EXHIBIT 103

COMMENT ON NFPA NEC COMMITTEE REPORT ON PROPOSALS FOR 1999 NATIONAL ELECTRICAL CODE

DATE: 9/30/97 **NAME:** Wm H. King, Jr. **TEL. NO:** 301-504-0508

ORGANIZATION: U.S. Consumer Product Safety Commission

ADDRESS: 4330 East West Hwy, Bethesda, MD 20814-4408

ORG. REPRESENTED: U.S. Consumer Product Safety Comm. staff

1. **SECTION/PARAGRAPH:** 422 Part F

2. **COMMENT ON PROPOSAL NO:** 20-52

3. **COMMENT RECOMMENDS**
   - x_ **new text**
   - __ **revised text**
   - __ **deleted text**

4. **COMMENT:** Proposal No. 20-52 should be accepted.

5. **STATEMENT OF PROBLEM AND SUBSTANTIATION FOR COMMENT:**

The current situation where a few listed appliances intended for use on general purpose branch circuits have been permitted to exceed 80 percent of the branch circuit rating is the apparent result of individual mistakes at the outset of a product listing by a testing laboratory. Such listings clearly violate Article 210-23(a). In the interest of product safety, however, other testing/listing bodies, such as the Canadian Standards Association, report holding the limit to 1650 watts (80% of 15 amperes @ 125 volts x 110%) for portable, intermittent type appliances.

At present, many manufacturers, code experts and enforcing authorities believe that the electrical safety code currently limits appliances to 1500 watts (80 percent of 15 amperes @ 125 volts), and this has helped to avoid an escalation of ratings in many product categories. It would now help if Panel 20 would reconsider this matter with a view toward lining up with Article 210-23(a), and clarifying for appliance manufacturers and other users of the NEC the intended limit for a single appliance load for use on a general lighting 15- and 20-ampere branch circuit.

6. **THIS COMMENT IS ORIGINAL MATERIAL.**

This proposal represents the views of the writer and not necessarily the official position of the CPSC.

Signature

COMMENT ON NFPA NEC COMMITTEE REPORT ON PROPOSALS FOR 1999 NATIONAL ELECTRICAL CODE

DATE: 9/30/97 **NAME:** Wm H. King, Jr. **TEL. NO:** 301-504-0508

ORGANIZATION: U.S. Consumer Product Safety Commission

ADDRESS: 4330 East West Hwy, Bethesda, MD 20814-4408

ORG. REPRESENTED: U.S. Consumer Product Safety Comm. staff

1. **SECTION/PARAGRAPH:** 210-12-(New)

2. **COMMENT ON PROPOSAL NO:** 2-129

3. **COMMENT RECOMMENDS**
   _X_ **new text**
   ___ **revised text**
   ___ **deleted text**

4. **COMMENT:**
   Accept the panel action in the ROP for Proposal 2-129.

5. **STATEMENT OF PROBLEM AND SUBSTANTIATION FOR COMMENT:**

Bedrooms are the most frequently reported areas of origin for fires involving the residential electrical distribution system, according to a study by the U.S. Consumer Product Safety Commission.[1] Often these circuits are remote from the service equipment or loadcenter, presenting more opportunities for damage to the branch circuitry resulting in electrical arcing. The common failure modes resulting in branch circuit wiring fires noted in the CPSC report are mechanical damage, poor/loose splices, and ground faults. The branch circuits that serve these rooms especially deserve the added protection afforded by arc-fault circuit-interrupters (AFCIs). In the order of descending frequency, living rooms, kitchens, closet/storage areas, garages, bathrooms, laundries, halls, and dining rooms are the other functional locations in the home where electrical wiring fires are reported.

Explanations for negative votes regarding the arc-fault circuit protection proposals in the ROP indicate concerns about the magnitude of the requested change and the availability of product. The concern regarding the scope of the change has to be matched against the toll of fires attributed to the residential electrical distribution system as reported in the latest available loss figures (42,900 fires, 370 civilian deaths, $615 million property loss).[2] Regarding availability, CPSC staff has obtained listed AFCIs and plans to confirm the performance characteristics of the technology.

[1] Report "Residential Electrical Distribution System Fires", U.S. Consumer Product Safety Commission, Dec. 1987, Table 4 and Table 12.

[2] Report "1994 Residential Fire Loss Estimates", U.S. Consumer Product Safety Commission, Table 4.

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William H King Jr

Signature

Form for Proposals on NFPA National Electrical Code

NFPA Document and Reference: NFPA 70 Section 210-8 (3)

SUBMITTER INFORMATION:

First Name:	William	Last Name:	King
Company:	U.S. Consumer Product Safety Commission	Telephone#:	301-504-0508, ext. 1296
Address 1:	4330 East West Highway	PO Box:	
Address 2:			
City:	Bethesda	State:	MD Zip: 20814-4408
Representing:	U.S. Consumer Product Safety Commission staff	Country:	U.S.A.
	Please indicate organization represented (if any)	Date:	08/31/1999

FOR EACH PROPOSAL, PLEASE COMPLETE EACH OF THE FOLLOWING:

1.a) Document Title: **National Electrical Code** NFPA No.: **70** Year: **1999**

b) Article/Section: Section 210-8 (3)

2. Proposal recommends: (Check one): ☐ new text ☒ revised text ☐ deleted tex

3. **Proposal (include proposed new or revised wording, or identification of wording to be deleted):**

210-8. Ground-Fault Circuit-Interrupter Protection for Personnel.
(a) Dwelling Units....
(3) Outdoors. The device(s) providing ground-fault circuit-interrupter protection for personnel shall remove the power normally available for the loads at protected receptacles, and not restore this power, if the protection device fails to operate as intended in the test mode.

4. **Statement of Problem and Substantiation for Proposal:**

Data available from the files of the U.S. Consumer Product Safety Commission (CPSC) and Underwriters Laboratories (UL) indicate that a significant number of ground-fault circuit-interrupter (GFCI) devices installed in the field are inoperative. Until recently, the only GFCI devices that were available did not remove electrical power to loads when the device failed to operate as intended in the test mode. For example, when a GFCI test button was pushed and the reset button did not actuate, the GFCI still permitted the delivery of electrical power. Now, however, GFCIs are available that prevent the restoration of electrical power when the device is tested and fails the test. Such enhanced GFCIs should be used, as a minimum, to protect outdoor receptacles, because outdoor receptacles are considered to be high risk locations with many grounded surfaces.

5. ☒ **This Proposal is original material.**
☐ **This Proposal is not original material; its source (if known) is as follows:**

Form for Proposals on NFPA National Electrical Code

NFPA Document and Reference: NFPA 70 210-12 (c) (new paragraph)

SUBMITTER INFORMATION:

First Name: William | Last Name: King

Company: U.S. Consumer Product Safety Commission | Telephone#: 301-504-0508, ext. 1296

Address 1: 4330 East West Highway | PO Box:

Address 2:

City: Bethesda | State: MD | Zip: 20814-4408

Representing: U.S. Consumer Product Safety Commission staff | Country: U.S.A.

Please indicate organization represented (if any) | Date: 09/07/1999

FOR EACH PROPOSAL, PLEASE COMPLETE EACH OF THE FOLLOWING:

1.a)Document Title: **National Electrical Code** NFPA No.: **70** Year: **1999**

b) Article/Section: 210-12 (c) (new paragraph)

2. Proposal recommends: (Check one): ☒ new text ☐ revised text ☐ deleted tex

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

Add new paragraph to Section 210-12 as follows:
(c) Lighting and Appliance Branch Circuits. Each existing 125-volt, single-phase, 15- and 20-ampere lighting and appliance branch circuit shall be individually protected by an arc-fault circuit interrupter when the service equipment is replaced.

FPN: See Section 230-XX (Editorial note: Section 230-XX is a proposed new section, submitted separately to the CMP for Article 230, to complement this proposed new paragraph (c) to Section 210-12. For information purposes, the proposed new Section 230-XX reads as follows: 230-XX. Replacement of Service Equipment in Dwelling Units. When service equipment in dwelling units is replaced, each existing 125-volt, single-phase, 15- and 20-ampere lighting and appliance branch circuit shall be individually protected by an arc-fault circuit interrupter.)

4. Statement of Problem and Substantiation for Proposal:

According to a study conducted by the U.S. Consumer Product Safety Commission (CPSC), "Residential Electrical Distribution System Fires", Smith & McCoskrie, 1987, fires originating in branch circuit wiring predominately occurred in dwellings over 20 years old, with the highest rates of fires occurring in dwellings over 40 years old. Older dwellings are frequently upgraded with replacement service equipment to accomodate an increase in the service rating to supply additional appliance and equipment loads. However, often times, the existing lighting and appliance branch circuits in dwelling units are not replaced when the service is upgraded, due to the increased cost, and/or the inability to evaluate the remaining life expectancy of the branch circuit conductors. The branch circuit conductors are frequently located in concealed spaces surrounded with thermal insulation, and could be in a deteriorated condition at the time the service is upgraded. This proposal is intended to remedy this situation with the addition of arc-fault circuit interruption (AFCI) protection against fire hazard conditions for the existing branch circuit conductors.

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NFPA Document and Reference: **NFPA 70** Section 230-XX in Part E (new)

SUBMITTER INFORMATION:

First Name: William
Last Name: King
Company: U.S. Consumer Product Safety Commission
Telephone#: 301-504-0508, ext. 1296
Address 1: 4330 East West Highway
PO Box:
Address 2:
City: Bethesda
State: MD Zip: 20814-4408
Representing: U.S. Consumer Product Safety Commission staff
Please indicate organization represented (if any)
Country: U.S.A.

Date: 09/07/1999

FOR EACH PROPOSAL, PLEASE COMPLETE EACH OF THE FOLLOWING:

1.a)Document Title: **National Electrical Code** NFPA No.: **70** Year: **1999**

b) Article/Section: Section 230-XX in Part E (new)

2. Proposal recommends: (Check one): ☒ new text ☐ revised text ☐ deleted tex

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

Add new Section 230-XX as follows:

230-XX. Replacement of Service Equipment in Dwelling Units.

When service equipment in dwelling units is replaced, each existing 125-volt, single-phase, 15- and 20-ampere lighting and appliance branch circuit shall be individually protected by an arc-fault circuit interrupter.

FPN: See Section 210-12(c). (Editorial note: Section 210-12(c) is a proposed new paragraph, submitted separately to the CMP for Article 210, to complement this proposed new Section 230-XX. For information purposes, proposed new Section 210-12(c) reads as follows: Lighting and Appliance Branch Circuits. Each existing 125-volt, single-phase, 15- and 20-ampere lighting and appliance branch circuit shall be individually protected by an arc-fault circuit-interrupter when the service equipment is replaced.)

4. Statement of Problem and Substantiation for Proposal:

According to a study conducted by the U.S. Consumer Product Safety Commission (CPSC), "Residential Electrical Distribution System Fires", Smith & McCoskrie, 1987, fires originating in branch circuit wiring predominately occurred in dwellings over 20 years old, with the highest rates of fires occurring in dwellings over 40 years old. Older dwellings are frequently upgraded with replacement service equipment to accomodate an increase in the service rating to supply additional appliance and equipment loads. However, often times, the existing lighting and appliance branch circuits in dwelling units are not replaced when the service is upgraded, due to the increased cost, and/or the inability to evaluate the remaining life expectancy of the branch circuit conductors. The branch circuit conductors are frequently located in concealed spaces surrounded with thermal insulation, and may be in a deteriorated condition at the time the service is upgraded. This proposal is intended to remedy this situation with the addition of arc-fault circuit interruption (AFCI) protection against fire hazard conditions for the existing branch circuit conductors.

