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Electrical Arc Fault Safety Advice for Homeowners & Home Inspectors

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Efficiency of 120V vs

This article, based on a US CPSC article and supplemented with additional details and commentary answers most home owner and home inspector questions about installing, testing, and inspecting AFCIs - arc fault protectors in homes. Readers of this article should also see Electrical Code Basics and SAFETY FOR ELECTRICAL INSPECTORS.

ASHI Home Inspector Educational Seminar Proceedings: ASHI-NE Chapter Annual conference September 22-23, 2008, Randolph, MA. -- Daniel Friedman.
This is the fulltext version. A powerpoint presentation version of this class is also available.

This website provides information about a variety of electrical hazards in buildings, with articles focused on the inspection, detection, and reporting of electrical hazards and on proper electrical repair methods for unsafe electrical conditions. Critique and content suggestions are invited. Page top photo courtesy of the US CPSC.

 Information Accuracy & Bias Pledge is at below-left. **Use links at the left of each page to navigate** this document or to view other topics at this website. **Green links show where you are** in our document or website. The AFCI arc fault circuit breaker photo at page top courtesy of the US CPSC whose consumer advice is reported below.

Electrical Arc Fault AFCI Advice for Homeowners & Home Inspectors

This material was originally prepared for the American Society of Home Inspectors New England Chapter,(ASHI -NE) Educational Seminar, Sept 22-23, 2008. Portions of this text are quoted from the Arc Fault Circuit Interrupter (AFCI) FACT SHEET provided by the US CPSC . Additional notes and details have been added, drawing on a variety of sources listed at the end of this article.

What is an Arc Fault Circuit Interrupter or AFCI?

240V Equipment
DIRECTORY OF ELECTRICIANS
ELECTRIC METERS & METER BASES
ELECTRIC PANEL AMPACITY
ELECTRIC PANEL INSPECTION
ELECTRICAL BASICS
Electricity Basics - how it works
Electrical Circuit ID, Map & Label
Electrical Circuits, shorts
Electrical Code Basics
Electrical Conduit Tips
Electrical Definitions
Electrical Grounding Basics
Electrical Outlet-how to add
Electrical Splices, how to make
Electrical Tools & Tests
Electrical Wire Stripping Tips
Electrical Wiring Books & Guides
Electrical Wiring in Old Houses
FEDERAL PACIFIC FPE HAZARDS
GROUND SYSTEM INSPECTION
Why Grounding is Needed
Gas Piping Ground Bond
Table of Ground Wire Sizes
Case History: Double Fault Leads to Loss of Power

The “AFCI” is an arc fault circuit interrupter. AFCIs are newly-developed electrical devices designed to protect
against fires caused by arcing faults in the home electrical wiring.

InspectAPedia Note: **Arcing faults:** a series arc occurs in electrical wiring when there is a small gap or break in a conductor. a parallel arc occurs when a small gap or break which permits current to flow to ground (a ground fault) or between the hot and neutral wires (a short circuit). Arcing faults, especially parallel arcing faults, lead to overheating and a fire hazard even if no shock hazard is present.

AFCIs are an important safety addition to homes in part because they address an additional type of electrical fault that can cause a fire and one which may not be detected and interrupted by a conventional circuit breaker, nor by a ground-fault circuit interrupter (GFCI's).

We've seen that arcing of any type can result in burned debris on wire surfaces which causes an increase in electrical resistance and thus overheating at that point. Arcing was examined earlier in detailed studies of the aluminum electrical wiring fire hazard at connections in the wire. Arcing of any type, whether it is the micro-fretting type of arcing that occurs with aluminum wire or possibly larger arcing across a gap or short in a copper wire.

The Fire Problem [addressed by AFCIs]

Annually, over 40,000 fires are attributed to home electrical wiring. These fires result in over 350 deaths and over 1,400
injuries each year Note 1. Arcing faults are one of the major causes of these fires.

When unwanted arcing occurs, it generates high temperatures that can ignite nearby combustibles such as wood, paper, and carpets.

Our photo shows a Rhinebeck NY home that was totally destroyed by a fire caused by an electrical cord that was passed under a carpeting - a possible cause of pinched, overheated cord, and a fire that might have been prevented by an AFCI.

