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AFCI CIRCUIT BREAKERS: VALUABLE SAFEGUARD AGAINST ELECTRICAL FIRES

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How many times have you seen or heard of a home destroyed by fire due to faulty wiring? Oftentimes, it is not recently installed wiring, but wiring that had been in the walls for years.

Building occupants would hope that because considerable time has elapsed since installation, they could rest easy knowing that the wiring is safe and free of fault.

Well, not necessarily. Wires still cause fires, even years after installation. The phenomenon most likely responsible for these faulty wiring fires is something called an arc fault. Arc faults may start as a result of a small defect or damage to a cable, and grow over time into something far more significant. To protect against arc faults, a type of circuit breaker called an arc fault circuit interrupter (AFCI) was developed in the 1990s. The first official requirement for AFCIs is in the 2002 National Electric Code (NEC) and applied to bedroom circuits only.

Now, the 2008 NEC, published in September, expands this requirement to include nearly all receptacle circuits in dwelling units. Anyone involved in residential construction can expect to hear more about these devices in the not-too-distant future.

To fully understand an arc fault, we must first understand the difference between an arc fault and a bolted fault. Figure 1 illustrates the difference between a regular, or bolted fault and an arc fault. We can follow this figure to discuss how AFCI circuit breakers work.

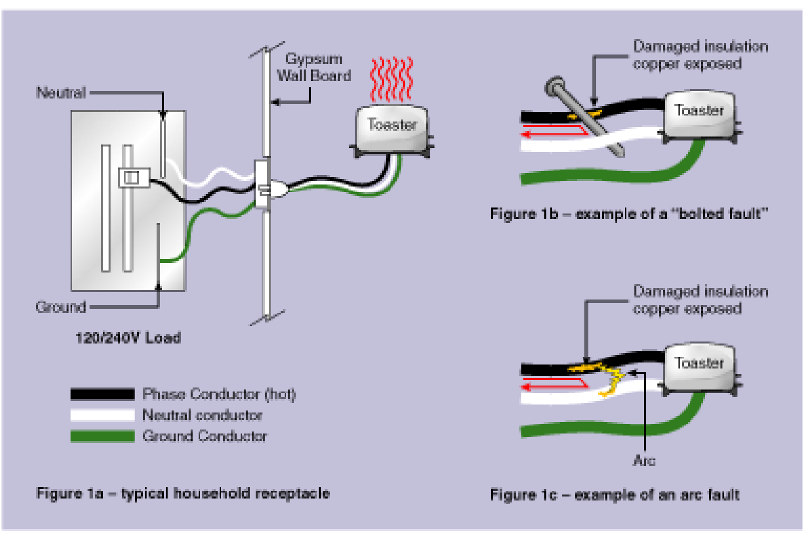

Figure 1 - When insulation is damaged to an extent that conducts either come in direct contact with one another or are connected by a metal object such as in Figure 1b, there is a bolted fault. The resistance in the conductors and through the nail is low.

Fault and arc fault

I will explain why an arc fault may exist undetected and in fact be harmless for long periods of time before sparking disaster—literally. But first, look at 1a in Figure 1, which shows that conductors come with a color-coded plastic coating designed to keep them from touching one another. Note that the overall sheath encasing these conductors is not shown for simplicity's sake. When the insulation becomes damaged to an extent that conductors either come in direct contact with one another or are connected by a metal object such as in 1b in Figure 1—where the metal object is a nail—one gets what's known as a bolted fault. The resistance in the conductors and through the nail is low.

As a consequence, currents as high as 10,000 amps—sometimes more—can occur. This sounds serious, and it is. However, conventional circuit breakers effectively protect against this scenario. Upon sensing this high current, conventional circuits open in less than 1/10th of a second.

An arc fault is similar inasmuch as conductor insulation damage is involved. However, with an arc fault, the conductors are not in direct contact with one another, nor are they connected by a metal object.