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Date Oct. 1, 2002 **Name** William King **Telephone** 301-504-0508, ext. 1296
Company U.S. Consumer Product Safety Commission
Address 4330 East West Highway **City** Bethesda **State** MD **Zip** 20814-4408
Please indicate organization represented (if any) U.S. Consumer Product Safety Commission

1. **a) NFPA Document Title** National Electrical Code
   b) NFPA No. & Edition 70-2002 **c) Section/Paragraph** 210.12
2. **Proposal Recommends** *(check one)*: ☑ **new text** ☐ **revised text** ☐ **deleted text**
3. **Proposal.** *(Include proposed new or revised wording, or identification of wording to be deleted.)* Note: Proposed text should be in legislative format, that is, use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).
   (See attachment for Proposal)
4. **Statement of Problem and Substantiation for Proposal.** Note: State the problem that will be resolved by your recommendation. Give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.
   (See attachment for Statement of Problem and Substantiation for Proposal)
5. ☑ **This Proposal Is Original Material.** Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought, or research and, to the best of his/her knowledge, is not copied from another source.
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Signature ***(Required)*** William H King Jr

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PROPOSAL.

Section/Paragraph: Art. 210, Part I. General, para. 210.12

Add a new 210.12 ( ) section to paragraph 210.12 as follows:

( ) Lighting and Appliance Branch Circuits in Dwelling Units. When the service equipment at a dwelling is replaced, a listed arc-fault circuit interrupter, branch/feeder type, or a listed arc-fault circuit interrupter, outlet branch circuit type, shall protect each branch circuit that existed prior to the replacement and that supply 125-volt, single-phase, 15- and 20-ampere outlets for lighting and appliances. The arc-fault circuit interrupter, outlet branch circuit type, shall be the outlet closest to, and within 3.0 m (10 ft) of the overcurrent device as measured along the branch circuit conductors.

FPN: See 230.XX for complementary requirement for service equipment.

(Editorial note: 230.XX is a proposed new section, submitted to the CMP 4 for Article 230, to complement the proposed new paragraph (B) to 210.12. For information purposes, the proposed new 230.XX reads as follow: Replacement of Service Equipment at Dwelling Units. When the service equipment at a dwelling is replaced, a listed arc-fault circuit interrupter, branch/feeder type, or a listed arc-fault circuit interrupter, outlet branch circuit type, shall protect each branch circuit that existed prior to the replacement and that supply 125-volt, single-phase, 15- and 20-ampere outlets for lighting and appliances. The arc-fault circuit interrupter, outlet branch circuit type, shall be the outlet closest to, and located within 3.0 m (10 ft) of the overcurrent device as measured along the branch circuit conductors.)

STATEMENT OF PROBLEM AND SUBSTANTIATION FOR PROPOSAL.

The new requirement for lighting and appliance branch circuits within existing dwellings that undergo service equipment replacement addresses the condition of wiring systems identified in technical studies sponsored by the U.S. Consumer Product Safety Commission (CPSC). The 1987 CPSC report ("Residential Electrical Distribution System Fires", Smith & McCoskrie) provided evidence that fires originating in branch circuit wiring predominately occurred in dwellings over 20 years old, with the highest rates of fires occurring in dwellings over 40 years old. Older dwellings are frequently upgraded with replacement service equipment to increase the service rating to supply additional appliance and equipment loads. However, existing lighting and appliance branch circuits are not replaced when the service is upgraded in many cases due to the increased cost, and/or the inability to evaluate the extent of degradation in aged circuits. The branch circuit conductors are frequently located in concealed spaces surrounded with thermal insulation, and could be in a deteriorated condition at the time the service is upgraded. This proposal is intended to provide extra protection with the addition of arc-fault circuit interrupter (AFCI) technology to address the potential fire hazards in existing branch circuits. This proposal is not intended to apply AFCI devices as a substitute for replacing unsafe wiring. Unsafe wiring should be replaced when it is identified, and the wiring methods should be done in accordance with the *NEC*.

In 1995 arc-fault detection was identified as a promising technology that could be applied to older homes to improve electrical safety by detecting symptoms that can cause fires (report "Technology for Detecting and Monitoring Conditions That Could Cause Electrical Wiring System Fires", sponsored by CPSC and prepared by Underwriters Laboratories Inc.). Shortly after this report was issued, the production of listed arc-fault circuit interrupter devices began. In 1999 the *NEC* introduced the first AFCI requirement for branch circuit protection, limited to branch circuits supplying outlets in bedrooms. When considering needs for additional AFCI protection, one of the priority locations is the older home that undergoes a service upgrade intended to extend the service life of the structure. This is the situation where the existing, older branch circuits in the dwelling will be expected to continue to supply power for appliance and lighting loads in the years ahead. These circuits need the benefit of the extra protection afforded by AFCI devices.

Other Considerations

- Cost of single-pole, 15 and 20 ampere AFCI circuit breakers currently on the market range from $20-35 in retail stores and electrical supply stores. Contractors' cost and wholesale cost are estimated to be in the $20-30 range. Costs will likely decrease with increasing volume.

- For 1998, CPSC estimates that there were 38,800 electrical distribution fires resulting in 280 civilian deaths, 1,230 injuries, and $680.0 million in property loss. Engineering experience indicates that most of these involve arcing conditions that precede ignition. Engineering judgment, based on fire investigations sponsored in the past by CPSC, indicates that AFCI devices currently on the market might address 50% or more of these fires.

- Once installed, AFCI devices will likely remain in place throughout the life of the structure and, if found defective in the future, be replaced with an equivalent device. This has been the experience with GFCI devices.

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Date Oct. 1, 2002 **Name** William King **Telephone** 301-504-0508, ext. 1296
Company U.S. Consumer Product Safety Commission
Address 4330 East West Highway **City** Bethesda **State** MD **Zip** 20814-4408
Please indicate organization represented (if any) U.S. Consumer Product Safety Commission

1. a) **NFPA Document Title** National Electrical Code
   b) **NFPA No. & Edition** 70-2002 c) **Section/Paragraph** 210.12
2. **Proposal Recommends** *(check one)*: ☑ **new text** ☐ **revised text** ☐ **deleted text**
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Signature ***(Required)*** William H King

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PROPOSAL.

Section/Paragraph: Art. 100, Part I. General

Add the following definitions to Part 1:

Arc-Fault Circuit Interrupter, Branch/Feeder Type. A device intended to protect the branch or feeder circuit from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the entire branch or feeder circuit when an arc fault is detected.

Arc-Fault Circuit Interrupter, Outlet Branch Circuit Type. A device intended to protect the branch circuit, outlet devices, and wires connected to outlet devices from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit at the load side of the arc-fault circuit interrupter (including de-energizing receptacles provided on an arc-fault circuit interrupter outlet device).

STATEMENT OF PROBLEM AND SUBSTANTIATION FOR PROPOSAL.

Definitions for arc-fault circuit interrupters have been expanded from the definition that exists in Section 210.12 of the 2002 edition to coincide with the listing of new arc-fault circuit interrupter devices. It is recommended that the definitions be re-located from Article 210 to Article 100 because a proposal has been submitted to include new requirements in both Articles 210 and 230.

Although AFCI devices currently available are incorporated within circuit breakers, AFCI devices have been listed that are incorporated into outlet devices. While only AFCI/circuit breakers can de-energize the entire branch circuit, listed AFCI/outlet devices can be applied in applications where fuses are provided as the branch circuit overcurrent protection devices. In addition, listed AFCI/outlet devices have been investigated and listed as an outlet branch circuit type with expanded arc detection capabilities, including sensing certain arcing conditions upstream of the AFCI/outlet device location, and sensing broader arcing conditions downstream of the AFCI/device location. These safety devices will provide the broadest range of fire protection to the occupants of dwellings.

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Company U.S. Consumer Product Safety Commission
Address 4330 East West Highway **City** Bethesda **State** MD **Zip** 20814-4408
Please indicate organization represented (if any) U.S. Consumer Product Safety Commission

1. a) **NFPA Document Title** National Electrical Code
   b) **NFPA No. & Edition** 70-2002 c) **Section/Paragraph** 210.8 (A)
2. **Proposal Recommends** *(check one)*: ☑ **new text** ☐ **revised text** ☐ **deleted text**
3. **Proposal.** *(Include proposed new or revised wording, or identification of wording to be deleted.)* Note: Proposed text should be in legislative format, that is, use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).
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PROPOSAL.

Section/Paragraph: Art. 210, Part I. General Provisions, para. 210.8 (A)

Replace the existing language in 210.8(A) with the following:

210.8 Ground-Fault Circuit-Interrupter Protection for Personnel

FPN: See 215.9 for ground-fault circuit-interrupter protection for personnel for feeders.

(A) Dwelling Units. All 125-volt, single phase, 15- and 20-ampere outlets installed in the locations specified in (1) and (2) shall have ground-fault circuit-interrupter protection for personnel.

(1) Receptacle outlets on general-purpose and individual branch circuits installed as required in 210.52 and for other purposes

Exception No. 1: Receptacles that are not readily accessible and that are located in garages, unfinished basements, and accessory buildings.

Exception No. 2: A single receptacle or a duplex for two appliances located in a garage, unfinished basement, or accessory building, with dedicated space for each appliance that, in normal use, is not easily moved from one place to another and that is cord-and-plug connected in accordance with 400.7(A)(6), (A)(7), or (A)(8).

Exception No. 3: A receptacle outlet for refrigeration equipment.

Exception No. 4: A receptacle for security equipment, smoke/fire alarm, carbon monoxide alarm, medical appliance, or other life-safety equipment.

(2) Outlets for boat hoist motors and associated equipment wiring

STATEMENT OF PROBLEM AND SUBSTANTIATION FOR PROPOSAL.

Approximately 200 people are electrocuted each year in incidents in and around the home; this number dipped to 170 in 1999, the most recent year reported. (Reference: CPSC Report dated July 2002 "1999 Electrocutions Associated with Consumer Products", available on CPSC web site (www.cpsc.gov) or from CPSC Freedom of Information Office. Copies provided to NFPA with this proposal.)

Analysis of CPSC investigations of electrocution incidents indicates that significant numbers occur when consumers come in contact with energized circuit conductors and ground associated with appliances, tools and equipment connected to receptacle outlets not presently required by the *NEC* to be provided with ground-fault circuit-interrupter (GFCI) protection for personnel. Example after example can be cited. The following is a selection of those cases investigated by CPSC where the receptacle outlets were located in areas of dwellings not presently required by the *NEC* to provide ground-fault circuit-interrupter protection for personnel.

Middleburg, FL September 14, 2000 A 17-year-old male electrocuted when he contacted a portable, floor fan in the bedroom of his home. CPSC Case No. 001108HCC0080.

Winder, GA May 29, 1998 A 32-year-old female and her 10 year old son electrocuted when they contacted a band saw in the workshop in their home. CPSC Case No. 990316HCC2327.

Macon, GA July 22, 1998 A 39-year-old female electrocuted when she touched an antique lamp in the master bedroom of her home. CPSC Case No. 990316HCC2328.

Portland, OR April 15, 1998 A 49-year-old male electrocuted when he touched exposed conductors on a damaged power cord of a portable saw connected to a hallway receptacle outlet while working alone remodeling an apartment. CPSC Case No. 990104CCC3105.

Brooklyn, NY August 1, 1998 A 1-year-old male electrocuted when he bit into the electrical cord of an stereo amplifier in the living room of a residence. CPSC Case No. 981110HCC0083.

Hartville, MO April 17, 1998 A 2-year-old female electrocuted when she touched exposed electrical wires energized from a 110-volt ac receptacle outlet under a kitchen table. The victim was also in contact with the heating system vent cover. CPSC Case No. 980827HCC2807.

Dexter, NM April 24, 1997 A 2-month-old male electrocuted by a heating pad. The pad had a damaged cord with tape repairs. CPSC Case No. 990609CCC3365.

Cincinnati, OH July 16, 1997 A 9-month-old female electrocuted when she contacted the bare wires of the cord for a pedestal fan. CPSC Case No. 990408HCC2395.

McAllen, TX August 25, 1997 A 15-month-old male electrocuted when he contacted the metal door plate of the mobile home of his parents. The metal plate was electrically charged from an extension cord that was worn and frayed. CPSC Case No. 981110HCC3049.