Case History:Loss of Neutral Shocks Homeowner
Electrical Service Grounding Checklist
KNOB & TUBE WIRING
LIGHTNING PROTECTION
LOW VOLTAGE BUILDING WIRING
MAIN DISCONNECT AMPACITY
MULTI-WIRE CIRCUITS
PUSHMATIC - BULLDOG PANELS
RUST in ELECTRICAL PANELS
SAFETY FOR ELECTRICAL INSPECTORS
SE CABLE SIZES vs AMPS
SQUARE-D RECALLS
UNDERGROUND SERVICE LATERALS
VOLTAGE MEASUREMENT EQUIPMENT
ZINSCO / SYLVANIA HAZARDS

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InspectAPedia Note: According to Mike Holt, *"Studies have shown that over 60 percent of fires are from causes in the fixed wiring, switches, receptacle outlets and lighting fixtures that are part of the fixed electrical system of a residence."* In other words, AFCI's are focused on detecting arcing and preventing fires in an area where the risk is significant.

Arcing faults often occur in damaged or deteriorated wires and cords. Some causes of damaged and deteriorated wiring include:

- puncturing of wire insulation from picture hanging or cable staples,
- poorly installed outlets or switches,
- cords caught in doors or under furniture,
- furniture pushed against plugs in an outlet,
- natural aging,

and cord exposure to heat vents and sunlight.

InspectAPedia Note: What Types of AFCIs are Available?

UL in January 2002 described various types of AFCIs which we summarize here. The first three types of AFCI's, Branch Feeder AFCIs, Outlet Circuit AFCIs, and Combination AFCIs are the three most basic types of arc fault detectors and are important definitions for the home owner or home inspector to understand:

1. **Branch Feeder AFCIs** - basically a special circuit breaker to be installed in the electrical panel and which will protect all of the devices on an individual electrical branch circuit. (15A or 20A 125V single phase wiring.)
2. **Outlet circuit AFCIs** - a device installed right in the branch circuit receptacle box. As with GFCIs this device may also protect wiring which is connected "downstream" electrically from the device itself.
3. **Combination AFCIs** - this device combines the function of Branch Feeder AFCIs and Outlet Circuit AFCIs and will protect power cords plugged into receptacles protected by the AFCI.

   The following are additional types of AFCI's described by Underwriters Laboratories.

Insulate Ventilate
Interiors
Mold Inspect/Test
Plumbing Water Septic
Roofing
Structure
Accuracy & Bias Pledge
Contact Us

4. **Outlet Branch Circuit AFCIs** - this device, which sounds to us just like #2 above, is installed as the first outlet in a string of electrical receptacles on a single circuit; it protects the downstream receptacles.
5. **Portable AFCIs -** these devices can be plugged into a conventional electrical receptacle and provide one or more outlets into which additional devices can be connected. This device would be used by contractors working on a building to obtain additional electrical safety when using power tools.
6. **Cord-AFCIs** - this device is like the portable AFCI #5 above, but may be incorporated into the permanent power cord of a device or appliance so that when it is plugged into an electrical receptacle the appliance is protected from arc faults.
7. **Leakage Current Detection and Interruption LDCIs** - these devices are built into a device or appliance and detect current leakage from the device's electrical cord. If a hand held hair dryer contained this device and its damaged cord was dangled in a sink filled with water, the LDCI would detect the current leakage and would shut off the device.

How does an Arc Fault Circuit Interrupter (AFCI) Work?

Conventional circuit breakers only respond to overloads and short circuits; so they do not protect against arcing conditions that produce erratic current flow. An AFCI is selective so that normal arcs do not cause it to trip.

The AFCI circuitry continuously monitors current flow through the AFCI. AFCIs use unique current sensing circuitry to discriminate between normal and unwanted arcing conditions. Once an unwanted arcing condition is detected, the control circuitry in the AFCI trips the internal contacts, thus de-energizing the circuit and reducing the potential for a fire to occur.

An AFCI should not trip during normal arcing conditions, which can occur when a switch is opened or a plug is pulled from a receptacle.

