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LOG OF MEETING  
DIRECTORATE FOR ENGINEERING SCIENCES

SUBJECT: Arc Fault Circuit Interrupters (AFCI) Demonstration  
by Cutler-Hammer

DATE OF MEETING: April 29, 1997

PLACE OF MEETING: Engineering Sciences Laboratory,  
Gaithersburg, MD

LOG ENTRY SOURCE: Doug Lee, ESEE *DL*

COMMISSION ATTENDEES:

Andrew Stadnik, ES	Ed Krawiec, LSE
William King, ESEE	Mai Ngo, ESEE
Doug Lee, ESEE	Linda Edwards, ES
Robert Garrett, LSE	Hammad Malik, ESEE
Aaron Banerjee, ESEE	Sheela Kadambi, ESEE
Julie Ayres, EXHR	Ted Gordan, LSE
Richard Schenck, LSE	Diane Porter, LSE
Anna Luo, ESEE	Ron Reichel, LSE

NON-COMMISSION ATTENDEES:

Robert Clarey, Cutler-Hammer	Tom Mock, EIA
John Wafer, Cutler-Hammer	Ned Schiff, TRC
Bruce Terhorst, Cutler-Hammer	Saul Rosenbaum, Leviton
Joe Engel, Cutler-Hammer	Ted Marks, JVC
Clive Kimblin, Cutler-Hammer	Christine Eames, Product Safety Letter
Tom Doring, Cutler-Hammer	

SUMMARY OF MEETING:

Doug Lee opened the meeting by giving a brief history of interest by CPSC. The CPSC sponsored work by UL which produced the report Technology for Detecting and Monitoring Conditions that Could Cause Electrical Wiring System Fires was noted.

John Wafer provided some introductory remarks for Cutler-Hammer. The EIA pioneering work and the improvements to arc fault detection were mentioned.

A Cutler-Hammer AFCI video was shown which defined the problem and the arc fault solution. The conventional circuit breaker thermal and instantaneous tripping methods were described. Typical sources of home wiring degradation which could start arcing were illustrated in the video (e.g. lightning, nicked wires from staples, drilling, and chairs, old extension cords, old wiring, loose connections, chemicals, and overheating from exceeding current ratings). The three types of arcing - line to neutral, line to line, and line to ground were described.



Robert Clarey gave the presentation for Cutler-Hammer. Cutler-Hammer began work in 1990 responding to the question, "Why didn't the circuit breaker trip?" This question sparked research at Cutler-Hammer leading up to an AFCI being introduced in September 97. An outline of the presentation follows:

**Characteristics of today's branch circuit protective devices** - They are designed to protect conductors from overcurrent. There are two methods of tripping. Instantaneous or magnetic tripping on large currents (greater than 150 A rms) and thermal tripping based on the handle rating. They are not designed for arcing waveforms where the rms level is below the handle rating and the peak levels are below the instantaneous trip levels.

**Technical challenge of arcing faults** - Challenge is to present safety enhancement that doesn't nuisance trip due to very complex loads. AFCIs are capable of distinguishing between dangerous arcs and the inrush transients and arcing patterns associated with normal operational loads.

**Enhanced protection of AFCIs** - New residential circuit breakers have additional circuitry to mitigate the effects of arcing faults. These AFCI's recognize the arc signatures associated with sputtering Arcing Faults of 75 amps and above, and also respond to arcing faults to ground.

**Studies cited and work performed**

1991: NEMA formed task force - paper on purpose of circuit breakers

1993: EIA proposal to NEC for Low Instantaneous Trip (LIT)

1993: NEMA formed task force to develop new standard for Arc Fault Circuit Breakers

1995: CPSC sponsored work by UL - Technology for Detecting and Monitoring Conditions That Could Cause Electrical Wiring System Fires

1996: Cutler-Hammer, Square D, EIA proposals to 1999 NEC

1996: Cutler-Hammer obtained UL listing in Dec 96 (UL 489)

**Insurance study** - Based upon information in the reports which could lead one to suspect arcing fault lead to fire, it is estimated that AFCIs could have prevented 38% of total electric fires in study.

**Cutler-Hammer product** - Testing in homes since 1993, September 97 introduction to market, cost approximately same as GFCI breakers, first step in enhancing safety

The AFCI demonstration was given by Bruce Terhorst, Robert Clarey, and Joe Engel. A test setup was brought by Cutler-Hammer to demonstrate their AFCI breakers tripping on two arcing methods. Conventional circuit breakers were used to demonstrate that arcing may not trip conventional breakers before possibly starting a fire. The arcing methods demonstrated were:

- 1) Guillotine or point contact arc (bridging of line and neutral)
- 2) Long term degradation/carbonized path arc fault (bridging of line and neutral)

Approximately 350 A available current was measured at the receptacle which was reduced with series wiring to reduce available current at the test breaker.

SPT-2 and 12-2 NM-B wire were used to demonstrate with the AFCI and conventional thermal/magnetic breakers for method 1). For the point contact arc, it was demonstrated that the AFCI breaker tripped and the conventional breaker did not.

SPT-2 was used with method 2). A high voltage transformer was used to accelerate the degradation/carbon path fault. It was also demonstrated that the AFCI breaker tripped and the conventional breaker did not.