Pascagoula, MS July 12, 1997 A 5-month-old male electrocuted at his home when he came in contact with exposed wires in the cord of an alarm clock on the floor where he was playing. CPSC Case No. 981110HCC2055.

Sycamore Tnsp, OH November 5, 1997 A 74-year-old female electrocuted when she contacted bare wires while attempting to repair an electric lamp. CPSC Case No. 980817HCC2788.

Brownsville, TX June 3, 1997 A 15-month-old male electrocuted when he pulled an extension cord from a wall outlet in a bedroom. CPSC Case No. 980219CCC3606.

Newport Beach, CA July 15, 1997 A 35-year-old male electrocuted when he contacted a modified portable fan and plugged the fan into a receptacle in the bedroom of a home. CPSC Case No. 980202CCC3570.

Muskogee, OK August 16, 1997 A 9-month-old female electrocuted when she reached from a baby walker she was in and grabbed the exposed socket portion of a table lamp with no bulb in the socket. The lamp was laying on the floor of her home. CPSC Case No. 9709009CWE7048.

Barbourville, KY January 13, 1996 A 76-year-old male electrocuted when he contacted a broken aquarium heater while cleaning the fish-tank in his apartment. CPSC Case No. 960523CCC6231.

Millville, NJ July 7, 1996 A 5-year-old female electrocuted in the living room of the residence when she contacted an electric fan and the frame of a sliding glass door. CPSC Case No. 970423CCC1157.

Evansville, IN September 2, 1996 A 7-year-old female electrocuted when she contacted an electric fan and metal heat register in the doorway area between the living room and kitchen. CPSC Case No. 96093CCC7462.

Springfield, MO October 10, 1995 A 4-year-old male electrocuted when he contacted the blade of an attachment plug of a floor lamp partially inserted into a receptacle outlet located above a metal floor heating grate and behind a couch in the family room. CPSC Case No. 970220HCC7384.

The GFCI has been in service on selected circuits in homes and elsewhere for 30 years. Reductions in the number of electrocutions have occurred for receptacle outlets and equipment that are required by code to be provided with GFCI protection. The average cost of the GFCI device has decreased substantially since the early period, with the retail cost for a receptacle GFCI below $10. It is time to expand the scope of GFCI protected areas in dwellings to include all general-purpose receptacle outlets. This will provide the same level of electrocution protection as now provided at those receptacle locations that were identified in the early years on the basis of priority. The unit cost of a GFCI is offset by the increased protection.

GFCIs manufactured to the current industry-supported safety standard (UL 943) are more reliable than those units manufactured in the past. UL 943 requires stringent voltage surge testing, improved resistance to corrosion, and resistance to false tripping from electronic interference.

With regard to boat hoists at dwelling premises, outlets that provide power for motor-operated boat hoist equipment should be provided with GFCI protection for personnel. In the 1980s, in cooperation with manufacturers of boat hoist equipment, CPSC staff identified motor-operated boat hoist equipment intended for use at residential settings as consumer products that needed GFCI protection to reduce the risk of electrocution when using this equipment while near bodies of water. This action was taken because there were a number of electrocutions with boat hoists in residential settings where the equipment did not have GFCI protection. Grounding provisions associated with fixed wiring cannot be relied upon alone for adequate electrocution protection for boat hoists. This is based on the fact that these installations are exposed to harsh weather conditions, the presence of moisture corrosive to the typical boat hoist metallic apparatus, and the presence of cords associated with the motor and motor control wiring harnesses commonly found on fixed wired electrically powered boat hoists. Including the requirement for GFCI protection for boat hoists at dwelling units harmonizes the *NEC* with accepted manufacturing practice and will reduce confusion and the chance that products without GFCI protection will enter service in the future.

100

6b OK
TAS

John C. Grosz, Esq.
Solinger & Gordon
250 Park Avenue
New York, N.Y. 10017

Dear Mr. Grosz:

I am in receipt of your letter dated March 15, 1974, which concerns the "Repurchase of Banned Hazardous Substances" regulations published in the Federal Register of February 4, 1974 (39 F.R. 4469). You explain that Gimbel's has four autonomous divisions each of which operates several stores in a single metropolitan area - New York, Philadelphia, Pittsburgh and Milwaukee. You further explain that you are concerned with a situation in which a banned product has been sold only by one division and request an opinion whether signs posted in accordance with section 1500.202(i) of the regulation must be posted in all of Gimbel's divisions or only in those divisions in which the product was sold.

It is the view of this office that the selling of a banned hazardous product exclusively in one division, for e.g. New York, does not require the posting of signs in other metropolitan areas where the product has never been sold. Signs should be posted in all stores of the division involved, however.

Please let me know if I can be of further assistance.

Sincerely,

Michael A. Brown
General Counsel

AHSchoem:clb:4/2/74

cc: Executive Director
BCM
OSCA
OFC (for distribution to Area Directors)
A. Schoem

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NEW YORK 10017

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JOHN C. GROSZ

MURRAY HILL 7-1140
CABLE: SOLGORLAWS

March 15, 1974

Michael Brown, Esq., General Counsel
Consumer Products Safety Commission
1753 K Street
Washington, D.C. 20207

Attention: Alan Schoem, Esq.

Dear Mr. Brown:

On behalf of our client, Gimbel Brothers, Inc., we are writing to you at the suggestion of Alan Schoem of your office for clarification of the recently issued regulation implementing Section 15 of the Federal Hazardous Substances Act. This regulation, requiring the posting of signs upon receiving notification that a company has sold a banned hazardous article or substance, was published in the Federal Register of February 4, 1974.

Gimbels has four autonomous divisions, each of which operates several stores in a single metropolitan area (New York, Philadelphia, Pittsburgh and Milwaukee). We are concerned with a situation in which a banned product has been sold by the New York division and no other. In such a circumstance, no purpose would be served in posting a sign in the stores of the Philadelphia, Pittsburgh and Milwaukee divisions, whose customers have had no opportunity to purchase the products. Moreover, a sign posted, for example, in a Milwaukee store would then be inaccurate in its reference to a list of products "sold by this store".

Accordingly, we consider that in the situation described above, Gimbels would be in compliance with the Commission's regulation if it posted signs in all of the Gimbel stores in the New York division. Your Mr. Schoem, one of the drafters of the regulation, has agreed with this view in our telephone conversations with him.

We would greatly appreciate your confirming to us in writing that in the opinion of the Commission's legal staff, a hazardous product sold only in a particular metropolitan area does not require the posting of signs in other metropolitan areas where the Company's customers have had no opportunity to purchase the products. Please call me if you have any questions regarding our request. Thank you for your cooperation.

Very truly yours,

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Date Oct. 1, 2002 **Name** William King **Telephone** 301-504-0508, ext. 1296
Company U.S. Consumer Product Safety Commission
Address 4330 East West Highway **City** Bethesda **State** MD **Zip** 20814-4408
Please indicate organization represented (if any) U.S. Consumer Product Safety Commission

1. a) **NFPA Document Title** National Electrical Code
   b) **NFPA No. & Edition** 70-2002 c) **Section/Paragraph** 230.XX in Part V
2. **Proposal Recommends** *(check one)*: ☑ **new text** ☐ **revised text** ☐ **deleted text**
3. **Proposal.** *(Include proposed new or revised wording, or identification of wording to be deleted.)* Note: Proposed text should be in legislative format, that is, use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).
   (See attachment for Proposal)
4. **Statement of Problem and Substantiation for Proposal.** Note: State the problem that will be resolved by your recommendation. Give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.
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   This proposal represents the views of the writer and not necessarily the official position of the CPSC.

Signature ***(Required)*** William H King

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PROPOSAL.

Section/Paragraph: Art. 230, Part V. Service Equipment – General, new Section 230.XX

Add new Section 230.XX as follows:

230.XX Replacement of Service Equipment at Dwelling Units. When the service equipment at a dwelling unit is replaced, a listed arc-fault circuit interrupter, branch/feeder type, or a listed arc-fault circuit interrupter, outlet branch circuit type, shall protect each branch circuit that existed prior to the replacement and that supply 125-volt, single-phase, 15- and 20-ampere outlets for lighting and appliances. The arc-fault circuit interrupter, outlet branch circuit type, shall be the outlet closest to, and located within 3.0 m (10 ft) of the overcurrent device as measured along the branch circuit conductors.

FPN: See 210.12 (B) for complementary requirement for branch circuits.

(Editorial note: 210.12 (B) is a proposed new paragraph submitted to the CMP for Article 210, to complement the proposed new Section 230.XX. For information purposed, the proposed new paragraph (B) of Section 210.12 reads as follows: Lighting and Appliance Branch Circuits in Dwelling Units. When the service equipment at a dwelling is replaced, a listed arc-fault circuit interrupter, branch/feeder type, or a listed arc-fault circuit interrupter, outlet branch circuit type, shall protect each branch circuit that existed prior to the replacement and that supply 125-volt, single-phase, 15- and 20-ampere outlets for lighting and appliances. The arc-fault circuit interrupter, outlet branch circuit type, shall be located closest to, and within 3.0 m (10 ft) of the overcurrent device as measured along the branch circuit conductors.)

STATEMENT OF PROBLEM AND SUBSTANTIATION FOR PROPOSAL.

A report issued by the U.S. Consumer Product Safety Commission in 1987 ("Residential Electrical Distribution System Fires", Smith & McCoskrie) provided evidence that fires originating in branch circuit wiring predominately occurred in dwellings over 20 years old, with the highest rates of fires occurring in dwellings over 40 years old. Older dwellings are frequently upgraded with replacement service equipment to increase the service rating to supply additional appliance and equipment loads. However, existing lighting and appliance branch circuits are not replaced when the service is upgraded in many cases due to the increased cost, and/or the inability to evaluate the extent of degradation in aged circuits. The branch circuit conductors are frequently located in concealed spaces surrounded with thermal insulation, and could be in a deteriorated condition at the time the service is upgraded. This proposal is intended to provide extra protection with the addition of arc-fault circuit interrupter (AFCI) protection to address the potential fire hazards in existing branch circuits. This proposal is not intended to apply AFCI devices as a substitute for replacing unsafe wiring. Unsafe wiring should be replaced when it is identified, and the wiring methods should be done in accordance with the *NEC*.

In 1995 arc-fault detection was identified as a promising technology that could be applied to older homes to improve electrical safety by detecting symptoms that can cause fires (report "Technology for Detecting and Monitoring Conditions That Could Cause Electrical Wiring System Fires", sponsored by CPSC and prepared by Underwriters Laboratories Inc.). Shortly after this report was issued, the production of listed arc-fault circuit interrupter devices began. In 1999 the *NEC* introduced the first AFCI requirement for branch circuit protection, limited to branch circuits supplying outlets in bedrooms. When considering needs for additional AFCI protection, one of the priority locations is the older home that undergoes a service upgrade intended to extend the service life of the structure. This is the situation where the existing, older branch circuits in the dwelling will be expected to continue to supply power for appliance and lighting loads in the years ahead. These circuits need the benefit of the extra protection afforded by AFCI devices.

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Date Oct. 1, 2002 **Name** William King **Telephone** 301-504-0508, ext. 1296
Company U.S. Consumer Product Safety Commission
Address 4330 East West Highway **City** Bethesda **State** MD **Zip** 20814-4408
Please indicate organization represented (if any) U.S. Consumer Product Safety Commission

1. a) **NFPA Document Title** National Electrical Code
   b) **NFPA No. & Edition** 70-2002 c) **Section/Paragraph** 210.8 (B)
2. **Proposal Recommends** *(check one)*: ☑ **new text** ☐ **revised text** ☐ **deleted text**
3. **Proposal.** *(Include proposed new or revised wording, or identification of wording to be deleted.)* Note: Proposed text should be in legislative format, that is, use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).
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4. **Statement of Problem and Substantiation for Proposal.** Note: State the problem that will be resolved by your recommendation. Give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.
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PROPOSAL.