Presently, AFCIs are designed into conventional circuit breakers combining traditional overload and short-circuit protection with arc fault protection. AFCI circuit breakers (AFCIs) have a test button and look similar to ground fault circuit interrupter (GFCI) circuit breakers.

Some designs combine GFCI and AFCI protection. Additional AFCI design configurations are anticipated in the near future.

It is important to note that AFCIs are designed to mitigate the effects of arcing faults but cannot eliminate them completely. In some cases, the initial arc may cause ignition prior to detection and circuit interruption by the AFCI.

The AFCI circuit breaker serves a dual purpose – not only will it shut off electricity in the event of an "arcing fault", but it will also trip when a short circuit or an overload occurs. The AFCI circuit breaker provides protection for the branch circuit wiring and limited protection for power cords and extension cords. Single-pole, 15- and 20- ampere AFCI
circuit breakers are presently available.

Where should Arc Fault Circuit Interrupters (AFCIs) be used?

The 1999 edition of the National Electrical Code, the model code for electrical wiring adopted by many local jurisdictions, requires AFCIs for receptacle outlets in bedrooms, effective January 1, 2002. Although the requirement is limited to only certain circuits in new residential construction, AFCIs should be considered for added protection in other circuits and for existing homes as well.

Older homes with aging and deteriorating wiring systems can especially benefit from the added protection of AFCIs. AFCIs should also be considered whenever adding or upgrading a panel box while using existing branch
circuit conductors.

InspectAPedia Notes: What are the code requirements for AFCIs?
AFCI Requirements under the US National Electrical Code NEC:

AFCI requirements have not been adopted uniformly in all jurisdictions, but the requirement is being increasingly accepted, and we certainly recommend the use of AFCIs as described by the US CPSC and the NEC. The US National Electrical Code, the NEC, specifies the following requirements for AFCIs (quoted indirectly from the U.S. State of Vermont office of the state fire marshal, January 2007. Vermont has required AFCIs to the NEC 2008 standard since 2000.)

History of AFCI Requirements in Homes

The 1999 NEC rules, effective in 2002, in NEC Sec. 210.12. introduced AFCI's and called for their installation on bedroom receptacle circuits powered by single phase 125V(nominal) 15A and 20A circuits.

The 2002 NEC expanded the use of AFCI's to include all bedroom circuits (such as lighting and hard-wired smoke alarms), kitchens.

The 2005 NEC code expanded the section to include combination AFCIs combined with GFCIs, basically an update to reflect improvements in the technology. The technology of AFCIs was improved to add the detection of series arcing to the previously available parallel arcing. By removing the word "receptacle" from the code in 2002, and by leaving the word "outlet" in the code, the 2005 code indicated that all outlets, including receptacles, light fixtures, smoke alarms, etc. must be protected.

- **Series arcing** occurs in an electrical circuit when there is a small **gap in a conductor** in a home. Series arcs are less dangerous than parallel arcs because they do not usually get hot enough to start a fire.
- **Parallel arcs** in an electrical circuit occur when there is a **current leak** from the "line" or hot wire (fault) to the neutral wire (ground or earth side of the circuit), or when there is a **short circuit** (a direct connection between the hot wire and the neutral wire, such as a wire being cut or damaged and its conductors brought into contact).

The 2008 NEC expanded the use of AFCI's to include all habitable rooms in new homes such as living rooms and dining rooms. The 2008 requirements mean that only only Combination AFCI's will meet all of the requirements of the code. GFCI's (Ground Fault Circuit Interrupters) continue to be required to protect areas of high shock risk: bathrooms, kitchens, garages, un-finished basements.

Combination devices required after 1 Jan 2008: Simplifying a bit, after January 1, 2008, AFCI protection must be provided by a "Combination AFCI's" . That's because these are an improved arc fault interrupter product that offer much more sensitive arc fault detection (5 A arc peaks as opposed to 75 A arc peak detection).

210-12. Arc-Fault Circuit-Interrupter Protection *(1999, Effective 2002)*

(A) Definition*. An arc-fault circuit interrupter is a device intended to provide protection from the effects of arc faults by recognizing the characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.*

(B) Dwelling Unit Bedrooms*. All branch circuits that supply 125-volt, single phase, 15- and 20-ampere receptacle circuits installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002.*

Beginning with the 2008 edition of the U.S. National Electrical Code, AFCI's are required not only in bedrooms but in other areas of the home such as dining rooms, living rooms, and other habitable areas, and apply to most electrical circuits including hard-wired smoke detectors, overhead fans, etc.

