# U.S. Consumer Product Safety Commission
## LOG OF MEETING



**SUBJECT: Discussion with Assoc. of Home Appliance Mfrs. (AHAM) (Richard Cripps and others) regarding power cord fire prevention for room air conditioners.**

**DATE OF MEETING: December 17, 2002**

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

**DATE OF LOG ENTRY: December 18, 2002**

**LOCATION: Room 612, Bethesda Towers**

**CPSC ATTENDEE(S):**
**William H. King, Jr., ES**
**Andrew Trotta, ESEE**
**Linda Edwards, ESEE**
**Ed Krawiec, LS**

**NON-CPSC ATTENDEE(S):**
**Richard Cripps, AHAM**
**Larry Wethje, AHAM**
**Ed Heiden, Heiden Associates**
**Douglas Troutman, National Electrical Mfrs. Assoc.**
**Joel Solis, Air Conditioning and Refrigeration Institute**
**Ned Schiff, Technology Research Corp.**
**Tina Simmons, Technology Research Corp.**
**Aaron Chase, Leviton Manufacturing Company**

SUMMARY OF MEETING: The AHAM staff presented proposals prepared by AHAM for inclusion in the "National Electrical Code" ("NEC"). Mr. Heiden, under contract to AHAM, discussed his analysis of fire data associated with room air conditioners. Copies of the documents provided by AHAM are attached.

CPSC staff questioned the data analysis and indicated that the CPSC staff supported the electrical code, NEC para. 440.64, as it exists in the 2002 edition. CPSC staff encouraged all interested parties to participate in the process to revise the NEC, and thanked AHAM for sharing their views and actions with the us.

association of home appliance manufacturers

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Mark W. Earley, P.E.
Assistant Vice President
Electrical Engineering & Council Secretary to NFPA 70
National Fire Protection Association (NFPA)
1 Batterymarch Park
PO Box 9101
Quincy, MA 02269-9101

Re: Tentative Interim Amendment to 2002 NFPA 70, Section 440.65

Dear Mr. Earley:

The *Association of Home Appliance Manufacturers* (*AHAM*) respectfully requests that you forward our request for consideration of a Tentative Interim Amendment (TIA) to the NFPA Standards Council for consideration. The TIA is regarding the 2002 edition of NFPA 70, National Electrical Code®, Section 440.65, *Leakage Current Detection and Interruption (LCDI) and Arc Fault Circuit Interrupter (AFCI).* This TIA proposes to revise Section 440.65 after careful consideration of the impact of this Section on the industry and the safety of the public.

## I. Business Interest

*AHAM* is a national trade association representing the manufacturers of room air-conditioning products. Members and non-members combined produce over six million air conditioners annually that meet the definition of room air conditioner as described in Section 440.60.

## II. Emergency Nature

On September 3, 2002, Underwriters Laboratories revised UL 484, *Room Air Conditioners*. The revision incorporated NFPA 70, Section 440.65. The effective date for industry to comply with the change is August 1, 2004, prior to the next revision of the NFPA 70. To effect a change in the Code® before implementation of UL 484 requires that *AHAM* submit this TIA outside the normal code cycle. Otherwise, all manufacturers of room air conditioners will have to make design changes, procurement decisions and manufacturing arrangements to comply with Section 440.65. The effectiveness and reliability of such devices (LCDIs and AFCIs) integral to the power cord are not yet proven. Proven alternatives offer superior cord protection, as well as protection of the entire branch circuit, not just the power cord. In addition, the adoption of this requirement without a sufficiently advanced date of effectiveness has already provoked rejections by AHJs of new air conditioner installations. Adoption of this TIA would negate those rejections by adding a realistic effective date.

## III. Evaluation of Emergency Nature

The purpose of this TIA is to correct a circumstance in which the revised NFPA 70 has caused an adverse impact not adequately considered in the adoption of this Section. Adoption of this TIA would allow earlier implementation of appropriate and available circuit protection devices without the adverse impact of adopting devices of unproven long-term reliability and safety in a product. Additionally, we believe that the Technical Committee reversed its initial finding of *Reject* at the ROP based upon inadequate and incomplete technical data provided by the submitter. This reversal did not provide industry with adequate time to oppose adoption based upon more thoroughly researched objective data. That data is provided with this proposal.

## IV. Proposed Solution

Appended to this document is a revised version of the format NFPA is currently using for the submittal of proposals. This format conveniently facilitates the use of this proposed TIA as a proposal for consideration during the next code cycle, in accordance with NFPA regulations. The Substantiation addresses in greater detail why we feel this revision of the Code better addresses the safety concerns of the NFPA.

The safe construction of home appliances is best left to industry working in cooperation with standards-writing bodies, a responsibility we have willingly shared with UL since the inception of the Association of Home Appliance Manufacturers. *AHAM* and industry work with UL to develop safety requirements based on accepted data, research, product experience, CPSC data, and engineering rationale.