Section/Paragraph: Article 210, Part I, General Provisions, para. 210.8 (B)

Add the following new item to paragraph 210.8 (B) covering GFCI requirements for "Other Than Dwelling Units:

(4) Places frequented by public and community segments at-large -- where the receptacles are installed for cord- and plug-connected appliances that are intended to be readily accessible to contact by populations at-large (for example, receptacles for such appliances located at schools, stores, theaters, shopping malls, restaurants, museums, houses of worship and other commercial, private and government structures, in corridors and lobbies, along sidewalks, plazas, parks, promenades, etc).

STATEMENT OF PROBLEM AND SUBSTANTIATION FOR PROPOSAL.

The U.S. Consumer Product Safety Commission (CPSC) estimates that there were 170 accidental electrocutions associated with consumer products in 1999 in the United States, the latest year available. Based on information provided on death certificates, CPSC identified six product categories involved in significant numbers of electrocutions: powered tools and equipment, installed wiring, antenna products, large appliances, small appliances, and lighting products. CPSC conducted its own follow-up investigations of a selection of the electrocution deaths that occurred over the seven-year period (1994-2000) in the United States to find causal factors. In total, 209 incidents were documented with sufficient detail (many included on-site visits by CPSC representatives, photographs, investigation reports by local authorities, and interviews with people with relevant knowledge). From these in-depth investigation reports, conditions that led to death were noted. Practical solutions to reduce the risk of electrocution under similar circumstances in the future emerged.

While most electrocutions to consumers occur in and around the home, electrocutions frequently are reported in public and community settings associated with cord-connected power equipment and large appliances, such as coin-operated machines, tools, pumps, and cleaning equipment. Providing GFCI protection for receptacle outlets, both indoor and outdoor, located at public and community access areas patronized by consumers will address these high-risk locations. The following is a partial list of electrocutions that occurred at areas covered by this proposal.

Williston, ND	October 8, 1996	A 9-year-old male electrocuted at an indoor recreation center by a cord- and plug-connected coin-operated machine. CPSC Case No. 970922CCC2427.
Waco, TX	May 29, 1997	A 44-year-old male electrocuted on public property while servicing a cold drink dispensing machine. CPSC Case No. 980402CCC3732.

Clanton, AL	August 21, 1995	A 10-year-old male electrocuted at a motel when he came in contact with a vending machine. CPSC Case No. 950823CCN2720.
Melbourne, FL	June 24, 1998	A 19-year-old male electrocuted at a rented unit in a public storage facility when he came in contact with an electric guitar and microphone plugged into a receptacle outlet not properly grounded. CPSC Case No. 98073CCC1613.
Tallahassee, FL	November 11, 1988	A 26-year-old male electrocuted after he contacted a change machine and a snack machine simultaneously at a college student lounge. CPSC Case No. 881202CCC1072.
Corwith, IA	May 4, 2000	A 16-year-old male electrocuted when he contacted a power tool plugged into a receptacle outlet within a shelter in a municipal park. CPSC Case No. 000530HCC2576.

The GFCI has been in service on selected circuits for 30 years. Reductions in the number of electrocutions have occurred for receptacle outlets and equipment that are required by code to be provided with GFCI protection. The average cost of the GFCI device has decreased substantially since the early period, with the retail cost for a receptacle GFCI below $10. It is time to expand the scope of GFCI protected areas to provide the same level of electrocution protection as now provided at those receptacle locations that were identified in the early years on the basis of priority. The unit cost of a GFCI is offset by the increased protection.

GFCIs manufactured to the current industry-supported safety standard (UL 943) are more reliable than those units manufactured in the past. UL 943 requires stringent voltage surge testing, improved resistance to corrosion, and resistance to false tripping from electronic interference.

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1. a) **NFPA Document Title** National Electrical Code
   b) **NFPA No. & Edition** 70-2002 c) **Section/Paragraph** 210.12
2. **Proposal Recommends** *(check one)*: ☑ **new text** ☐ **revised text** ☐ **deleted text**
3. **Proposal.** *(Include proposed new or revised wording, or identification of wording to be deleted.)* Note: Proposed text should be in legislative format, that is, use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).
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PROPOSAL.

Section/Paragraph: Art. 210, Part I. General, para. 210.12

Revise the section of the paragraph covering dwelling unit bedrooms as follows:

( ) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in dwelling unit bedrooms shall be protected by ~~an arc-fault circuit interrupter listed to provide protection to the entire branch circuit~~ a listed arc-fault circuit interrupter, branch/feeder type, or a listed arc-fault circuit interrupter, outlet branch circuit type. The arc-fault circuit interrupter, outlet branch circuit type, shall be the outlet closest to, and within 3.0 m (10 ft) of the overcurrent device as measured along the branch circuit conductors.

STATEMENT OF PROBLEM AND SUBSTANTIATION FOR PROPOSAL.

The existing requirement at 210.12 covering dwelling unit bedrooms has been modified to include both types of arc-fault circuit interrupters (i.e., branch/feeder type and outlet branch circuit type) that are to be covered by expanded definitions.

Although AFCI devices currently available are incorporated within circuit breakers, AFCI devices have been listed that are incorporated into outlet devices. While only AFCI/circuit breakers can de-energize the entire branch circuit, listed AFCI/outlet devices can be applied in applications where fuses are provided as the branch circuit overcurrent protection devices. In addition, listed AFCI/outlet devices have been investigated and listed as an outlet branch circuit type with expanded arc detection capabilities, including sensing certain arcing conditions upstream of the AFCI/outlet device location, and sensing broader arcing conditions downstream of the AFCI/device location. These safety devices that provide the broadest range of fire protection to the occupants of dwellings.

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Date 10/26/05 Name Doug Lee* Tel. No. (301)504-7569

Company U.S. Consumer Product Safety Commission

Street Address 4330 East West Hwy City Bethesda State Md Zip 20814

Please Indicate Organization Represented (if any) U.S. Consumer Product Safety Commission

1. Section/Paragraph 210.12(A)

2. Proposal recommends (check one): ☒ new text ☐ revised text ☐ deleted text

3. Proposal (include proposed new wording, or identification of wording to be deleted):

(See attached Proposal)

4. Statement of Problem and Substantiation for Proposal:

(See attached Statement of Problem and Substantiation for Proposal)

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Proposal for 210.12 (A)

Revise section 210.12 (A) to read as follows:

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

Statement of Problem and Substantiation for Proposal:

The acronym "AFCI" is used in 210.12(B) but is not previously defined. Appropriately, the acronym "GFCI" is in the definition of Ground-Fault Circuit Interrupter (GFCI) in article 100.

Some people are still confused by arc-fault circuit interrupters, which are used to protect against arcing faults to prevent fires, and ground-fault circuit interrupters, which are used for personnel protection against electrical shock. This addition will help users to relate arc-fault circuit interrupter to AFCI.

Submitter: Doug Lee, U.S. Consumer Product Safety Commission Staff*

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Company U.S. Consumer Product Safety Commission

Street Address 4330 East West Hwy City Bethesda State Md Zip 20814

Please Indicate Organization Represented (if any) U.S. Consumer Product Safety Commission

1. Section/Paragraph 210.12(B)

2. Proposal recommends (check one): ☒ new text ☐ revised text ☐ deleted text

3. Proposal (include proposed new wording, or identification of wording to be deleted):

(See attached Proposal)

4. Statement of Problem and Substantiation for Proposal:

(See attached Statement of Problem and Substantiation for Proposal)

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Proposal for 210.12(B)

Add text in Section 210.12 (B) to read as follows:

(B) Dwelling Unit Bedrooms. All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit bedrooms shall be protected by a listed arc-fault circuit interrupter, combination type installed to provide protection of the branch circuit.

Branch/feeder AFCIs shall be permitted to be used to meet the requirements of 210.12(b) until January 1, 2008. These requirements shall also apply to existing installations whenever the circuit protection device is replaced as part of a service capacity upgrade or renovation.

FPN: For information on types of arc-fault circuit interrupters, see UL 1699-1999, *Standard for Arc-Fault Circuit Interrupters.*

Exception: The location of the arc-fault circuit interrupters shall be permitted to be at other than the origination of the branch circuit in compliance with (a) and (b):

(a) The arc-fault circuit interrupter installed within 1.8m (6ft) of the branch circuit overcurrent device as measured along the branch circuit conductors.

(b) The circuit conductors between the branch circuit overcurrent device and the arc-fault circuit interrupters shall be installed in a metal raceway or a cable with a metallic sheath.

Statement of Problem and Substantiation for Proposal:

According to CPSC staff estimates, an average of 41,500 residential fires annually are associated with the electrical distribution system, having remained relatively constant over the 10-year period from 1989 through 1998 (*Residential Fire Loss Estimates, 1998* (and prior), *National Estimates of Fires, Deaths, Injuries, and Property Losses from Non-Incendiary, Non-Suspicious Fires*, CPSC Directorate for Epidemiology, 2002, see http://www.cpsc.gov/LIBRARY/fire98.pdf). A staff report issued by the U.S. Consumer Product Safety Commission in 1987 ("Residential Electrical Distribution System Fires", Smith & McCoskrie, see http://www.cpsc.gov/library/foia/foia04/os/reselecfire.pdf) provided evidence that fires originating in branch circuit wiring predominately occurred in dwellings over 20 years old, with the highest rates of fires occurring in dwellings over 40 years old.

AFCI technology offers the greatest potential for mitigation of electrical fires propagating from failures in the electrical distribution system and the subsequent reduction in fire-related deaths, injuries and property loss by its implementation into older homes. Because the *NEC* is an installation document, the only way to address this risk of electrical fires in older homes is when the overcurrent protection devices are replaced when the electrical service capacity is upgraded. When a panelboard is replaced, the existing wiring is rarely changed because it is cost prohibitive. Over the past 20 years the increased utilization of electrical appliances has stressed the branch circuit of homes that were designed to operate in previous decades with a lower demand of current on the branch circuit wiring.

While AFCIs can be added to all general purpose branch circuits to increase protection at the discretion of the installer, dwelling unit bedrooms especially need this protection. The bedroom circuits are typically the longest run from the panel and are often exposed to attics where environmental conditions increase the aging and stress placed on branch circuit wiring. Additionally, based on the highest rate of fire incidents and deaths, the bedroom is one of the higher risk areas in a home (see attached Table, National Estimates based on NFIRS and NFPA survey, Marty Ahrens, NFPA, March 2001). Consumers may be sleeping during the start of an electrical fire incident and not be aware of the fire until it is out of control.

A CPSC staff economic analysis indicates that adding Arc-Fault Circuit Interrupters (AFCIs) to older homes outweighs the cost of installation. See attached CPSC staff memorandum on *Economic Considerations--- AFCI Replacements*. By adding this requirement, consumers of older homes will benefit by the more advanced circuit breaker technology. Otherwise, consumers will install conventional circuit breakers that are less effective in preventing electrical wiring fires in older homes.

