The **ELECTRIC METER** is mounted outdoors where electricity enters your home. This device is used to measure the amount of electricity that is consumed in your home. The meter is monitored by your electric utility company and is protected by law—tampering with it is both extremely dangerous and illegal.

The **SERVICE PANEL** is the central distribution point for delivering electricity to switches, outlets, and appliances throughout the house. Located near the electric meter, the service panel is equipped with a breaker that shuts off power to the circuits if an electrical system failure occurs.

GROUNDING is the method used to connect an electrical system to the earth with a wire. Grounding adds critical protection against electric shock and electrocution by using a grounding rod to provide a third path for conducting electricity in the event of a short circuit or an overload. Grounding will help protect the person working on the system, the system itself, and any appliances and equipment that are connected to the system.



What's inside my service panel?

► *Home Electrical Service Panel*

Every home has a service panel that distributes electricity to switches, outlets, and appliances. Service panels are equipped with fuses or circuit breakers that protect the wires in each circuit from overheating and causing a fire. Older service panels use fuses, while more modern systems utilize circuit breakers.

A tripped breaker is likely the result of too many appliances overloading the circuit and should be fixed immediately. Follow these steps to turn the power back on.

INSTRUCTIONS FOR RESETTING A TRIPPED BREAKER

- 1 Unplug or turn **OFF** appliances in the room.
- 2 Find your main breaker panel and open the cover.
- 3 Locate the tripped breaker or blown fuse. A tripped circuit breaker will be in the off position or in a middle position between **ON** and **OFF**.
- 4 To reset the breaker switch it to **OFF** position and then back to **ON**. This may restore power to the room.
- 5 If the problem continues, there may be more serious issues. Contact an electrician to diagnose the problem.

Fortunately, many of the dangers associated with older systems can be prevented simply by upgrading your home's electrical service panel.

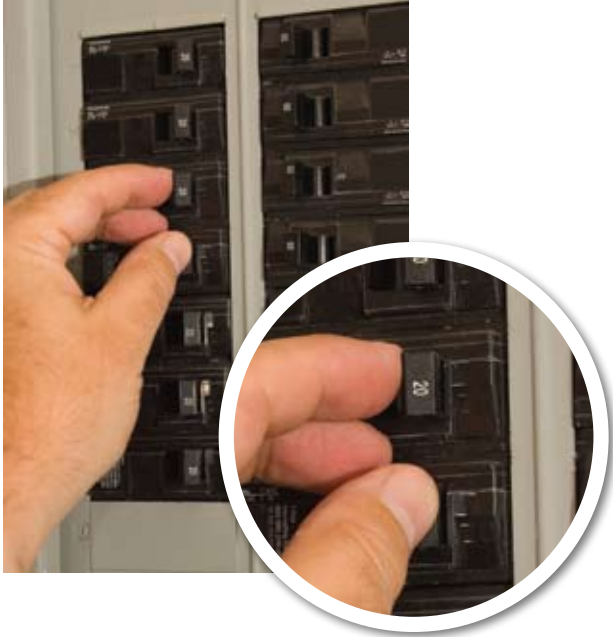
FUSES

Service panels installed before 1965 use fuses to protect each individual circuit. Once a fuse is blown, it must be unscrewed and thrown away.

Fuses were commonly used in 30- and 60-amp service panels. Today, most homes use 100- to 200-amp service.

INSTRUCTIONS FOR REPLACING FUSES

- 1 When replacing fuses in your service panel, the replacement fuse should always match the amperage rating of the circuit.
- 2 Never replace a fuse with one that has a larger amperage rating. This is a very dangerous practice.



CIRCUIT BREAKERS

All newer homes are protected by circuit breakers. Unlike a fuse that must be replaced when it blows, a circuit breaker that has “tripped” can be mechanically reset to resume operations once the problem has been resolved. Each circuit breaker contains a permanent metal strip that heats up and bends when electricity moves through it. If a circuit shorts out or becomes overloaded, the metal strip bends enough to “trip,” flipping a switch that immediately shuts off power to the circuit. Circuit breakers also protect branch circuits, which can be sized for 120-volts or 240-volts.



The 120-volt circuits use one phase of the electrical service to power standard home appliances.



The 240-volt circuits use both phases of the service to power larger appliances such as a clothes dryer.

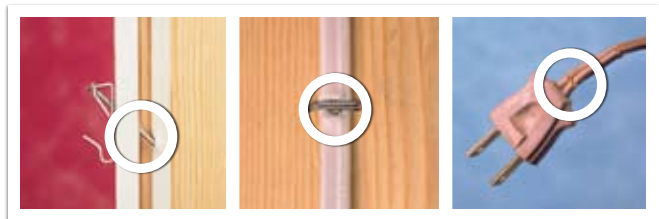
Electrical arcing causes more than 30,000 fires a year, according to the National Fire Protection Association.

ARC FAULT CIRCUIT INTERRUPTERS (AFCIs)

AFCIs are new protective devices that replace standard circuit breakers in the electric service panel. AFCIs provide enhanced protection against additional fire hazards known as arc faults. An arc fault is a dangerous electrical problem caused by damaged, overheated, or stressed electrical wiring or devices. Without AFCIs, arc faults may be hidden from plain view until it is too late.

