LOG OF MEETING

SUBJECT: Conference on Fire-Related and Electrical-Related Activities

DATE: January 24-25, 2000 **PLACE:** Greenbrier Hotel
White Sulphur Springs, WV

DATE OF LOG ENTRY: January 31, 2000

LOG ENTRY SOURCE: William H. King, Jr., ES

CPSC PARTICIPANT: William H. King, Jr., ES

NON-CPSC PARTICIPANTS:

Carlos Hilado, Product Safety Corporation
John Stimitz, Underwriters Laboratories Inc.
Frank McGarry, National Assoc. of State Fire Marshals
Robert White, USDA – Forest Service
Sang Lee, The Geon Company
Douglas Wetzig, The Geon Company
Kirk McCabe, Bayer Corporation
George Trapp, West Virginia University
Anthony Carrico, Office of the West Virginia State Fire Marshal
Ray Cull, Dow Corning Corporation

SUMMARY:

Attached are the session schedules and material presented by William H. King, Jr. A conference proceeding will include the material from the other presenters.

THIRTIETH INTERNATIONAL CONFERENCE ON FIRE SAFETY
TWELFTH INTERNATIONAL CONFERENCE ON THERMAL INSULATION
FOURTH INTERNATIONAL CONFERENCE ON ELECTRICAL AND ELECTRONIC PRODUCTS

Monday, January 24, 2000

8:30 am	Registration
9:00	Opening of Conference Conference Director: Carlos J. Hilado, Product Safety Corporation Introduction of participants

Session on Fire Safety of Buildings and Furnishings

Chairman: William H. King Jr., U.S. Consumer Product Safety Commission

9:15-9:45	An Update on Fire-Related Activities of the U.S. Consumer Product Safety Commission William H. King Jr., U.S. Consumer Product Safety Commission
9:45-10:15	Fire Safety in Consumer Products Francis A. McGarry, National Association of State Fire Marshals
10:15-10:30	break
10:30-11:00	International Incapacitation Study Update Rick Mulhaupt, National Fire Protection Research Foundation
1:00-1:30pm	Wildland Urban Interface Research at the Forest Products Laboratory: Past, Present, and Future Robert H. White, USDA Forest Products Laboratory
1:30-2:00	Fire Safety in Industrial Parks Jack D. Burlingame, Jackson County Development Authority

This program is subject to change.

U.S. Consumer Product Safety Commission

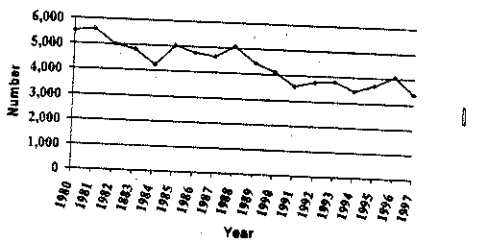
Presentation to the 30th International Conference of Fire Safety
January 24, 2000

William H. King, Jr.
Chief Engineer for Electrical & Fire Safety

CPSC - FY 2000

- Total Budget - $49 million
- About 480 staff
  - Headquarters 310 (Bethesda, MD)
  - Field 137
  - Laboratory 33 (Gaithersburg, MD)

Estimated Residential Structure Fire Deaths 1980-1997



Source: National Fire Protection Association

Past CPSC Fire Activities

- Mattresses
- Children's Sleepwear
- Upholstered Furniture
- Carpets
- Blankets
- Household Wiring
- Electric Blankets
- TV Receivers
- Matchbooks
- Halogen Lamps
- Cigarettes/Lighters
- Extension Cords
- Christmas Lights
- Electric Heaters
- Kerosene Heaters
- Cellulose Insulation
- Electric Toys
- Wood Burning Products
- Gas Heating Equipment
- Heat Tapes
- Smoke Alarms
- Fire Safety Devices

Current CPSC Fire Projects

- Upholstered Furniture
- Plastic Appliance Enclosures/Components
- Range Cooking Fires
- Bedding/Mattresses
- Gas Water Heaters
- Multi-Purpose Lighters
- Candles
- Pellet Stoves
- Smoke Alarms
- Fixed Room Heaters
- Arc Fault Circuit Interrupters (AFCI)
- Gas Water Heaters
- Cigarette Lighters
- Countertop Cooking Appliances
- Clothes Dryers
- Sprinklers
- Extension Cords
- Portable Fans
- Batteries

UPHOLSTERED FURNITURE

- 13,100 fires, 650 deaths in 1996
  - Societal cost almost $4 billion
  - Leading cause of residential fire deaths among products under Commission jurisdiction
- National Association of State Fire Marshals 1993 petition
  - Granted: standard for small open flame ignition
  - Denied: large open flame ignition
  - Deferred: cigarette ignition, pending evaluation