Submitter: Doug Lee, U.S. Consumer Product Safety Commission Staff*

NFPA®
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org

Structure Fires in One- and Two-Family Dwellings in which the Form of Heat of Ignition was the Heat from Electrical Equipment Arcing Excluding and Including Unclassified or Unknown-Type Arcing or Overload by Area of Origin, 1994-1998 Annual Averages

And

Structure Fires in One- and Two-Family Dwellings by Form of Heat of Ignition, 1994-1998 Annual Averages

Prepared by: Marty Ahrens
National Fire Protection Association
One-Stop Data Shop
1 Batterymarch Park
Quincy, MA 02169-7471

May 2002

Table 1.
Structure Fires in One- and Two-Family Dwellings in which the Form of Heat of Ignition was the Heat from Electrical Equipment Arcing Including Unclassified or Unknown-Type Arcing or Overload, by Area of Origin
1994-1998 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Kitchen	12,800	(21.1%)	82	(16.7%)	364	(20.0%)	$118.1	(13.1%)
Bedroom	9,500	(15.7%)	112	(22.8%)	499	(27.4%)	$170.9	(18.9%)
Living room, family room or den	5,400	(8.8%)	121	(24.6%)	286	(15.7%)	$116.3	(12.9%)
Laundry room or area	4,500	(7.4%)	23	(4.7%)	90	(5.0%)	$45.2	(5.0%)
Attic or ceiling/roof assembly or concealed space	4,100	(6.7%)	12	(2.4%)	50	(2.7%)	$73.9	(8.2%)
Crawl space or substructure space	3,400	(5.5%)	15	(3.1%)	74	(4.1%)	$50.4	(5.6%)
Garage or vehicle storage area*	2,500	(4.1%)	11	(2.2%)	65	(3.6%)	$70.3	(7.8%)
Heating equipment room	2,500	(4.0%)	5	(1.1%)	47	(2.6%)	$19.6	(2.2%)
Wall assembly or concealed space	2,200	(3.6%)	10	(2.0%)	41	(2.2%)	$32.8	(3.6%)
Exterior wall surface	1,900	(3.2%)	3	(0.5%)	21	(1.1%)	$16.0	(1.8%)
Lavatory	1,900	(3.1%)	7	(1.4%)	32	(1.8%)	$20.9	(2.3%)
Ceiling/floor assembly or concealed space	1,100	(1.8%)	16	(3.2%)	20	(1.1%)	$25.1	(2.8%)
Closet	1,000	(1.7%)	3	(0.5%)	25	(1.4%)	$16.0	(1.8%)
Supply storage room or area	800	(1.3%)	2	(0.3%)	13	(0.7%)	$12.6	(1.4%)
Unclassified structural area	800	(1.3%)	4	(0.9%)	22	(1.2%)	$14.1	(1.6%)
Dining room	800	(1.3%)	16	(3.3%)	28	(1.5%)	$11.6	(1.3%)
Hallway, corridor or mall	800	(1.3%)	8	(1.6%)	14	(0.8%)	$8.1	(0.9%)
Unclassified area of origin	600	(1.0%)	6	(1.2%)	16	(0.9%)	$11.0	(1.2%)
Other service or equipment area	900	(1.5%)	0	(0.0%)	13	(0.7%)	$9.2	(1.0%)
Other structural area	800	(1.3%)	4	(0.9%)	14	(0.8%)	$10.2	(1.1%)

* This does not include dwelling garages coded as a specific fixed property use.

Table 1.
Structure Fires in One- and Two-Family Dwellings
in which the Form of Heat of Ignition was the
Heat from Electrical Equipment Arcing
Including Unclassified or Unknown-Type Arcing or Overload,
by Area of Origin
1994-1998 Annual Averages
(Continued)

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Other storage area	700	(1.2%)	4	(0.8%)	25	(1.4%)	$13.2	(1.5%)
Other function room or area	700	(1.1%)	7	(1.4%)	26	(1.4%)	$12.3	(1.4%)
Other known area	1,300	(2.2%)	22	(4.5%)	39	(2.1%)	$26.7	(3.0%)
Total	60,900	(100.0%)	490	(100.0%)	1,822	(100.0%)	$904.6	(100.0%)

This table shows structure fires (incident type 11) in one- and two-family dwellings and manufactured housing (fixed property use 410-419) in which the form of heat of ignition was one of the following:

21-Water caused short circuit arc;
22-Short circuit arc from mechanical damage;
23-Short circuit arc from defective or worn insulation;
24-Unspecified short circuit arc;
25-Arc from faulty contact, loose connection or broken conductor;
26-Arc or spark form operating equipment or switch;
29-Unclassified electrical equipment arcing or overloaded;
20-Unknown-type electrical equipment arcing or overloaded; or

These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires are rounded to the nearest hundred, civilian deaths and civilian injuries are expressed to the nearest one and property damage is rounded to the nearest hundred thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. A proportional share of fires in which the form of heat of ignition was unknown has been included in this table. Electrical equipment arcing fires in which the area of origin was unknown were allocated proportionally among fires with known area of origin.

Source: National estimates based on NFIRS and NFPA survey.

Table 2.
Structure Fires in One- and Two-Family Dwellings in which the Form of Heat of Ignition was the Heat from Electrical Equipment Arcing Excluding Unclassified or Unknown-Type Arcing or Overload, by Area of Origin
1994-1998 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Kitchen	9,000	(18.4%)	52	(15.1%)	193	(14.1%)	$88.0	(12.3%)
Bedroom	8,000	(16.4%)	70	(20.2%)	415	(30.3%)	$135.4	(19.0%)
Living room, family room or den	4,600	(9.4%)	97	(28.0%)	232	(16.9%)	$94.4	(13.2%)
Attic or ceiling/roof assembly or concealed space	3,500	(7.2%)	9	(2.5%)	44	(3.2%)	$61.1	(8.6%)
Laundry room or area	3,400	(7.0%)	19	(5.4%)	65	(4.7%)	$35.6	(5.0%)
Crawl space or substructure space*	2,900	(5.9%)	10	(2.8%)	60	(4.4%)	$42.2	(5.9%)
Garage or vehicle storage area	2,000	(4.2%)	6	(1.6%)	49	(3.6%)	$54.8	(7.7%)
Heating equipment room	1,900	(4.0%)	5	(1.4%)	39	(2.8%)	$15.5	(2.2%)
Wall assembly or concealed space	1,900	(3.9%)	4	(1.3%)	28	(2.0%)	$26.8	(3.8%)
Exterior wall surface	1,700	(3.4%)	2	(0.5%)	18	(1.3%)	$13.1	(1.8%)
Lavatory	1,600	(3.2%)	5	(1.5%)	26	(1.9%)	$16.3	(2.3%)
Ceiling/floor assembly or concealed space	900	(1.9%)	15	(4.4%)	16	(1.2%)	$20.4	(2.9%)
Closet	800	(1.7%)	2	(0.5%)	20	(1.5%)	$12.3	(1.7%)
Supply storage room or area	700	(1.3%)	0	(0.0%)	10	(0.7%)	$10.0	(1.4%)
Dining room	600	(1.3%)	13	(3.9%)	23	(1.7%)	$9.8	(1.4%)
Hallway, corridor or mall	600	(1.3%)	3	(1.0%)	13	(0.9%)	$6.8	(1.0%)
Unclassified structural area	600	(1.2%)	1	(0.4%)	16	(1.2%)	$9.6	(1.3%)
Other service or equipment area	700	(1.5%)	0	(0.0%)	12	(0.8%)	$7.5	(0.0%)
Other structural area	700	(1.3%)	3	(1.0%)	13	(0.9%)	$8.3	(1.2%)
Other storage area	600	(1.2%)	4	(1.2%)	22	(1.6%)	$10.7	(0.0%)
Other function area	500	(1.0%)	2	(0.5%)	16	(1.2%)	$8.6	(0.0%)
Other known area	1,500	(3.1%)	24	(6.9%)	40	(2.9%)	$26.6	(3.7%)
Total	48,800	(100.0%)	345	(100.0%)	1,371	(100.0%)	$713.8	(100.0%)

* This does not include dwelling garages coded as a specific fixed property use.

Table 2.
Structure Fires in One- and Two-Family Dwellings
in which the Form of Heat of Ignition was the
Heat from Electrical Equipment Arcing
Excluding Unclassified or Unknown-Type Arcing or Overload,
by Area of Origin
1994-1998 Annual Averages
(Continued)

This table shows structure fires (incident type 11) in one- and two-family dwellings, including manufactured housing (fixed property use 410-419) in which the form of heat of ignition was one of the following:

21-Water caused short circuit arc;
22-Short circuit arc from mechanical damage;
23-Short circuit arc from defective or worn insulation;
24-Unspecified short circuit arc;
25-Arc from faulty contact, loose connection or broken conductor;
26-Arc or spark form operating equipment or switch;

These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires are rounded to the nearest hundred, civilian deaths and civilian injuries are expressed to the nearest one and property damage is rounded to the nearest hundred thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. A proportional share of fires in which the form of heat of ignition was unknown has been included in this table. Electrical equipment fires in which the area of origin was unknown were allocated proportionally among fires with known area of origin.

Source: National estimates based on NFIRS and NFPA survey.

Table 3.
Structure Fires in One- and Two-Family Dwellings
by Form of Heat of Ignition
1994-1998 Annual Averages

Code	Form of Heat	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
10	Heat from unknown-type fuel-fired object	1,300	(0.4%)	8	(0.3%)	47	(0.4%)	$14.1	(0.4%)
11	Spark, ember or flame escaping from gas-fueled equipment	5,600	(1.8%)	53	(1.9%)	271	(2.2%)	$65.0	(1.9%)
12	Heat from gas-fueled equipment	28,600	(9.3%)	249	(8.9%)	1,283	(10.4%)	$210.5	(6.0%)
13	Spark, ember or flame escaping from liquid-fueled equipment	1,500	(0.5%)	20	(0.7%)	78	(0.6%)	$22.7	(0.7%)
14	Heat from liquid-fueled equipment	4,900	(1.6%)	75	(2.7%)	225	(1.8%)	$46.1	(1.3%)
15	Spark, ember of flame escaping from solid-fueled equipment	8,900	(2.9%)	38	(1.4%)	81	(0.7%)	$64.6	(1.9%)
16	Heat from solid-fueled equipment	19,600	(6.4%)	68	(2.4%)	186	(1.5%)	$136.6	(3.9%)
17	Spark, ember or flame escaping from equipment with unknown-type fuel	600	(0.2%)	6	(0.2%)	10	(0.1%)	$12.1	(0.3%)
18	Heat from equipment with unknown-type fuel	1,400	(0.5%)	7	(0.2%)	40	(0.3%)	$14.5	(0.4%)
19	Heat from unclassified fuel-fired or fuel-powered object	1,100	(0.4%)	10	(0.3%)	37	(0.3%)	$18.7	(0.5%)
20	Unknown-type electrical equipment arc or overload	8,000	(2.6%)	100	(3.6%)	290	(2.4%)	$132.6	(3.8%)
21	Water-caused short circuit arc	1,300	(0.4%)	3	(0.1%)	19	(0.2%)	$8.3	(0.2%)
22	Short circuit arc from mechanical damage	4,200	(1.4%)	18	(0.6%)	99	(0.8%)	$50.0	(1.4%)
23	Short circuit arc from defective or worn insulation	10,700	(3.5%)	77	(2.7%)	263	(2.1%)	$132.1	(3.8%)
24	Unspecified short circuit arc	27,600	(9.0%)	217	(7.7%)	801	(6.5%)	$458.3	(13.2%)
25	Arc from faulty contact	3,200	(1.0%)	14	(0.5%)	91	(0.7%)	$39.4	(1.1%)

Table 3.
Structure Fires in One- and Two-Family Dwellings
by Form of Heat of Ignition
1994-1998 Annual Averages
(Continued)

