LOG OF MEETING
DIRECTORATE FOR ENGINEERING SCIENCES

SUBJECT: Arc Fault Circuit Interrupter (AFCI) Testing

DATE OF MEETING: November 5, 1997

PLACE OF MEETING: Square D Company
3700 Sixth Street
Cedar Rapids, IA 52406-3069

LOG ENTRY SOURCE: Doug Lee, ESEE Dal

COMMISSION ATTENDEES:
Doug Lee, ESEE

NON-COMMISSION ATTENDEES:
Troy Bishop - Square D Company
Colin Cornhill - Square D Company
George Gregory - Square D Company
Ron Grage - Square D Company

SUMMARY OF MEETING:
Mr. Gregory and Mr. Bishop discussed Square D's AFCI for its QO and Homeline styles. The arc fault problem, the technology to reduce electrical fires, and Square D's support for the 1999 National Electrical Code (NEC) proposal to require AFCI protection on 15 and 20 amp dwelling unit branch circuits were discussed. A summary of this information is in the enclosed brochure on Arc Fault Circuit Protection. Data on fires caused by arcing from the NFPA, CPSC, and a major insurance company were also discussed. Several incident samples of power cords and wiring that started fires or created hazardous arcing were shown.

Mr. Gregory discussed the draft standard for Arc Fault Circuit Interrupters, UL 1699, and the tests that were designed through extensive research efforts. There are three major areas of testing: (1) Efficacy tests, (2) Unwanted tripping tests, and (3) Operation inhibition tests.

Mr. Cornhill discussed the tests that were chosen for the demonstration. A list of the tests are enclosed. Each of the tests are referenced to the appropriate section of the draft standard for Arc Fault Circuit Interrupters, UL 1699. Mr. Grage demonstrated that the AFCI tripped when an unwanted arc was simulated and that various loads would not mask the arc signal in operation inhibition tests. In addition, it was demonstrated that the AFCIs would not nuisance trip during unwanted tripping tests.

Enclosures
Agenda
Brochure - Arc Fault Circuit Protection
AFCI Draft Standard Outline
List of Tests for CPSC Demonstration

Nov. 5, 1997
CPSC Visit Agenda

Square D Representatives:

Troy Bishop
Colin Cornhill
George Gregory

Agenda

8:30 Conference room
Introductions

AFCI Product and Ratings (Bishop)

Background (Gregory)
What's in the draft standard

What you will see in the laboratory (Cornhill)

9:30 Laboratory tests

11:00 Conference room

Discussion of tests (Cornhill)
Are other tests needed?

Code proposals

Noon Catered lunch

1:00 Conference room

Resume discussion

Wrap-up

The Square D Arc Fault Circuit Interrupter

Square D, the company that pioneered the Ground Fault Circuit Interrupter (GFCI), has actively pursued the development of an Arc Fault Circuit Interrupter (AFCI) that combines traditional thermal-magnetic overcurrent protection with the ability to detect and interrupt electrical arcs.

Square D will have arc fault circuit interrupters in both our QO and HOMELINE styles. These devices will fit into our existing load centers that we sell today.

Square D supports the Arc Fault Code Proposal

The National Electrical Code (NEC) is a primary driver for safe application of the electrical system in residences. There is a proposal under consideration for the 1999 NEC to include AFCI for 15 and 20 amp dwelling unit branch circuits. If the proposal is adopted, the requirement to add AFCI would become mandatory in 2001. AFCIs can be used for applications with or without the code adoption.

Square D supports the NEC proposal because of its potential to reduce electrical fires. We have been active in explaining the potential use of the new technology to inspectors, installers and future users nationwide.

What can I do to drive the arc fault proposal?

The research conducted by many different groups and companies has proven that arcing faults are a problem that needs to be dealt with and Square D is ready to deliver.

However, in order to make the use of Arc Fault Circuit Interrupters mandatory, like GFCI's are required in the home today, a number of hurdles must be overcome.