The U.S. Department of Housing and Urban Development’s *Healthy Homes Report* listed the absence of AFCIs among the primary residential hazards associated with burns and fire-related injuries.

In fact, these devices are so effective that the 2008 edition of the *National Electrical Code* now requires that they be used to protect almost every circuit in the home.





What kind of wiring system is in my home?

► *Understanding Your Home's Wiring*

More than 30 million homes, or about one-third of the homes in the United States are at least 50 years old, and studies have shown that the frequency of fires in these aging homes is disproportionately high. Many older homes were built with electrical systems and components which are no longer safe and may be considered as fire hazards.

Electrical distribution systems are the third leading cause of home structure fires.

It is important to identify what type, color, and size wire is needed in order to properly address hazardous situations before they become critical.

Knob & Tube Wiring: 1800s–1930s

Knob and tube wiring was designed as an open air system that used ceramic knobs to separate wires from combustible framing. These suspended wires were directed through ceramic tubes to prevent contact with the wood framing and starting a fire. Today, knob and tube wiring is considered a fire hazard because it is not a grounded system, and is more susceptible to damage from aging and faulty renovations.

Aluminum Wiring: 1960s–1970s

As the price of copper soared in the 1960s, it became common to replace copper wires with aluminum instead. Because aluminum is highly responsive to temperature fluctuations, it is more likely to become loose over time and lead to a high-resistance connection that is a fire hazard.

It is estimated that nearly two million homes were wired with aluminum between 1962 and 1972. If your home is equipped with aluminum wiring, consult an electrician about updating your wiring system and other options that can protect your home.

Grounded Electrical Systems: 1940s–Present

Electricity always seeks to return to its source and complete a continuous circuit. A typical circuit in your home's wiring system has two conductors—one that flows from the service panel to appliances in your home, and another that returns the current to the main service panel. In a grounded electrical system, a third or "grounding" wire is connected to all outlets and metal boxes in your home, and is then connected directly to the earth using a metal grounding rod or a cold water pipe. In contrast, an ungrounded system does not prevent electricity from taking the path of least resistance – even if that path is through an unsuspecting person who comes into contact with an appliance that has a short circuit.

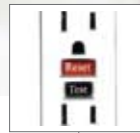
Grounding is a critical safety feature that protects you from shock or electrocution. If your home is not grounded, contact an electrician to upgrade your electrical system.



1920s–1940s
Polarized Outlet



1940s–Present
Grounded Outlet



1970s–Present
GFCI Outlet



2008
Tamper-Resistant Outlet

Does my home have grounded outlets?

► *Electrical Outlets & Receptacles*

Electrical outlets are the place where you are most likely to interact with your home's electrical system on a daily basis.

Polarized & Grounded Outlets: 1920s – Present

Since 1920, most homes have been outfitted with polarized outlets that feature two vertical slots of different sizes. These outlets are designed so that the slot for the neutral wire is wider than the slot for the hot wire, making it difficult to insert an electrical plug the wrong way. When used with a polarized plug, these outlets provide protection by keeping electrical

current directed. Grounded outlets have a round hole for the grounding conductor in addition to the two vertical slots. The circle slot is connected to a ground wire.

Grounded outlets are required to be installed in all modern homes today. If your home does not have grounded outlets, then your electrical system is likely missing critical safety features. Consult an electrician about updating your home.



What is a Tamper-Resistant Outlet?

► *Tamper-Resistant Outlets*

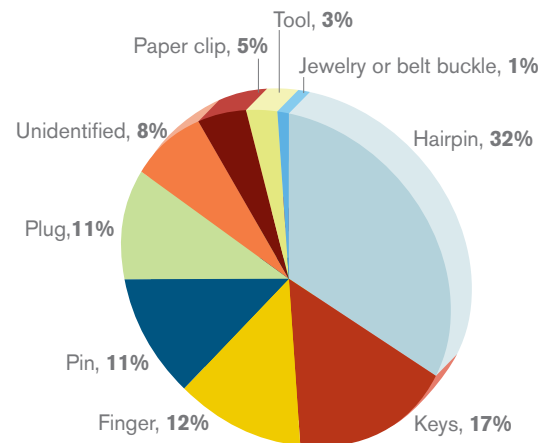
Every year, 2,400 children are injured from inserting household objects into electrical outlets. Tamper-resistant outlets (TROs) look like standard wall outlets, but they feature an internal shutter mechanism which prevents children from sticking objects like hairpins, keys, and paperclips into the receptacle.

This spring-loaded shutter system in a TRO outlet only opens when equal pressure is applied simultaneously to both shutters, such as when an electrical plug is inserted. Unlike plastic outlet covers, TROs provide automatic and continuous protection for children.



While hospitals have required TROs for decades, the 2008 edition of the *National Electrical Code* has just recently mandated that these specialized outlets be installed in new home construction.

Household Objects Commonly Placed in Outlets



What is a GFCI?