Code	Form of Heat	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
26	Arc or spark from operating equipment or switch	1,800	(0.6%)	16	(0.6%)	97	(0.8%)	$25.7	(0.7%)
27	Heat from overloaded equipment	7,000	(2.3%)	68	(2.4%)	249	(2.0%)	$90.5	(2.6%)
28	Fluorescent light ballast	400	(0.1%)	2	(0.1%)	5	(0.0%)	$4.7	(0.1%)
29	Unclassified electrical equipment arc or overload	4,000	(1.3%)	45	(1.6%)	162	(1.3%)	$58.2	(1.7%)
30	Heat from unknown-type smoking material	1,100	(0.4%)	58	(2.1%)	66	(0.5%)	$18.5	(0.5%)
31	Cigarette	13,900	(4.5%)	565	(20.1%)	1,128	(9.2%)	$177.0	(5.1%)
32	Cigar	200	(0.0%)	7	(0.3%)	11	(0.1%)	$2.5	(0.1%)
33	Pipe	100	(0.0%)	15	(0.5%)	5	(0.0%)	$1.4	(0.0%)
39	Heat from unclassified smoking material	700	(0.2%)	11	(0.4%)	32	(0.3%)	$9.9	(0.3%)
40	Heat from unknown-type open flame or spark	6,100	(2.0%)	85	(3.0%)	257	(2.1%)	$97.2	(2.8%)
41	Cutting torch	600	(0.2%)	1	(0.0%)	16	(0.1%)	$7.6	(0.2%)
42	Welding torch	700	(0.2%)	2	(0.1%)	26	(0.2%)	$9.8	(0.3%)
43	Torch, not cutting or welding	2,100	(0.7%)	8	(0.3%)	67	(0.5%)	$28.1	(0.8%)
44	Candle	7,500	(2.5%)	92	(3.3%)	756	(6.1%)	$111.7	(3.2%)
45	Match	14,700	(4.8%)	145	(5.2%)	778	(6.3%)	$163.9	(4.7%)
46	Lighter	8,600	(2.8%)	172	(6.1%)	1,031	(8.4%)	$118.0	(3.4%)
47	Open fire	5,900	(1.9%)	32	(1.1%)	143	(1.2%)	$45.2	(1.3%)
48	Backfire from internal combustion engine	200	(0.1%)	0	(0.0%)	13	(0.1%)	$4.5	(0.1%)
49	Heat from unclassified open flame or spark	4,100	(1.3%)	41	(1.5%)	166	(1.3%)	$46.9	(1.3%)
50	Heat from unknown-type hot object	3,600	(1.2%)	39	(1.4%)	123	(1.0%)	$41.6	(1.2%)
51	Heat or spark from friction	900	(0.3%)	1	(0.0%)	14	(0.1%)	$5.1	(0.1%)
52	Molten or hot material	600	(0.2%)	3	(0.1%)	27	(0.2%)	$5.3	(0.2%)

Table 3.
Structure Fires in One- and Two-Family Dwellings
by Form of Heat of Ignition
1994-1998 Annual Averages
(Continued)

Code	Form of Heat	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
53	Hot ember or ash	6,800	(2.2%)	27	(1.0%)	123	(1.0%)	$76.9	(2.2%)
54	Electric lamp	4,000	(1.3%)	23	(0.8%)	133	(1.1%)	$56.2	(1.6%)
55	Rekindle or reignition	3,900	(1.3%)	1	(0.0%)	4	(0.0%)	$26.9	(0.8%)
56	Heat from properly operating electrical equipment	38,500	(12.6%)	189	(6.7%)	2,148	(17.5%)	$234.9	(6.7%)
57	Heat from improperly operating electrical equipment	5,200	(1.7%)	31	(1.1%)	171	(1.4%)	$48.1	(1.4%)
59	Heat from unclassified hot object	3,300	(1.1%)	26	(0.9%)	123	(1.0%)	$37.0	(1.1%)
60	Heat from unknown-type explosive or fireworks	100	(0.0%)	0	(0.0%)	3	(0.0%)	$1.0	(0.0%)
61	Explosive	100	(0.0%)	0	(0.0%)	8	(0.1%)	$1.3	(0.0%)
62	Blasting agent	0	(0.0%)	0	(0.0%)	0	(0.0%)	$0.2	(0.0%)
63	Fireworks	800	(0.3%)	2	(0.1%)	25	(0.2%)	$8.7	(0.2%)
64	Party cap, party popper	0	(0.0%)	0	(0.0%)	0	(0.0%)	$2.2	(0.1%)
65	Model rocket, not amateur rocketry	0	(0.0%)	1	(0.0%)	2	(0.0%)	$0.9	(0.0%)
66	Incendiary device	1,900	(0.6%)	12	(0.4%)	62	(0.5%)	$27.7	(0.8%)
69	Heat from unclassified explosive or fireworks	100	(0.0%)	1	(0.0%)	1	(0.0%)	$2.2	(0.1%)
70	Heat from unknown-type natural source	100	(0.0%)	0	(0.0%)	1	(0.0%)	$1.0	(0.0%)
71	Sun's heat	200	(0.1%)	0	(0.0%)	1	(0.0%)	$1.5	(0.0%)
72	Spontaneous ignition or chemical reaction	2,100	(0.7%)	3	(0.1%)	51	(0.4%)	$35.9	(1.0%)
73	Lightning	5,700	(1.9%)	12	(0.4%)	52	(0.4%)	$122.9	(3.5%)
74	Static discharge	100	(0.0%)	0	(0.0%)	3	(0.0%)	$0.6	(0.0%)
79	Heat from unclassified natural source	100	(0.0%)	0	(0.0%)	0	(0.0%)	$0.7	(0.0%)
80	Unknown-type heat spreading from another hostile fire	700	(0.2%)	1	(0.0%)	10	(0.1%)	$15.5	(0.4%)

Table 3.
Structure Fires in One- and Two-Family Dwellings
by Form of Heat of Ignition
1994-1998 Annual Averages
(Continued)

Code	Form of Heat	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
81	Heat from direct flame or convection current	5,900	(1.9%)	24	(0.8%)	88	(0.7%)	$81.9	(2.4%)
82	Radiated heat	6,400	(2.1%)	17	(0.6%)	71	(0.6%)	$53.2	(1.5%)
83	Heat from flying brand, ember or spark	700	(0.2%)	2	(0.1%)	4	(0.0%)	$13.0	(0.4%)
84	Conducted heat	900	(0.3%)	2	(0.1%)	28	(0.2%)	$8.7	(0.3%)
89	Unclassified heat spreading from another hostile fire	600	(0.2%)	3	(0.1%)	7	(0.1%)	$8.1	(0.2%)
97	Multiple forms of heat	1,100	(0.3%)	9	(0.3%)	32	(0.3%)	$34.9	(1.0%)
99	Unclassified form of heat	4,600	(1.5%)	55	(1.9%)	144	(1.2%)	$80.1	(2.3%)
	Total	306,800	(100.0%)	2,810	(100.0%)	12,288	(100.0%)	$3,481.2	(100.0%)

This table shows the form of heat of ignition in structure fires (incident type 11) in one- and two-family dwellings, including manufactured housing (fixed property use 410-419) These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires are rounded to the nearest hundred, civilian deaths and civilian injuries are expressed to the nearest one and property damage is rounded to the nearest hundred thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. A proportional share of fires in which the form of heat of ignition was unknown has been included in this table.

Source: National estimates based on NFIRS and NFPA survey.

Appendix: How National Estimates Statistics Are Calculated

Estimates are made using the National Fire Incident Reporting System (NFIRS) of the Federal Emergency Management Agency's (FEMA's) United States Fire Administration (USFA), supplemented by the annual stratified random-sample survey of fire experience conducted by the National Fire Protection Association (NFPA), which is used for calibration.

Databases Used
NFIRS provides annual computerized databases of fire incidents, with data classified according to a standard format based on the NFPA 901 Standard. Roughly three-fourths of all states have NFIRS coordinators, who receive fire incident data from participating fire departments and combine the data into a state database. These data are then transmitted to FEMA/USFA. Participation by the states, and by local fire departments within participating states, is voluntary. NFIRS captures roughly one-third to one-half of all U.S. fires each year. More than one-third of all U.S. fire departments are listed as participants in NFIRS, although not all of these departments provide data every year.

The strength of NFIRS is that it provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. (The NFPA survey separates fewer than 20 of the hundreds of property use categories defined by NFPA 901 and solicits no cause-related information except for incendiary and suspicious fires.) NFIRS also captures information on the avenues and extent of flame spread and smoke spread and on the performance of detectors and sprinklers.

The NFPA survey is based on a stratified random sample of roughly 3,000 U.S. fire departments (or just over one of every ten fire departments in the country). The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined by the NFPA 901 Standard; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results.

The NFPA survey begins with the NFPA Fire Service Inventory, a computerized file of about 30,000 U.S. fire departments, which is the most complete and thoroughly validated such listing in existence. The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities protect fewer people per department and are less likely to respond to the survey, so a large number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

Projecting NFIRS to National Estimates
To project NFIRS results to national estimates, one needs at least an estimate of the NFIRS fires as a fraction of the total so that the fraction can be inverted and used as a multiplier or scaling ratio to generate national estimates from NFIRS data. But NFIRS is a sample from a universe whose size cannot be inferred from NFIRS alone. Also, participation rates in NFIRS are not necessarily uniform across regions and sizes of community, both of which are factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second database - the NFPA survey - is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

There are separate projection formulas for four major property classes (residential structures, non-residential structures, vehicles, and other) and for each measure of fire severity (fire incidents, civilian deaths, and civilian injuries, and direct property damage).

For example, the scaling ratio for 1998 civilian deaths in residential structures is equal to the total number of 1998 civilian deaths in residential structure fires reported to fire departments, according to the NFPA survey (3,250), divided by the total number of 1998 civilian deaths in residential structure fires reported to NFIRS (1,224). Therefore, the scaling ratio is 3,250/1,224 = 2.66.

The scaling ratios for civilian deaths and injuries and direct property damage are often significantly different from those for fire incidents. Except for fire service injuries, average severity per fire is generally higher for NFIRS than for the NFPA survey. Use of different scaling ratios for each measure of severity is equivalent to assuming that these differences are due either to NFIRS under-reporting of small fires, resulting in a higher-than-actual loss-per-fire ratio, or possible biases in the NFIRS sample representation by region or size of community, resulting in severity-per-fire ratios characteristic only of the oversampled regions or community sizes.

Note that this approach also means that the NFPA survey results for detailed property-use classes (e.g., fires in storage structures) may not match the national estimates of the same value.

Calculating National Estimates of Particular Types of Fires
Most analyses of interest involve the calculation of the estimated number of fires not only within a particular occupancy but also of a particular type. The types that are mostly frequently of interest are those defined by some ignition-cause characteristic. The six cause-related characteristics most commonly used to describe fires are: form of the heat that caused the ignition, equipment involved in ignition, form or type of material first ignited, the ignition factor that brought heat source and ignited material together, and area of origin. Other characteristics of interest are victim characteristics, such as ages of persons killed or injured in fire.

For any characteristic of interest in NFIRS, some reported fires have that characteristic unknown or not reported. If the unknowns are not taken into account, then the propensity to report or not report a characteristic may influence the results far more than the actual patterns on that characteristic. For example, suppose the number of fires remained the same for several consecutive years, but the percentage of fires with cause unreported steadily declined over those years. If the unknown-cause fires were ignored, it would appear as if fires due to every specific cause increased over time while total fires remained unchanged. This, of course, does not make sense.

Consequently, most national estimates analyses allocate unknowns. This is done by using scaling ratios defined by NFPA survey estimates of totals divided by only those NFIRS fires for which the dimension in question was known and reported. This approach is equivalent to assuming that the fires with unreported characteristics, if known, would show the same proportions as the fires with known characteristics. For example, it assumes that the fires with unknown ignition factor contain the same relative shares of child-playing fires, incendiary-cause fires, short circuit fires, and so forth, as are found in the fires where ignition factor was reported.

Rounding Errors

The possibility of rounding errors exists in all our calculations. One of the notes on each table indicates the extent of rounding for that table, e.g., deaths rounded to the nearest one, fires rounded to the nearest hundred, property damage rounded to the nearest hundred thousand dollars. In rounding to the nearest one, functional values of 0.5 or more are rounded up and functional values less than 0.5 are rounded down. For example, 2.5 would round to 3, and 3.4 would round to 3. In rounding to the nearest one, a stated estimate of 1 could be any number from 0.5 to 1.49, a roughly threefold range.

The impact of rounding is greatest when the stated number is small relative to the degree of rounding. As noted, rounding to the nearest one means that stated values of 1 may vary by a factor of three. Similarly, the cumulative impact of rounding error - the potential gap between the estimated total and the sum of the estimated values as rounded - is greatest when there are a large number of values and the total is small relative to the extent of rounding.

Suppose a table presented 5-year averages of estimated deaths by item first ignited, all rounded to the nearest one. Suppose there were a total of 30 deaths in the 5 years, so the total average would be 30/5 = 6.

In case 1, suppose 10 of the possible items first ignited each accounted for 3 deaths in 5 years. Then there would be 10 entries of 3/5 = 0.6, rounded to 1, and the sum would be 10, compared to the true total of 6.