Instead, because there are exposed conductors relatively close to each other, an arc forms between the two. The current in this case literally has to jump an air gap to get from one conductor to the next. Because air is a poor conductor, the resultant current is relatively small, often much too small to trip a conventional breaker.

In this case, the arc is outside the cable and continues indefinitely. When protected by a conventional breaker, the resultant heat may start a fire.

How AFCIs work

AFCI is yet another example of an advance in solid state technology. These breakers actually monitor the waveform pattern—or signature—rather than just the magnitude of the circuit that they are feeding. When AFCIs detect a pattern similar to the blue one in Figure 2, they recognize this signature as being an arc fault. As can be seen in the figure, an arc fault is characterized by a steady, relatively low-level, high-frequency current waveform.

However, one growing pain problem that this technology encountered when it first came into use involved normal, controlled, and acceptable arcing in electrical circuits. Examples of a normal arc include the arc that is seen when pulling out an electrical cord or the arc a light switch makes when it is operated. Power tools are another example, as power tools generate a sustained arc while being operated.

How does the AFCI breaker know when to trip and when not to? As it turns out, all of these types of electrical arcs have subtle differences in their signatures. As AFCI technology has evolved, it has reached a point where it can effectively filter out normal and safe arcing and only trip on the occurrence of a true arc fault.

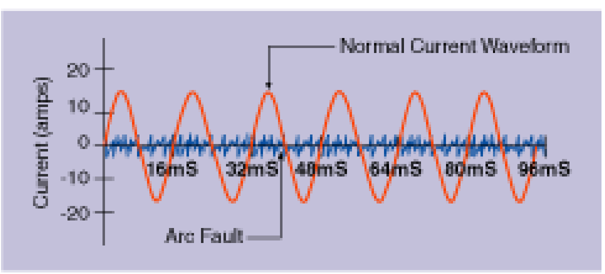

Figure 2 - AFCIs monitor wave form. When they detect a pattern similar to the blue one, AFCIs recognize this signature as being an arc fault.

Arc faults take time

An arc fault can begin with the smallest of damage to conductor insulation. At first, an imperceptible current flows through that weak link from one conductor to another. Over time, further damage develops as the insulation is heated by the arc beyond its tolerance. Eventually, the damage becomes significant enough to allow a more intense arc and to ultimately cause a fire.

The intent of this article is not to scare anyone. The fact of the matter is electrical wiring, when installed correctly, results in relatively few fires—let alone fatalities. The fact remains that AFCI circuit breakers can make projects safer ones. They are about 10 times more expensive than a regular breaker ($35 vs. $3.50), but the labor to install them is the same. It strikes me as a small price to pay. Regardless, as it looks right now, if you're building residential construction in 2008 and beyond, you will not have a choice.

And occupants of the building where you design electrical systems can rest easy that new wiring will be free of arc fault.

NEMA launches AFCI safety Web site

The Natl. Electrical Manufacturers Assn. has set up a Web site at www.AFCISafety.org as a one-stop information resource for residential arc fault breaker safety information.

AFCISafety.org states its goals:

1. Increase the level of awareness of arc fault circuit interrupters (AFCIs) and their uses in residential applications.
2. Inform engineers about the differences between branch/feeder AFCIs, combination AFCIs, and ground fault circuit interrupter (GFCI) devices.
3. Provide information related to AFCIs' preventative aspects of arcing faults and their links to fire safety.
4. Highlight proper installation and operation of AFCI devices.

Research in arc fault began in the late 1980s and early 1990s when the Consumer Product Safety Commission (CPSC) identified a concern with the residential fires of electrical origin. A large number of these fires were estimated to be in branch circuit wiring systems.

NEC Code-Making Panel 2 (CMP2) reviewed many proposals, and after much data analysis and discussion, CMP2 concluded that AFCI protection should be required for branch circuits that supply receptacle outlets in bedrooms. Subsequent editions of the NEC further upgraded the requirements to include protection on all outlets (lighting, receptacle, smoke alarm, etc.) In bedrooms along with other some other enhancements.