How Much Does an AFCI Cost? Cost Benefit Calculation of AFCI's:

An AFCI circuit breaker typically costs about $30. to $35. U.S. A conventional 15A circuit breaker typically costs $2. to $4. There is an additional cost to install an AFCI circuit breaker, but as it's basically a "plug-in" device that is placed in the electrical panel, that number should be small, smaller still if the AFCI installation is combined with other electrical work needed at a home.

While these specialized AFCI circuit breakers cost more, our opinion is that this is not a significant cost compared with the value of a home, not to mention the more difficult to measure cost of possible injuries or fatalities should a fire occur. If we use the current (2008) median price of a home in the U.S. of about $215,000., the cost of adding AFCI to a home circuit is less than two ten-thousandths of the cost of the home. (An AFCI costs 0.00016 x median value of a home in the U.S.).

If a home needs a dozen AFCI's to meet the 2008 NEC, the cost should be less than $400., or less than two thousandths of the cost of the home. (0.0019 x the median value of a home in the U.S.).

What About Nuisance Tripping of AFCI's

Nuisance tripping refers to a circuit breaker or an AFCI that trips off, turning off electrical power when there was no apparent reason to do so. Some sources assert that what appears to be "nuisance tripping" of AFCI's actually occurs due to wiring practices of some electricians more than for any other reason. These include

- **Reversed hot and neutral wires** - reversed polarity - which is an unsafe condition
- **Shared neutral wiring** on single pole circuit breaker circuits: this is already an existing problem with GFCI's on multiwire branch circuits.
- **Incorrect or accidental connections between the ground and neutral** wire: this is also an unsafe condition which can permit live current to flow on a ground wire that should normally never carry current. We've personally seen this condition lead to an electric shock.

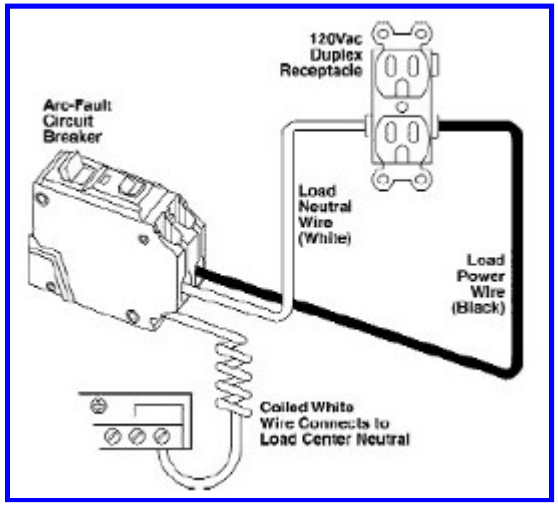
  A common source of accidental ground-neutral connections occurs when an electrician

over-tightens the clamp connector on BX (armored cable) where it connects to a steel junction box. Our ex-brother-in-law made this mistake at every single BX connector when he did his own over-zealous wiring in a New York City apartment. When he installed a GFCI circuit breaker to protect some circuits, he could not keep the breaker from tripping immediately whenever power was turned on.

We saw that his over-tightening the connector pinched inwards the edges of the BX cable. If the BX cable edge cuts into the hot wire the electrician (or Matthew) discovers this fault immediately when power is restored to the circuit. But if the cable edge cuts into the neutral wire, the electrician (or our brother in law) does not discover this fault until a GFCI or an AFCI is installed on the circuit, or until someone touches a supposedly safe armored cable wire exterior and gets a shock.

- **Normal arcing in appliances**: Nuisance tripping that could occur from the normal arcing that occurs in some appliances (such as a vacuum cleaner motor) has been considered in the design of the AFCI circuit. The AFCI is designed to tell the difference between this ordinary arcing and the type of arcing in a circuit that may cause a fire.

How to Install an Arc Fault Circuit Interrupter (AFCI)



AFCI circuit breakers should be installed by a qualified electrician. The installer should follow the instructions accompanying the device and the panel box.