In case 2, suppose 15 of the possible items first ignited each accounted for 2 deaths in 5 years. Then there would be 15 entries of 215 = 0.4, rounded to 0, and the sum would be 0, compared to the true total of 6.

Here is another example: Suppose there were an estimate of 7 deaths total in 1992 through 1996. The 5-year average would be 1.4, which would round to 1, the number we would show as the total. Each death would represent a 5-year average of 0.2.

If those 7 deaths split as 4 deaths in one category (e.g., smoking) and 3 deaths in a second category (e.g., heating), then we would show 4 x 0.2 = 0.8 deaths per year for smoking and 3 x 0.2 = 0.6 deaths per year for heating. Both would round to 1, there would be two entries of 1, and the sum would be 2, higher than the actual rounded total.

If those 7 deaths split as 1 death in each of 7 categories (quite possible since there are 12 major cause categories), then we would show 0.2 in each category, always rounding to 0, and the sum would be 0, lower than the actual rounded total. The more categories there are, the farther apart the sum and total can -- and often do -- get.

Note that percentages are calculated from unrounded values, and so it is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero.

Appendix A: How National Estimates Statistics Are Calculated

Estimates are made using the National Fire Incident Reporting System (NFIRS) of the Federal Emergency Management Agency's (FEMA's) United States Fire Administration (USFA), supplemented by the annual stratified random-sample survey of fire experience conducted by the National Fire Protection Association (NFPA), which is used for calibration.

Data Bases Used

NFIRS provides annual computerized data bases of fire incidents, with data classified according to a standard format based on the NFPA 901 Standard. Roughly three-fourths of all states have NFIRS coordinators, who receive fire incident data from participating fire departments and combine the data into a state data base. These data are then transmitted to FEMA/USFA. Participation by the states, and by local fire departments within participating states, is voluntary. NFIRS captures roughly one-third to one-half of all U.S. fires each year. More than one-third of all U.S. fire departments are listed as participants in NFIRS, although not all of these departments provide data every year.

The strength of NFIRS is that it provides the most detailed incident information of any national data base not limited to large fires. NFIRS is the only data base capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. (The NFPA survey separates fewer than 20 of the hundreds of property use categories defined by NFPA 901 and solicits no cause-related information except for incendiary and suspicious fires.) NFIRS also captures information on the avenues and extent of flame spread and smoke spread and on the performance of detectors and sprinklers. For more information about NFIRS visit http://www.usfa.fema.gov/nfirs.

The NFPA survey is based on a stratified random sample of roughly 3,000 U.S. fire departments (or just over one of every ten fire departments in the country). The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined by the NFPA 901 Standard; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results.

The NFPA survey begins with the NFPA Fire Service Inventory, a computerized file of about 30,000 U.S. fire departments, which is the most complete and thoroughly validated such listing in existence. The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities protect fewer people per department and are less likely to respond to the survey, so a large number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate. The results of the survey are published in the annual report Fire Loss in the United States. To download a free copy of the report visit http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf

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There are separate projection formulas for four major property classes (residential structures, non-residential structures, vehicles, and other) and for each measure of fire severity (fire incidents, civilian deaths, and civilian injuries, and direct property damage).

For example, the scaling ratio for 2002 civilian deaths in residential structures is equal to the total number of 2002 civilian deaths in residential structure fires reported to fire departments, according to the NFPA survey (2,695), divided by the total number of 2002 civilian deaths in residential structure fires reported to NFIRS (1,029). Therefore, the scaling ratio is 2,695/1,029 = 2.62.

The scaling ratios for civilian deaths and injuries and direct property damage are often significantly different from those for fire incidents. Except for fire service injuries, average severity per fire is generally higher for NFIRS than for the NFPA survey. Use of different scaling ratios for each measure of severity is equivalent to assuming that these differences are due either to NFIRS under-reporting of small fires, resulting in a higher-than-actual loss-per-fire ratio, or possible biases in the NFIRS sample representation by region or size of community, resulting in severity-per-fire ratios characteristic only of the oversampled regions or community sizes.

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UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: March 10, 2003

TO : William H. King, Jr., ESEE

THROUGH: Warren J. Prunella, Associate Executive Director For Economic Analysis

FROM : Terrance R. Karels, EC

SUBJECT : Economic Considerations --- AFCI Replacements

You asked that Economic Analysis provide you with some preliminary estimates of the costs and benefits of replacement of circuit breakers with newer-technology arc-fault circuit interrupters (AFCIs). The following estimates are based on staff reports, contacts with trade and industry sources, and other readily available information regarding residential fires and AFCIs.

Electrical Fire Cost to Society

The Commission's Directorate for Epidemiology reports that there were an average of 41,500 residential fires involving residential electrical distribution systems over the 9 year period 1990-1998.[1] These fires resulted in an average of 326 deaths, 1,481 injuries, and $646 million in property losses per year over that period. For analytical purposes, the CPSC assigns a statistical value per life of $5 million; using the CPSC's Injury Cost Model, the estimated average cost of fire-related injury (including burns and smoke inhalation) is about $56,000. Adding each of these three cost elements, the average total estimated cost to society of these residential electrical fires would be about $2.360 billion per year ($1.630 billion+$83 million+$646 million).

It should be noted that "societal costs" is confined in this analysis to consumer deaths, injuries, and property loss to residents involved in a residential fire. Deaths and injuries sustained by fire personnel and the cost of fighting fires were not included in the society cost estimate.

Costs by Age of Housing Units

According to a 1990 CPSC Epidemiological study, "Residential Electrical Distribution System Fires," 85% of all such fires involved housing over 20 years old.[2] Thus, the societal costs of these fires in older homes would be significantly greater than that for newer housing. If

[1] Revised Residential Fire Loss Estimates, 1980-1998, National Estimates of Fires, Deaths, Injuries, and Property Losses from Non-Incendiary, Non-Suspicious Fires, July, 2002.
[2] The study was based on 149 investigated fires in 16 cities, and do not represent a statistically representative sample.

residential fires for the period 1990-98 (the period for which fire incident data were used) tracked the same pattern as the 1990 study, some 85% of fires --- and 85% of the expected societal costs--- would occur with housing over 20 years old. According to data derived from the **Annual Housing Survey, 1999** (US Census Bureau), there was an average of about 98.7 million housing units during the period 1990-98 (the period for which fire incident data were used). Over this period, an average of 70 million housing units (or 71%) were over 20 years old.

Thus, it appears that the age of housing units is a significant factor in the risk of residential fire involving electrical distribution systems. For houses under 20 years of age, the societal cost of these fires would be $354 million per year ($2.36 billion x .15). Since there were an average of 28.7 million houses under 20 years old over the period, the average expected societal cost would be $12.33 per year ($354 million / 28.7 million) per housing unit.

For housing over 20 years old, the societal costs would be $2.01 billion per year. For the 70 million houses that were over 20 years old, the expected societal costs of these fires would be $28.66 per unit per year ($2.006 billion /70 million).

Savings Over the Life of the AFCI

The CPSC's Engineering staff estimate that current-technology AFCIs may remain in service for 40 years or more, based on the industry's reported rate of replacement of existing circuit breakers in the US. For the purpose of this preliminary estimate, we assume that AFCIs will experience a service life of 30 to 40 years. Benefits associated with their use would accrue over the entire lifetime of the products.

The total benefits would be the present discounted value of the reduction in societal costs associated with residential electrical fires. Since the electrical fires appear concentrated after the structure is over 20 years old, the societal costs would differ depending upon when the AFCIs were installed. The following table shows the expected societal costs that would be addressed by AFCIs, under several scenarios. All societal costs were discounted at a rate of 3%.

	Present Value of Societal Costs Addressed by AFCIs	
	If a 30-year life	If a 40-year life
If installed at initial construction[3]	$324	$425
If installed after 10 years[4]	$429	$530
If installed after 20 years[5]	$572	$673

The discount rate has a significant effect on the present value of societal costs. For example, at a 7% discount rate, the discounted addressable societal costs for AFCIs installed at initial construction decline to $184 (if a service life of 30 years) and to $208 (if a 40 year service life). If AFCIs are installed after the housing was 10 years old, the discounted societal costs would

[3] This example assumes societal costs of $12.33 annually for the first 20 years, and $28.66 thereafter
[4] This example assumes societal costs of $12.33 annually for 10 years, and $28.66 thereafter
[5] This example assumes societal costs of $28.66 annually

range from $243 (if 30 year service life) to $267 (if 40 year service life). If installed in housing over 20 years old, the discounted societal costs would range from $363 (if 30 year service life) to $387 (if 40 year service life).

Cost of AFCIs

According to Engineering Sciences staff (ES), the average cost differential of residential AFCI circuit breakers compared to residential circuit breakers without the AFCI feature is $15 to $20 per unit. Staff also estimate that an average of 10 additional circuits per household would require AFCI protection beyond those currently required by the National Electrical Code. Thus, the cost of adding AFCI protection would total about $150 to $200 per housing unit. For the purposes of this preliminary analysis, we have used $175 (the midpoint of the estimates) as the cost of adding AFCI protection, per housing unit.

Effectiveness and Comparison of Costs and Benefits

As noted earlier, industry estimates put replacement sales of circuit breakers at levels that suggest that circuit breakers experience useful lives in excess of 40 years. If AFCIs experience a service life of 40 years (the most likely scenario based on the useful life of current-technology circuit breakers), and are installed at the time of initial construction of the residence, the inclusion of AFCIs would need to achieve effectiveness of about 41% in order for the estimated discounted benefits (the reduction in societal costs) to be equal to the costs of installation of the AFCIs ($175 in costs/$425 in benefits).

If the AFCIs were installed after the housing units were 10 years old (as might occur with early housing renovations), AFCIs would need only a 33% effectiveness in order to achieve cost-effectiveness ($175/$530). And if AFCIs were installed after the housing units were 20 years old (a likely time frame for major housing renovations), a 26% rate of effectiveness would yield benefits equivalent to costs ($175/$673).

Using a 30-year useful life for AFCIs, if installed at the time of initial construction, AFCIs would need to be about 54% effective in order to be cost-effective ($175/$324). If installed after the housing were over 10 years old, an effectiveness rate of 41% would yield a balance of costs and benefits ($175/$429). And if the AFCIs were installed after the housing was 20 years old, an effectiveness of 31% would result in costs in balance with benefits ($175/$572).

The inclusion of AFCI protection is expected to reduce, but not eliminate residential fires from electrical distribution systems. Citing reviews of in-depth investigations, ES staff estimate that the inclusion of AFCI protection in circuit breakers could have prevented 50% or more of these fires.

Thus, if the ES staff estimate of 50% effectiveness is correct (and assuming a 3% discount rate), the preliminary estimate of benefits of installing AFCI protection would exceed the costs in all but one scenario: for AFCIs with a 30-year useful life installed at the time of the initial construction, the projected benefits would be $162 (50% of $324), while the expected costs would be $175.

However, it should be noted that the results of the analysis are sensitive to the discount rate used. If a 7% discount rate is applied to the societal costs, the benefits of installing AFCI protection expected to last 30 to 40 years in *new* housing could be less than the costs: $92 to $104 (50% of $189 and $208, respectively); if AFCIs were installed in housing over 10 years old, the benefits would be $122 to $134 (50% of $243 and $267, respectively). However, the installation of AFCIs in housing over 20 years old still results in significant benefits over costs: $181 to $194 (50% of $363 to $387, respectively).

Aggregated Benefits and Costs

The preceding section described the expected benefits and costs of requiring AFCIs on a per-house basis. However, because industry sources indicate that about 1.9 million housing units undergo major electrical renovations annually, we can also describe the aggregate discounted benefits and costs associated with these renovations over the expected useful lives of the installed AFCIs. While the average age of this housing is unknown, it is likely that they are older residences. If AFCIs were incorporated in these older housing as renovations were conducted, and if such renovations involved housing over 20 years old, the aggregate discounted benefits (i.e., the reduction in societal costs) could be in the range of $286 to $336[6] each, or $543 to $638 million for all 1.9 million houses. The total cost of the addition of AFCIs would total $175 per housing unit, or $332 million for all renovated houses. Thus, in this scenario, the total benefits of such an action are almost double the expected costs.