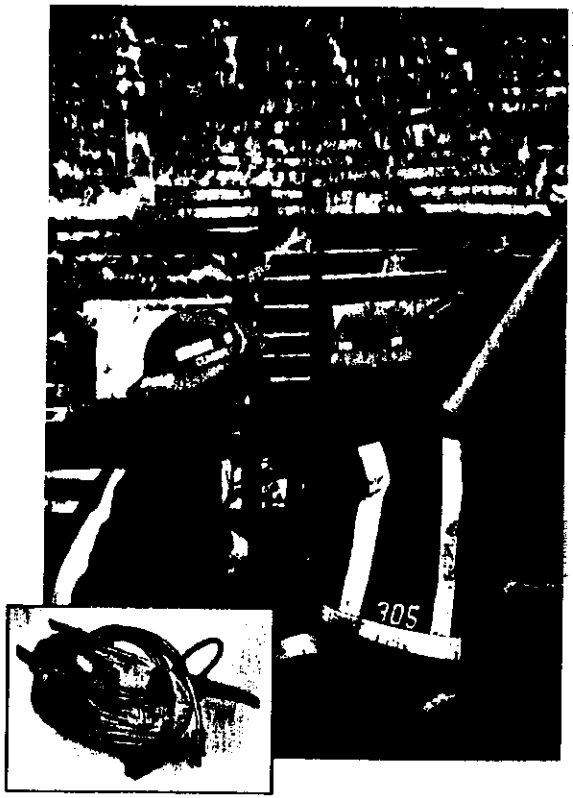
The first is the approval of the NEC proposal. Without approval, there's no code adoption and enforcement. Informed, written comments to the National Fire Protection Association (who develops and publishes the NEC) expressing your thoughts about the hazards of arc faults and the need to provide homeowners with improved protection are invited.

Square D will continue its support through educational programs directed toward inspectors, installers and homeowners. As the leading manufacturer in residential electrical distribution equipment, we're committed to electrical safety. For a copy of the pending NEC proposal and the form to be used to register your comment, please call the Square D Fulfillment Center at 1-800-888-2448 and request publication number RP8900797.

SQUARE D
GROUPE SCHNEIDER

RP8870797

Arc Fault Circuit Protection



Developing New Technology To Improve Electrical Safety

SQUARE D
GROUPE SC 'DER

New technology improves electrical circuit protection

In recent years, Underwriters Laboratories Inc. (UL) and electrical manufacturers have gained an understanding that another type of potential electrical hazard exists in homes - arc faults.

The most recent Consumer Product Safety Commission (CPSC) report on home electrical fires stated that there were 451,000 total home fires, of which 42,900 were attributed to the electrical system. In that year, 370 deaths were attributed to those electrical fires.

What caused those fires? The CPSC, industry trade groups, such as the Electronic Industries Association (EIA), as well as electrical manufacturers have determined that low-level arcs associated with a building's electrical wiring system can lead to electrical fires by igniting combustible material.

Traditional overcurrent protective devices, such as circuit breakers and fuses, cannot detect these low-level arcs. However, through research and development efforts by Square D and other electrical manufacturers, the capability now exists to detect most of these arcing conditions and disconnect the problem circuit.

What is an arc fault?

An arc is a high temperature electrical discharge that can be caused from loose connections, aging, damage to components or the breakdown of the insulation material protecting an electrical conductor, such as the wire within the conduit or an extension cord that is damaged.

Arc faults are unintended arcs that may occur and cause the ignition of combustible materials in a home.

What about present day overcurrent protective devices?

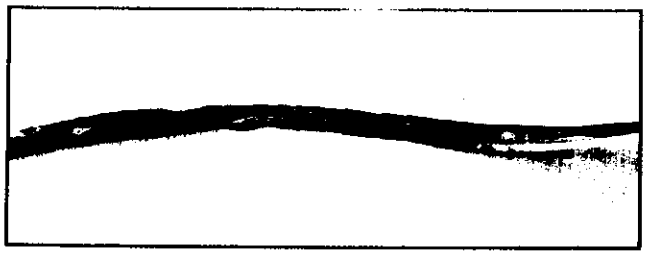
Traditional circuit breakers and fuses are excellent at performing their intended function...protecting against overloads and short circuits. GFCIs were developed to add protection against electrical shock. Now, AFCIs have been developed to provide additional protection against arc faults. Remember, arc faults are not typical short circuits or overloads.