In homes equipped with conventional circuit breakers rather than fuses, an AFCI circuit breaker may be installed in the panel box in place of the conventional circuit breaker to add arc protection to a branch circuit. Homes with fuses are limited to receptacle or portable-type AFCIs, which are expected to be available in the near future, or AFCI circuit breakers can be added in separate panel boxes next to the fuse panel box.

An AFCI hookup wiring diagrams and detailed instructions from GE is available here. Other manufacturer's Arc Fault Interrupter installation guidelines will be similar. Typically for an electrical circuit to be protected by AFCI, in the electrical panel the circuit hot and neutral wires are connected to marked terminals on the AFCI circuit breaker and a third wire connects the AFCI breaker to the neutral bus in the electrical panel. The AFCI installation wiring diagram shown here and others are available

from GE, General Electric Corporation and GE circuit breaker distributors.

Safety Warning:

Do not attempt to work on your electrical wiring, switches, or outlets unless you are properly trained and equipped to do so. Electrical components in a building can easily cause an electrical shock, burn, or even death.

Even when a hot line switch is off, one terminal on the switch is still connected to the power source. Before doing any work on the switch, the power source must be turned off by setting a circuit breaker to OFF or removing a fuse. See SAFETY FOR ELECTRICAL INSPECTORS and Electrical Wiring Books & Guides

How to Test an Arc Fault Circuit Interrupter (AFCI)

Using the test button on an AFCI

AFCIs should be tested after installation to make sure they are working properly and protecting the circuit.

Subsequently, AFCIs should be tested once a month to make sure they are working properly and providing protection from fires initiated by arcing faults.

A test button is located on the front of the device. The user should follow the instructions accompanying the device. If the device does not trip when tested, the AFCI is defective and should be replaced.

InspectAPedia Notes: How the AFCI Test Button Functions

Because it has been misunderstood and criticized it's worth noting that the test button on an AFCI does not simply force the mechanical internal switch of the AFCI to trip. Rather, the test button on an AFCI tests the arc fault detection circuitry to be sure that it is working properly, that it will respond to an arc fault, and that the circuitry will in turn cause the mechanical internal switch to open.

This is an important distinction to remember, since the Ground Fault Circuit Interrupter (GFCI) has faced similar criticism. We've certainly found lots of GFCI's which exhibited an error when the GFCI test button was pressed: the button caused the GFCI to trip but the device was defective or improperly wired so that it would not protect the circuit.

Using AFCI indicator tools vs AFCI "test tools" - AFCI Indicators is not recommended

As of September 2008 we have found no test tool that reliably and completely tests the function of an AFCI. Only the integral test button tests the circuitry of the device as well as the trip mechanism. UL classes these "test" devices not as "testers", but as "indicators".

A problem is that some devices used to "inspect" an AFCI, in trying to produce a simulated arc fault condition, may fail to cause the AFCI device to trip even though it is perfectly fine.

Literature from the manufacturer of a popular "test tool" tells the user of the tool to go to the electric panel and use the test button on the AFCI device to make sure it trips. In other words the inspector cannot rely on the separate test tool. For this reason you will see such tools referred to as "indicators" rather than "testers": they are not a complete and reliable test instrument for AFCIs. -- Mike Holt

AFCIs vs. GFCIs: What is the difference between an Arc Fault Circuit Interrupter and a Ground Fault Circuit Interrupter?

What is the difference between an AFCI Arc Fault Circuit Interrupter and a GFCI Ground Fault Circuit Interrupter? The AFCI should not be confused with the GFCI or ground fault circuit interrupter.

An AFCI is a device intended to prevent a fire. It detects a type of arcing in the electrical circuit that can lead to overheating and a fire. An AFCI can protect against some types of shock by detecting a short circuit if the short is also affecting an individual, but it is not designed as a shock protector and will not detect all of the same faults as a GFCI.

A GFCI is a device intended to prevent electrical shock. A GFCI will not necessarily detect the type of electrical arcing that can cause a fire. The GFCI is designed to protect people from severe or fatal electric shocks while the AFCI protects against fires caused by arcing faults. The GFCI also can protect against some electrical fires by detecting arcing and other faults to ground but cannot detect hazardous

across-the-line arcing faults that can cause fires.