[6] Based on 50% effectiveness and 3% discount rate, and 30-year and 40-year expected life.

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LOG #

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Date 10/26/05 Name Doug Lee* Tel. No. (301)504-7569

Company U.S. Consumer Product Safety Commission

Street Address 4330 East West Hwy City Bethesda State Md Zip 20814

Please Indicate Organization Represented (if any) U.S. Consumer Product Safety Commission

1. Section/Paragraph 210.12(B)

2. Proposal recommends (check one): ☒ new text ☐ revised text ☐ deleted text

3. Proposal (include proposed new wording, or identification of wording to be deleted):

(See attached Proposal)

4. Statement of Problem and Substantiation for Proposal:

(See attached Statement of Problem and Substantiation for Proposal)

5. ☒ This Proposal is original material (Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought or research and, to the best of his/her knowledge, is not copied from another source.)

☐ This Proposal is not original material, its source (if known) is as follows:

* This proposal is that of the CPSC staff, has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

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Signature **(Required)**

Mail to: Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101 Quincy, MA 02269 or FAX to 617-770-3500

Proposal for 210.12 (B)

Add text in Section 210.12 (B) to read as follows:

(B) Dwelling Unit Bedrooms. All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit bedrooms shall be protected by a listed arc-fault circuit interrupter, combination type installed to provide protection of the branch circuit.

Branch/feeder AFCIs shall be permitted to be used to meet the requirements of 210.12(b) until January 1, 2008.

FPN: For information on types of arc-fault circuit interrupters, see UL 1699-1999, *Standard for Arc-Fault Circuit Interrupters*.

Exception: The location of the arc-fault circuit interrupters shall be permitted to be at other than the origination of the branch circuit in compliance with (a) and (b):

(a) The arc-fault circuit interrupter shall be installed within 1.8m (6ft) of the branch circuit overcurrent device as measured along the branch circuit conductors.

(b) The circuit conductors between the branch circuit overcurrent device and the arc-fault circuit interrupters shall be installed in a metal raceway or a cable with a metallic sheath.

Statement of Problem and Substantiation for Proposal:

Substantiation –The proposed text is to match the verb tense in (b).

Submitter: Doug Lee, U.S. Consumer Product Safety Commission Staff*

LOG OF MEETING

Subject: Meeting of Core Concept Task Group for Proposed Smoke Alarm Project

Date of Meeting: March 24, 1999

Date of Log Entry: March 30, 1999

Person Submitting Log: Julie Ayres, Office of Hazard Identification and Reduction

Location: U.S. Consumer Product Safety Commission, Bethesda, MD

Attendees:

Julie Ayres	U.S. Consumer Product Safety Commission
Richard Bukowski	National Institute of Standards and Technology
John Hall	National Fire Protection Association
James Hoebel	U.S. Consumer Product Safety Commission
James Milke	University of Maryland
Linda Smith	U.S. Consumer Product Safety Commission
Stephen Vastagh	National Electrical Manufacturers Association

Summary of Meeting

Three Task Groups are in place to assist in the planning of the proposed smoke alarm project. The purpose of the Core Concept Task Group is to assist in developing the framework for the proposed project and to ensure that focus on the goal is maintained throughout the project. The Core Concept Task Group discussed and refined the goal of the proposed research project, which is to determine if different types of fire alarms can respond to threatening residential fires in order to permit adequate egress of typical occupants, while being able to avoid nuisance alarms.

The participants discussed three main issues at the meeting: types of occupant sets to be considered, past research conducted on human capabilities and behavior, and the use of computer modeling in the proposed project. Specifics on fire scenarios, sensor selections for the testing program, and testing methods were not discussed. The specific Task Groups for the project will discuss these issues and make recommendations for the project.

Action Items for Core Concept Task Group

- Set-up meeting for participants in all Task Groups in July (J. Ayres – due 4/5/99)
- Generate a list of tasks for each Task Group and distribute to all participants (J. Ayres – due 4/15/99)
- Prepare document on how computer modeling can assist in project (J. Milke – due 4/30/99)
- Contact individuals who can assist with human capabilities and pre-movement activity (J. Hall)

Next Meeting Date for Conceptual Core Task Group

Tuesday, May 18, 1999 7:30 a.m. Baltimore, MD

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Date 10/26/05 Name Doug Lee* Tel. No. (301)504-7569

Company U.S. Consumer Product Safety Commission

Street Address 4330 East West Hwy City Bethesda State Md Zip 20814

Please Indicate Organization Represented (if any) U.S. Consumer Product Safety Commission

1. Section/Paragraph 210.8(C)

2. Proposal recommends (check one): ☐ new text ☒ revised text ☐ deleted text

3. Proposal (include proposed new wording, or identification of wording to be deleted):

(See attached Proposal)

4. Statement of Problem and Substantiation for Proposal:

(See attached Statement of Problem and Substantiation for Proposal)

5. ☒ This Proposal is original material (Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought or research and, to the best of his/her knowledge, is not copied from another source.)

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Signature **(Required)**

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Proposal for 210.8 (C)

Revise 210.8(C) as follows:

(C) Boat Hoists
Ground-fault circuit-interrupter protection for personnel shall be provided for outlets that supply 120/240-volt boat hoists installed in dwelling unit ~~locations and supplied by 125-volt, 15- and 20-ampered~~ branch circuits.

Statement of Problem and Substantiation for Proposal:

The essential severe shock/electrocution protection provided by 210.8(C) for personnel in contact with a boat hoist or in the water near a boat hoist should not be limited to 120 V installations.

The following four reports from the CPSC In-depth Investigation (IDI) database describe four incidents resulting in five electrocution deaths from 1994 to 2003 from contact with a boat hoist:

IDI No. 940817CNE5182 - A 17-year old young man was electrocuted as he stood in water to guide a boat as it was being lowered by a powered boat lift or hoist. An electrified lift cable came in contact with the victim's chest, and the victim was electrocuted. No GFCI was present in the hoist or electrical system.

IDI No. 960530CCC6242 - A 14-year old male was electrocuted when he grabbed the cable on an activated boat davit while waist deep in water. Local code enforcement officials stated that the davit, which was not GFCI-protected, was not grounded properly.

IDI No. 000531CNE5571 - An 11-year old male was electrocuted while standing on a metal portion of a seawall. He reached out and touched an electrical boatlift cable. The victim had been swimming in a canal and playing with some ducks. He had gotten out of the canal and was attempting to get a better view of the ducks by supporting himself with the cable. The victim died at the hospital.

IDI No. 030630HCC1686 - Two males, ages 15 and 16, were electrocuted while retrieving a football in a canal and coming in contact with metal components of a boatlift. The wiring leading to the lift was reported to be not installed to Code (only buried seven inches). A rebar had inadvertently been driven through the supply cable, bridging the hot and ground conductors. No information was available as to the presence of a GFCI.

These accounts show the high level of risk that dock installations pose when a fault occurs because of the exposure to readily-accessible dead metal parts and large body surface area exposure with a favorable ground path (bodies of water). Although these cases were caused by non-Code compliant wiring practices, these deaths may have been preventable through the implementation of ground fault protection.

Also, electrical installations at residential piers and docks are often not subjected to regular safety or maintenance inspections. Water and weather exposure subject electrical components to corrosion problems that could degrade grounding and bonding connections and accelerate equipment failures. Even if the systems are inspected, the hazards can develop suddenly after a storm or from high tide water. Protection is needed at this location whether it is 120-volt or 240-volt equipment. This location is hazardous for electrical shock incidents based on the electrical source of energy in this location and the corrosive environment. See attached articles on "*Is Your Boat Or Marina on Unsafe Ground? Electric Shock Drowning*" and "*The Critical Ground System.*"

Any source of energy near water needs to have ground-fault circuit-interrupter protection for personnel. By adding this requirement, all energy sources around a residential boat dock would be protected by ground-fault personnel protection and reduce the chances of additional electrocution incidents.

Submitter: Doug Lee, U.S. Consumer Product Safety Commission Staff*

LOG OF MEETING

Subject: Meeting of Core Concept Task Group for Proposed Smoke Alarm Project

Date of Meeting: March 24, 1999

Date of Log Entry: March 30, 1999

Person Submitting Log: Julie Ayres, Office of Hazard Identification and Reduction

Location: U.S. Consumer Product Safety Commission, Bethesda, MD

Attendees:

Julie Ayres	U.S. Consumer Product Safety Commission
Richard Bukowski	National Institute of Standards and Technology
John Hall	National Fire Protection Association
James Hoebel	U.S. Consumer Product Safety Commission
James Milke	University of Maryland
Linda Smith	U.S. Consumer Product Safety Commission
Stephen Vastagh	National Electrical Manufacturers Association

Summary of Meeting
Three Task Groups are in place to assist in the planning of the proposed smoke alarm project. The purpose of the Core Concept Task Group is to assist in developing the framework for the proposed project and to ensure that focus on the goal is maintained throughout the project. The Core Concept Task Group discussed and refined the goal of the proposed research project, which is to determine if different types of fire alarms can respond to threatening residential fires in order to permit adequate egress of typical occupants, while being able to avoid nuisance alarms.

The participants discussed three main issues at the meeting: types of occupant sets to be considered, past research conducted on human capabilities and behavior, and the use of computer modeling in the proposed project. Specifics on fire scenarios, sensor selections for the testing program, and testing methods were not discussed. The specific Task Groups for the project will discuss these issues and make recommendations for the project.

Action Items for Core Concept Task Group
- Set-up meeting for participants in all Task Groups in July (J. Ayres – due 4/5/99)
- Generate a list of tasks for each Task Group and distribute to all participants (J. Ayres – due 4/15/99)
- Prepare document on how computer modeling can assist in project (J. Milke – due 4/30/99)
- Contact individuals who can assist with human capabilities and pre-movement activity (J. Hall)

Next Meeting Date for Conceptual Core Task Group
Tuesday, May 18, 1999 7:30 a.m. Baltimore, MD

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1. (a) NFPA Document Title National Electrical Code **NFPA No. & Year** NFPA 70- 2011

(b) Section/Paragraph 550.13(B) Exception

2. Proposal Recommends (check one): ☐ new text **X** revised text ☐ deleted text

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted): [Note: Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).]

550.13 (B) Exception: ~~Receptacles installed for appliances in dedicated spaces, such as for dishwashers, disposals, refrigerators, freezers, and laundry equipment.~~ Exceptions listed in 210.8 shall be permitted.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that would be resolved by your recommendation; give the specific reason for your Proposal, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

During the development of the 2008 NEC, CMP-2 recognized that present-day ground-fault circuit-interrupter (gfci) devices are compatible with electrical appliances in the home and that there is no need to exclude refrigerators, freezers, and laundry equipment from gfci protection. Exceptions shall only be permitted as recognized in 210.8 to provide users with the optimum electric shock protection by extending this expansion of gfci protection to manufactured housing.

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Signature (Required) Doug Lee

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1. (a) NFPA Document Title National Electrical Code **NFPA No. & Year** NFPA 70- 2011

(b) Section/Paragraph 550.25

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550.25 Arc-Fault Circuit-Interrupter Protection (B) **~~Bedrooms of~~ Mobile Homes and Manufactured Homes**. All 120-volt branch circuits that supply 15- and 20- ampere outlets installed in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas of mobile homes and manufactured homes shall comply with 210.12(B).

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CMP-2 recognized the fire prevention capabilities of arc-fault circuit-interrupters (afcis) by expanding areas requiring afci protection as set forth in section 210.12 during the 2008 NEC code-making cycle. From 1999-2002, the fire death rate is roughly twice as high in manufactured homes as in other one- and two-family dwellings, and electrical distribution equipment continues to be one of the leading causes of manufactured home fires[1]. By making the requirements for manufactured homes consistent with the requirements for other dwelling units, additional electrical wiring system fires can be mitigated.

1. Hall, John R., Jr., Manufactured Home Fires, National Fire Protection Association, February 2005.

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