GAS APPLIANCES

- Approach - develop and recommend changes to voluntary standards and model codes
- Furnace fires - flame rollout
- Gas water heaters- flammable vapor

PLASTIC APPLIANCE ENCLOSURES

- Thousands of appliance fires reported each year
  - E.G., fans, nursery monitors, humidifiers, coffeemakers, telephone answering machines, irons, others
- Internal components fail and ignite non-FR plastic enclosures
- UL 746C permits non-FR enclosures, if internal live parts meets insulation spec
- Assessed enclosure fire performance in 1997-8 - multiple product/materials tests
- UL Plastics Flammability Ad Hoc Group formed
- Developed solution to eliminate non-FR plastics
- Modifications to UL standards in process

ARC-FAULT CIRCUIT-INTERRUPTERS

- New technology to address arcing faults
  - Line-to-line, broken wire
- Tested in 1997-98 to draft UL standard - work really well!
- Introduced into the *National Electrical Code* this year for 2002 edition

CANDLE PRODUCTS

- 10,300 fires, 120 deaths in 1996
- Expanding market
- ASTM Subcommittee for new voluntary standard
- Labeling task force drafted guidelines
  - Awaiting Subcommittee ballot
- Test requirements being developed
  - Glass Breakage, Sooting, Lead (Pb), Aeromatics

FIRE SPRINKLERS

- Omega Recall - 1998
- Two year project started 10/98
- Assess basic product designs/reliability
- Collect field data
- Codes Assessment
- Product Standards Assessment
- Product Design Assessment
- Limited Testing

THIRTIETH INTERNATIONAL CONFERENCE ON FIRE SAFETY
TWELFTH INTERNATIONAL CONFERENCE ON THERMAL INSULATION
FOURTH INTERNATIONAL CONFERENCE ON ELECTRICAL AND ELECTRONIC PRODUCTS

Tuesday, January 25, 2000

8:30 am	Registration
9:00	Introduction of participants Conference Director: Carlos J. Hilado, Product Safety Corporation

Session on Electrical and Electronic Products
Chairman:

9:15-9:45	Residential Electrical Wiring Fires: New Devices Offering Improved Protection William H. King Jr., U.S. Consumer Product Safety Commission
9:45-10:15	Combustion Gas Analysis from a Vertical Ladder Flame Test for Electrical Cables Wilber F. Powers Jr., Southwire Company
10:15-10:30	break
10:30-11:00	Electrical Fires and the Licensing Program for Electricians in West Virginia Anthony Carrico, Office of West Virginia State Fire Marshal
11:00-11:30	Updates to the National Electrical Code Jack Murphy, Chief Building Official, City of Lorain
1:00-1:30pm	Requirements for Fire Alarms Jack Murphy, Chief Building Official, City of Lorain
1:30-2:00	UL's Perspective on Plastics Used in Electrical and Electronic Products John Stimitz, Underwriters Laboratories
~~2:00-2:30~~	~~An Overview of the Activities of the Bradley Electrical and Computer Engineering Department at Virginia Tech~~ Cancelled Leonard A. Ferrari, Virginia Polytechnic Institute and State University
2:30-3:00	An Overview of the Activities of the Computer Science and Electrical Engineering Department at West Virginia University George E. Trapp, West Virginia University

This program is subject to change.

U.S. Consumer Product Safety Commission

Presentation to the 4th International Conference
on Electrical & Electronic Products
January 25, 2000

William H. King, Jr.
Chief Engineer for Electrical & Fire Safety

CPSC - FY 2000

- Independent Federal regulatory agency
- Total Budget - $49 million
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  - Field 137
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Past CPSC Electrical Activities

- Household Wiring
- Electric Blankets
- TV Receivers
- Halogen Lamps
- Countertop Cooking Appliances (coffeemakers)
- Ground-Fault Circuit-Interrupters
- Extension Cords
- Christmas Lights
- Portable Electric Heaters
- Electric Toys
- Heat Tapes
- Smoke Alarms

Current CPSC Electrical Projects

- Plastic Appliance Enclosures/Components
- Range Cooking Fires
- Smoke Alarms
- Fixed Room Heaters
- Extension Cords
- Portable Fans
- Batteries
- Arc Fault Circuit Interrupters (AFCI)
- Countertop Cooking Appliances (toasters, toaster-ovens, deep fat fryers)
- Clothes Dryers
- National Electrical Code
- Shock prevention devices