A ground fault is an unintentional electric path diverting current to ground. Ground faults occur when current leaks from a circuit.

How the current leaks is very important. If a person's body provides a path to ground for this leakage, the person could be injured, burned, severely shocked, or electrocuted.

The National Electrical Code requires GFCI protection for receptacles located outdoors, in bathrooms, garages, kitchens, crawl spaces and unfinished basements; and at certain locations such as near swimming pools.

A combination AFCI and GFCI can be used to satisfy the NEC requirement for GFCI protection only if specifically marked as a combination device.

InspectAPedia Note: don't confuse this "combination" with the "Combination AFCI described earlier in this article.

While we're discussing the 2008 electrical code changes for AFCI's let's also update ourselves about GFCI's:

2008 Code Changes Affecting Ground Fault Circuit Interrupters GFCI's

NEC *210.8* is the code section pertaining to GFCI's. (AFCI's are addressed in NEC *210.12*.). These GFCI requirements are intended to address residential electrical wiring using 15A or 20A 120V electrical receptacles and circuits. Heavier-duty circuits such as a 30A welder circuit are excluded.

Basically GFCI protection requirements have been expanded to all basement, garage, and accessory building receptacles, and a wording change to drop "receptacles" and keep "outlets" expands GFCI coverage in other areas.

> For 2008 the NEC deleted Nos. 1 and 2 to 210.8(A)(2) and Nos. 1 and 2 to 210.8(A)(5) from the prior NEC version.

210.8(A)(2) & (A)(5): Expanded GFCI protection requirements by deleting exceptions for receptacles that are not readily accessible and receptacles located in dedicated spaces to supply an appliance.

Deleting "receptacle" and leaving "outlet" in the NEC expands the required coverage of any device being discussed. That's because a "receptacle" is taken to mean an electrical outlet (a wall socket) while "outlet" is any place in the electrical wiring system from which electrical power is taken (a ceiling fan, a hard-wired smoke detector, etc.).

• 210.8(B)(4): Expanded GFCI protection requirements to include all outdoor 15- and 20-ampere, 125-volt receptacles, and added a conditional exception to permit use of assured equipment grounding conductor program in industrial establishments.

• 210.8(B)(5): Added GFCI protection requirements for all 15- and 20-ampere 125-volt receptacles installed within 6 ft of the outside edge of sinks, and added exceptions for receptacles in industrial laboratories where the loss of power would introduce a greater hazard and for receptacles in patient care areas where critical care equipment may be utilized.

Basement GFCI changes: The GFCI protection requirements for receptacles in basements, garages, and accessory buildings have been expanded to all 125-volt, single-phase, 15- and 20-ampere receptacles regardless of accessibility or movability of an appliance from one location to another. - Minnesota Electrical Association

A Summary of Current (2008) Residential Ground Fault Circuit Interrupter GFCI Requirements

GFCI's are required safety devices to be installed in the following locations:

- **Bathrooms**: are required to provide one 15A or 20A, 125V receptacle (or more). All bath receptacles have to have GFCI-protection, and at east one must be within 3 feet of the outside edge of each basin [210.52(D)]. The bathroom receptacle circuit cannot provide power to other outlets elsewhere in the house [210.11(C)(3)] - something that is commonly found in older homes.

  There is an exception for a 20A circuit that supplies only a single bathroom: other equipment within the same bathroom, such as lights or a bath vent fan can be powered from the circuit. (A home inspector who detects this might point out the inconvenience of being left in the dark if the GFCI

trips.) Whether inspecting a new home, to which the 2008 NEC applies, or inspecting an older home that was wired before this code was written, the tracing of wiring to determine what devices are powered by each electrical circuit is not within the scope of practice of a normal home inspection meeting national or state standards. But some circumstances will require this level of scrutiny on existing structures.

- **Boathouses**: do not require that electrical receptacles be installed at all, but if a receptacle is present it must be GFCI protected.
- **Crawl spaces** (at or below grade): receptacles are not required to be installed in these areas unless HVAC equipment is installed in the crawl area, but if an optional electrical receptacle *is* installed in the crawl space, it must be GFCI protected. We pose that such receptacles may be in place for temporary work lighting or for powering sump pumps. (GFCI trips, no sump pump, flood).
- **Garages**: must provide a GFCI protected electrical outlet, regardless of whether or not the garage is attached or detached.

