FORM FOR PROPOSALS FOR 2008 NATIONAL ELECTRICAL CODE®

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Type or print **legibly** in **black** ink. Use a separate copy for each proposal. Limit each proposal to a **SINGLE** section. All proposals **must be received by NFPA by 5 p.m., EST, Friday, November 4, 2005**, to be considered for the 2008 National Electrical Code. Proposals received after 5:00 p.m., EST, Friday, November 4, 2005, will be returned to the submitter. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

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. 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*

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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
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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

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 data base - 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 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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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.

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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.

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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.

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

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[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.

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