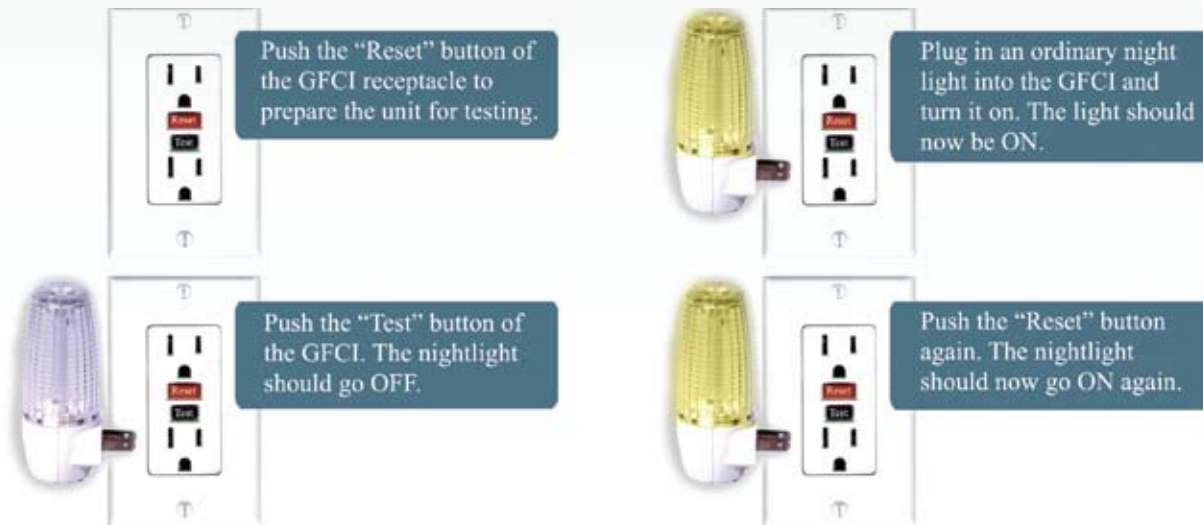
► *Ground Fault Circuit Interrupters*

Since the 1970s, ground fault circuit interrupters (GFCIs) have saved thousands of lives and have helped cut the number of home electrocutions in half.

GFCIs are electrical safety devices that trip electrical circuits when they detect ground faults or leakage currents. A person who becomes part of a path for leakage current will be severely shocked or electrocuted. These outlets prevent deadly shock by quickly shutting off power to the circuit if the electricity flowing into the circuit differs by even a slight amount from that returning.

A GFCI should be used in any indoor or outdoor area where water may come into contact with electrical products. The 2008 edition of the *National Electrical Code* currently requires that GFCIs be used in all kitchens, bathrooms, garages, and outdoors.

GFCIs should be tested once a month to confirm that they are working properly.



The night light should go out when the **TEST** button is pushed. If the light does not go out, then the GFCI may have been improperly wired or damaged and does not offer shock

protection. In this case, contact a licensed electrician to check the GFCI and correct the problem.



What is Energy Efficient Lighting?

► *Energy Efficient Lighting*

Today, lighting accounts for nearly 20 percent of a typical home's energy bill. Fortunately, there is a way to dramatically cut down your household energy costs while improving safety at the same time.

Compact Fluorescent Lamps (CFLs)

Compact fluorescent light bulbs (CFLs) use 75 percent less energy than a standard incandescent light bulb and last up to ten times longer. In addition to cutting your home energy costs, CFLs also produce 75 percent less heat—making them a much safer option for your home as well.

CFLs contain an extremely small amount of mercury – about as much as would fit on the tip of a ball point pen. However, they still offer a net environmental benefit. In fact, four to five times more mercury is emitted when powering a standard incandescent light bulb than a CFL.

CFLs are estimated to cut our national electric bill by over \$10 billion annually.

Standard incandescent light bulbs will soon no longer be available. The Energy Independence and Security Act of 2007 requires light bulbs to be 70 percent more efficient beginning in 2012 which means that CFLs will become more widely used.



How do I clean up a broken CFL?

► *Cleanup and Disposal of CFLs*

Many states still allow CFLs to be discarded with normal garbage. However, recycling your CFL is a far more environmentally-friendly alternative. Stores such as The Home Depot and IKEA take back used, unbroken CFLs at no cost.

Unless a CFL breaks, the mercury is fully contained within the bulb. Even if the CFL does break, the majority of the mercury will remain with the lamp fragments.

INSTRUCTIONS FOR CLEANING UP A BROKEN CFL

- 1 Ventilate the room.
- 2 Scoop up glass fragments and powder using stiff paper or cardboard and seal in a plastic bag.
- 3 Use duct tape to pick up any fragments or powder.
- 4 Immediately place all clean up materials in an outdoor trash container and wash your hands.
- 5 Discard any clothing or bedding that comes in direct contact with broken glass or powder from inside the bulb. Washing tainted items may cause mercury fragments in the clothing to contaminate the machine and/or pollute sewage.

To learn more about CFLs, visit the U.S. Environmental Protection Agency official website at www.epa.gov.

FOR MORE INFORMATION PLEASE VISIT OUR WEBSITE

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ELECTRICAL-SAFETY.ORG