  There are exceptions in the garage for electrical outlets which are *not readily accessible*, such as a ceiling receptacle used to power a garage door opener, and an exception for *dedicated* circuits such as one to provide power to a refrigerator or freezer. (In freezing climates these appliances may not work properly in an un-heated space even if it's legal to hook them up there.) NEC 100 defines "readily accessible."
- **Kitchens**: GFCI protected receptacles are required for all receptacles that serve counter surfaces. (We like this rule because in the past builders would skip the GFCI protection for a receptacle that was over a kitchen counter but was just one inch more than six feet from the sink.)

  Exceptions to GFCI requirements for kitchens include circuits for built-in appliances like garbage grinders and dishwashers.
- **Laundry** (and also wet-bars): require that GFCI protection be provided for any receptacles within six feet of the laundry sink (or wet bar sink). So a receptacle used to power a washing machine or a gas-fired clothes dryer needs to be GFCI protected if it's within six feet of a sink.
- **Outside** electrical outlets that are GFCI protected are required, at least one for a single family dwelling. 210.52(E). All outside electrical receptacles must be GFCI protected, even those receptacles found under the roof eaves and typically used for holiday lighting or for an ice-dam stop-gap measure heat tape. (Better solutions for ice dam problems than a heating tape are discussed at Ice Dam Leaks.)

An exception outside is for a *dedicated* ice-dam snow-melting heating tape on a dedicated circuit that is *not readily accessible* and complies with 426.28 for ground-fault protection of equipment.

- **Unfinished basement** areas: a single GFCI protected electrical receptacle is required in each room or area of an un-finished basement. 210.52(G), and all receptacles that are installed (thus including optional additional receptacles) must be GFCI protected.

  Exceptions to the GFCI protected receptacle requirement for un-finished basements include the usual cases: receptacles that are not readily accessible and receptacles on dedicated circuits, such as a freezer appliance circuit.

AFCI Square D Arc Fault Circuit Breaker Recall

In 2004 Schneider Electric issued a recall of early model Square D® AFCIs manufactured between March 1 2004 and September 23, 2004 because tests indicated that "... arc detection in these breakers may become inoperable due to an issue with a third party-supplied internal component in the electronic detection unit."

Schneider's letter emphasized in an opening statement that "... Square D Company, the leading manufacturer of electrical equipment, is committed to the safety of our people, our customers, and our products." The company's letter provided additional detail:

> While these circuit breakers will continue to function normally, providing short-circuit and overload protection, a small percentage of the breakers may not function as an arc fault circuit breaker (AFCI) and detect a high-resistance low-current arc fault. The unique role of an AFCI is its ability to detect an electrical arc and shut down a circuit before a fire can start or spread. It is important to note that the affected circuit breaker itself does not pose a hazard.

[The company was concerned about inaccurate and misleading information in the electrical products market and asked that concerned parties turn to them for information regarding their products, including AFCIs.]

- *The issue with the component has been corrected and we have significantly increased our manufacturing capacity of AFCI breakers, allowing us to replenish our distribution network as quickly as possible. We are shipping significant quantities of AFCI circuit breakers from our manufacturing*

facilities every day.

- [intervening paragraphs addressing the ramp-up of production are here omitted as now obsolete-DF]
- *We are also initiating a program to recover product that has been installed during this timeframe and replacing affected breakers with newly manufactured AFCIs. we are working directly with electricians, homebuilders and homeowners to inspect and replace affected breakers. the nationwide effort is being managed by us directly with our customers. There is no specific action you need to take in this recovery program other than help us make sure everyone has accurate information.*

  The positive responses we have received from electrical inspectors regarding our honest and direct approach to resolving this issue have been appreciated. Many inspectors have been working actively with us as well as their local electrical contractors and builders to minimize the disruption in the construction process. Those combined efforts have been successful at a vast number of localities.

[...]

We believe that we can accept nothing less than excellence when it comes to safety. For more than 100 years, our customers have associated the Square D brand with industry leadership, safety, quality, and reliability. We intend that our efforts through this AFCI program will continue those qualities.