What are some examples of arc faults?

Arc faults can occur under many different conditions. The illustrated examples below are from actual fires or near fire occurrences.

Pierced Wiring Insulation

The photo below was from an actual fire occurrence involving No. 12 AWG copper wire that was installed in flexible metallic conduit. Firemen disconnected the electricity from the circuit on a call of reported smoke.

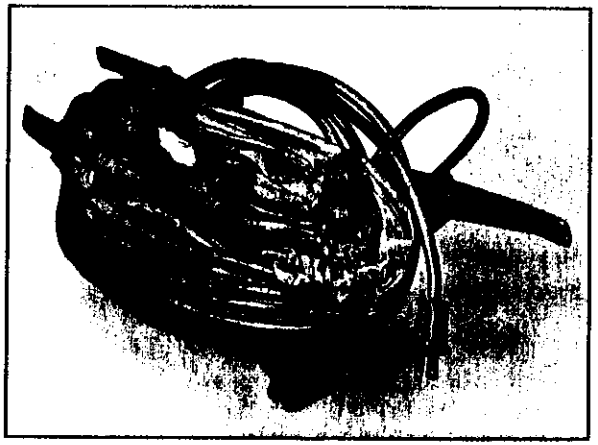


Although there is some melting of the insulation on all three wires, a short circuit between wires had not occurred. Exposed conductors (wire) of both the red and white wires each indicate arcing to the conduit, not directly to each other. Apparently the conduit had become hot enough to melt the wire insulation. Firemen discovered burned construction sawdust next to the conduit in its concealed location as the source of the smoke.

Overheated Wiring

The wound cord in the photo below had been connected to a window air conditioner. Heating from current flow heating within the cord had apparently caused significant melting of the insulation, resulting in arcing between conductors. Fortunately in this case, the unit was unplugged before a fire occurred.

The cord wires were arcing to each other, but at such a low level that the standard overcurrent device could not detect a problem.



There are many other ways in which arc faults can occur within a home. Research aimed at understanding how, why and when arc faults occur has resulted in the development of a product called the Arc Fault Circuit Interrupter (AFCI).

AFCI Draft Standard

- Efficacy Tests
  - Carbonized Path
  - Point Contact (Guillotine)
- Unwanted Tripping Tests
- Operation Inhibition Tests

Unwanted Tripping Tests

I. Inrush Current

II. Normal Operation Arcing

III. Non-sinusoidal Waveform

IV. Cross Talk

V. Multiple Load

VI. Service Life

Operation Inhibition Tests

- Masking
  - Selected loads in series and parallel
- EMI Filters
- Line Impedance
- Minimum Voltage

Tests for CPSC Demonstration

1.) 13.2 **Carbonized Path Arc Test - Type A**
5 and 20 amp resistive loads
SPT-2 16 with cotton indicator

2.) 13.4 **Opposing Electrode - Type A**
5 and 20 amp resistive loads

3.) 13.3 **Carbonized Path Arc Test - Type B**
NM-B with cut neutral and cotton indicator
300mA, 5 and 20 amp resistive loads

3.) 15.1 **Masking the Signal, Configuration D - Type B**
5 amp heater in parallel with:
- Computers
- Air compressor
- Vacuum cleaner
- RFI filter

4.) 14.4a **Normal Operation Arcing - Type B**
Plug and unplug vacuum cleaner

5.) 14.4d **Normal Operation Arcing - Type A and B**
Arc welder operation

6.) 13.5 **Guillotine Test - Type A and B**
75 and 150 amp bolted fault

7.) 14.6 **Cross Talk - Type A and B**
5 amp heater on AFCI circuit
150 amp fault on non-AFCI circuit