PLASTIC APPLIANCE ENCLOSURES

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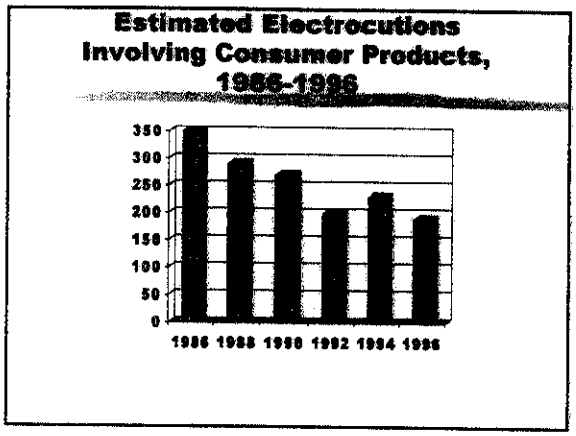

Estimated Electrocutions
Involving Consumer Products,
1986-1996
350
300
250
200
150
100
50
0
1986 1988 1990 1992 1994 1996

New "Smart" Circuit Interrupters Can Prevent Home Wiring Fires

By
Douglas A. Lee
Andrew M. Trotta
William H. King, Jr.

The Fire Problem

Electricity is a powerful energy source that runs many of the appliances, tools and multimedia systems that make our lives easier and more enjoyable. Electricity is also the powerful energy source that causes problems in residential electrical distribution systems that erupt into more than 40,000 residential fires each year. According to estimates from the U.S. Consumer Product Safety Commission (CPSC) staff, these fires claim over 350 lives and injure 1,400 victims annually. Approximately one-third of these fires are attributed to the installed wiring in homes. A 1994 insurance company survey of 660 electrical fires indicated that over 33% of the fires resulted from arcing conditions. This data is consistent with a 1987 CPSC staff report, "Residential Electrical Distribution System Fires."

The conditions for a fire could be looming inside your home, and you may not know about it until it's too late. Damaged or deteriorating wiring can exist for years without any sign of a problem -- the Romex® wire that was pierced by a staple that the electrician accidentally drove through it while fastening it to the stud; the insulation on the wire that was scraped by the drill bit when you were installing a fastener to hang a picture; or the lamp or appliance cords caught in doors or under furniture. Gradually, the damaged insulation can deteriorate until arcing occurs, producing localized temperatures hot enough to melt steel and cause a fire.

What Are Arc-Faults?

An arc is a momentary, brilliant visible glow that is produced when electrical current flows through an insulator such as plastic or air. Arcs cannot be sustained through air in systems below 350 V. Therefore, arcs in household electrical systems are only sustained through the insulating material of the equipment. Some arcs are produced as a normal consequence of operating electrical equipment and appliances. These include switching a light off or operating an appliance with a universal motor. In the context of this discussion, these are referred to as "good" arcs. Since equipment designers anticipate that good arcs will occur, the materials adjacent to the arc are selected to withstand or dissipate the heat generated by the arc.

If there are good arcs, then there must also be "bad" arcs. A "bad" or "unwanted" arc can occur in faulty wiring or equipment. Since a bad arc is an unanticipated event, the adjacent materials may not sufficiently contain the heat, resulting in either further damage or possibly propagating fire to adjacent combustibles. Arcing conditions may be categorized as either series or parallel. A series arc occurs because of a disruption of the current path. A broken conductor produces an arc when the two pieces move apart while current is flowing. An example is a frayed wire in an extension cord. The magnitude of the current in a series arc is determined by the load that the wire is supplying. For example, in a 120-volt branch circuit supplying a 1500-watt heater, a series arc in the

wires to the heater will not exceed the 12.5 amperes that the heater draws. Since the current is within the rating of the branch circuit, the protective device will not trip.

A parallel arc occurs between conductors of opposite polarity (hot and neutral or hot and ground). The current in a parallel arc is only limited by the resistance of the path between the circuit panel and the damaged area. Parallel arcing faults are generally considered more hazardous than series arcing faults since the current, and therefore the energy, associated with a parallel arcing fault is higher. Additionally, the damage produced by a series fault will often develop into a parallel fault.

Arc-Fault Circuit Protection: Limits of Conventional Circuit Breakers

The role of conventional circuit protection devices, such as circuit breakers and fuses, is to protect branch circuit wiring from overheating due to faults (overloads or short circuits) without tripping during normal transient load current increases, such as from a refrigerator compressor starting. An overload is a condition in which the sum of the electrical loads (appliances) that are connected to a particular circuit exceeds the current-carrying capacity (ampacity) of the branch wiring. For an overload that is two times the current rating of the circuit, a circuit breaker should trip within 2 minutes; for an overload of 1.35 times, the circuit breaker should trip within 1 hour.