...

Technical Reviewers & References

- Daniel Friedman - principal author/editor of the InspectAPedia® Website
- **Critique, contributions wanted**: Contact Us to suggest text changes and additions and, if you wish, to receive online listing and credit for that contribution. Particular thanks are due to experts and also consumers who read these articles and suggest corrections, changes, and additions to the material.

- Original Source: US CPSC Publication www.cpsc.gov/CPSCPUB/PUBS/afcifac8.pdf, with extensive edits and additions by the website author.
- Note 1 Ault, Singh, and Smith, “1996 Residential Fire Loss Estimates”, October 1998, U.S. Consumer
  Product Safety Commission, Directorate for Epidemiology and Health Sciences.
- Schneider Electric, North American Operating Division, 1415 South Roselle Road, Palatine IL 60067
  16 December 2004 , Letter addressed to Dan J Friedman, from Jim Pauley, Vice President, Industry and Government Relations.
- Underwriters Laboratories (UL) describes the the types of AFCIs and the types of tests performed on AFCIs at www.ul.com/regulators/afci/AFCI_scenarios020502.pdf. Also, UL 1699, “Standard for Arc-Fault Circuit Interrupters” at the UL website provides more detailed information on the differences between the older AFCI's and the new combination type devices.
- Nuisance tripping of AFCI's is described in detail, along with other details about AFCIs in an online article, "Arc Fault Detection: your questions answered", ecmweb.com, August 2008.
- Mike Holt, in our opinion the leading writer about electrical wiring and devices, has a nice article about AFCIs at https://www.mikeholt.com/mojonewsarchive/AFCI-HTML/HTML /Arc_Fault_Protection~20020124.htm. Mr. Holt discusses current electrical code requirements for GFCIs (Ground Fault Circuit Interrupters) at http://ecmweb.com /mag/electric_branch_circuits_part_2/.
- Testing of AFCIs using external devices (not the test button): see article by Underwriter's Laboratories (UL) March 21, 2005 at http://www.ul.com/tca/winter05/news.html and this comment by Ryan Jackson at Mike Holt's website: (a reply from Jim Gregorec, Group Manager - T&M Division, Ideal Industries posted at the website takes a different view which is also posted there)

> *To paraphrase the article,* ***there is no such thing as an AFCI tester, other than the test button that is an integral part of the AFCI device itself.*** *The reason for this is that an AFCI device is very complex, and recognizes the actual waveform of an arcing fault. While the advertised "AFCI Testers" do produce a waveform similar to that of an arc fault, they cannot produce an actual arc fault. Because of this, the "tester" may not trip the AFCI circuit breaker, despite the breaker having nothing wrong with it. For this reason, UL classifies these devices not as "testers", but as "indicators", which is much more accurate.*
>
> *These devices are tested under the UL 1436 standard, and are required to have included in the instructions the following clause (or equivalent):*
>
> ***"CAUTION: AFCIs recognize characteristics unique to arcing, and AFCI indicators produce characteristics that mimic some forms of arcing. Because of this the indicator may give a false indication that the AFCI is not functioning properly. If this occurs, recheck the operation of the AFCI using the test and reset buttons. The AFCI button test function will demonstrate proper***

operation."

While these indicators may have some value for convenience to determine if the outlet in question is on an AFCI protected circuit, they are not to be substituted for the test button of the AFCI circuit breaker, and they are not an AFCI tester.

The 2008 NEC National Electrical Code (ISBN 978-0877657903) Online Access LINK (you'll need to sign in as a professional or as a visitor)

GE, General Electric Corporation, General Electric Company, 41 Woodford Ave., Plainville, CT 06062, one of the companies producing AFCIs, provides wiring diagrams and installation instructions for their product. See GE's DEH-40117R4.pdf for detailed installation instructions from GE for the wiring of a typical AFCI on a simple 120V home electrical circuit.

The Minnesota Electrical Association has posted an article of the most important electrical code changes for 2008 at http://www.electricalassociation.com/catalog/2008NECTop10.aspx - by Michael J. Johnston, IAEI

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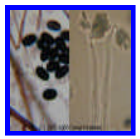

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