A short circuit is a condition in which circuit conductors of opposite polarity (e.g., the line and neutral) contact each other, resulting in peak currents above the rating of a conventional circuit breaker. Circuit breaker and fuse response times are consistent with the requirements above. However, in many arc-fault conditions, the available short-circuit (fault) current is limited by the circuit impedance or the arc-fault is intermittent resulting in insufficient energy needed to trip the conventional circuit breaker. Unfortunately then, conventional circuit protection devices will likely not respond to the types of arcing situations mentioned above and, thus, would fail to prevent the damaged wire from progressing to a fire. Therefore, a device to handle the arcing situation is needed.

"Smart" Circuit Interrupters: Arc-Fault Circuit Interrupters

In 1994 and 1995, CPSC staff embarked on an effort to reduce residential electrical system fires. CPSC contracted with Underwriters Laboratories Inc. (UL) to study possible methods for detecting and monitoring precursory conditions that could lead to or cause fires in homes. The study results are in UL's report entitled "Technology for Detecting and Monitoring Conditions that Could Cause Electrical Wiring System Fires" dated September 1995. The study uncovered several possible technologies and concluded that arc-fault detection combined with ground-fault protection was the most promising technology to reduce the risk of fire when combined with conventional circuit breakers.

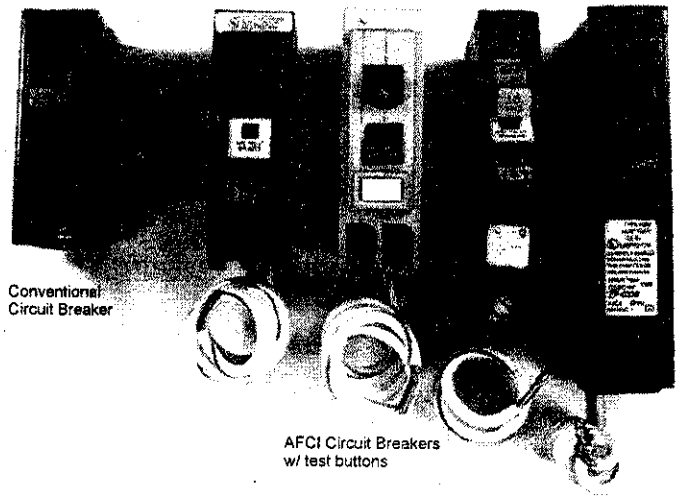
Subsequently, manufacturers have developed new devices that use electronics to detect the electrical signals that characterize these conditions and de-energize the circuit. These new electrical safety devices, called arc fault circuit interrupters, or AFCIs, are expected to offer protection from fires resulting from these unsafe conditions.

The objective of the AFCI is to detect "bad" arc conditions and trip while ignoring "good" arcs. The AFCI circuitry continuously monitors current flow through the AFCI. AFCIs use detection 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.

Presently, AFCIs are designed into conventional circuit breakers combining traditional overload and short-circuit protection with arc fault protection. Circuit breaker AFCIs can be installed in any 15 or 20-ampere branch circuit in homes today. The installation should be performed by a qualified electrician.

AFCI circuit breakers have a test button and look similar to ground fault circuit interrupter (GFCI) circuit breakers. However, AFCIs should not be confused with GFCIs which are designed to provide protection from electric shock. Some designs combine GFCI and AFCI protection. Additional AFCI design configurations are anticipated including AFCI technology for receptacles.



It is important to note that AFCIs may 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 does not detect another major cause of fires, the glowing connection, unless an arc or ground fault is present. A glowing connection is a special case of a poor connection that can dissipate a considerable amount of energy and glows to the point of incandescence. The AFCI will detect some of the secondary effects of the glowing connection. By detecting the secondary effects of glowing connections such as arc faults and ground faults, the AFCI can de-energize the circuit and stop further destruction.

1999 National Electrical Code Requirement

AFCIs are already recognized for their potential in preventing fires. The most recent edition of the *National Electrical Code ™*, the widely-adopted model code for electrical wiring, will require AFCIs for bedroom circuits in new residential construction, effective January 2002. Future editions of the code, which is updated every three years, could expand coverage. 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.

If you are considering an upgrade to a circuit breaker panel, particularly for houses with older wire, use of AFCIs may be an alternative that is well worth considering.

This article was prepared by the technical staff of the U.S. Consumer Product Safety Commission (CPSC) but does not necessarily reflect the official policy or position of the Commission. Mr. Lee and Mr. Trotta are staff Electrical Engineers with the CPSC and each have over 13 years of experience in electronic detection systems, electrical distribution systems, and electrical consumer products. Mr. King is currently the Chief Engineer for Electrical and Fire Safety with the CPSC and has over 36 years of experience in electrical product safety.