## V. Long-Term Solution

*AHAM* has submitted a proposal to revise the *2002 National Electrical Code* in a manner identical in content to this proposed TIA (with the exception of an implementation date). This has been done in recognition of the fact that the Standard Council, in its wisdom, may not choose to grant this TIA in time to permit a similarly worded proposal to be submitted before the deadline requirements for the 2005 Code. *AHAM* has also submitted two additional proposals. Realistically, the result of the research *AHAM* has conducted suggests that the best approach to the perceived problem of cord damage causing fires would be to require tougher cordsets in 440.64 and eliminate 440.65. If the TC chooses to require additional protection for the entire branch circuit supplying the air conditioner (the TIA's approach), then they can make that decision independently. This is the reason why *AHAM* has submitted a total of three proposals, where two appear to be in direct conflict.

Our intention is to afford the TC with the opportunity to choose between three future courses of action during the current (2002-2005) Code revision cycle.

1) Accept the *AHAM* proposals to improve cordset requirements and delete 440.65, or
2) Require protection for the entire branch circuit by revising 440.65 as offered in this TIA proposal and by a similar proposal submitted before November 1st by *AHAM*, or
3) Improve the cordset requirements *and* require protection for the entire branch circuit by approving all three *AHAM* proposals.

Respectfully Submitted,

William Keezer

Representing the Association of Home Appliance Manufacturers

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October 31, 2002

NB: This proposal has the endorsement of Rick Bunch, a principal member of NEC-P11.

# PROPOSAL of a TENTATIVE INTERIM AMMENDMENT to the 2002 *NATIONAL ELECTRICAL CODE®*

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

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|---|
| Log # _____ |
| Date Rec'd _____ |

**Date** 10/31/2002 **Name** William Keezer **Tel. No.** 508-655-4094

**Company** WJ Keezer Associates, Inc.

**Street Address** 94 Prospect Street, Sherborn, MA 01770-1301

**Please Indicate Organization Represented (if any)** Association of Home Appliance Manufacturers (AHAM)

**1. Section/Paragraph** 440.65.

**2. Proposed TIA Recommends: (Check one)** ❑ **new text** ■ **revised text** ❑ **deleted text**

**3. Proposed TIA (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~~).

**Revise Paragraph 440.65 as follows:**

**440.65 Leakage Current Detection and Interruption (LCDI) and Arc Fault Circuit Interrupter (AFCI).**

Branch circuits supplying single-phase cord-and-plug-connected room air conditioners shall be provided with ~~factory-installed~~ LCDI or AFCI protection. ~~The LCDI or AFCI protection shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug~~. The LCDI or AFCI shall also meet the requirements of 440.62 of this Article. This requirement shall become effective January 1, 2005

**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.)

**Problem:** AHAM supports legitimate concern for the safety of circuits and cordage used for room air conditioners, but it believes that those concerns are better addressed using currently available and proven technology. It further believes that there are reasons to expect a substantial safety and reliability risk if room air conditioners are designed to accommodate devices such as those required by this Section. We also believe a significant reduction in fire incidents attributed to room air conditioners can be achieved if the entire branch circuit is protected; an achievement not possible with the current Code requirement.

**Substantiation:**

1) There are no devices such as those required in this Section that have been produced in numbers adequate to insure their long-term reliability or safety in this application. We are concerned that the incorporation of a device with an unproven record of reliability can actually decrease the inherent safety of a room air conditioner. At this time, there is no manufacturer of an attachment plug or integral cord mounted LCDI or AFCI that can provide documented reliability statistics for these devices in this application. It is well known in the field of statistical failure analysis that the failure rate of any device is significantly increased as a result of the cumulative failure rate of each component. A standard power cord head has 4 components (3 conductors and 1 molded casing). A typical LCDI power cord head consists of more than 25 parts. Even without detailed component failure data (which is currently unavailable), it should be obvious that a complex electro-mechanical device is inherently more prone to failure than a power cord.

2) Protection of the entire branch circuit is a better way to insure against hazards due to circuit faults than by restricting the protective device to the cordset. **Annex A** (a supporting document submitted with this proposal) has been prepared by a thorough and objective analysis of consumer injury and fire incident databases. It shows that very few fires attributed to room air conditioners are initiated in unmodified power cords and plugs. The vast majority arise through the use of unsuitable extension cords, in cords subject to unauthorized modification by the user, in the receptacle or even within the branch circuit. Better protection from such incidents is provided through protection of the entire branch circuit. Indeed, the majority of fires initially attributed to "room air conditioners" in the Annex A data were, in fact, attributable to branch circuit outlets, receptacles, and wiring, not cords and plugs. In the sub-category of cords and plugs, the two greatest causes of cord and plug fires were cords spliced by the unit owner and the use of extension cords. There is evidence that when these splices were made, it was to extend the length of the cord, not necessarily to repair a damaged one. See **Exhibit 4 of Annex A**.

3) If a device as currently required trips as the result of a legitimate cord fault, through some power supply anomaly, or because it is defective, a trip indication and reset feature must be provided. If the device will not reset, the owner cannot confirm whether the fault is within the power cord, the air conditioner, or the protective device. By way of example only, currently available GFCIs (receptacle and panel mounted) and panel mounted AFCIs can both be tested by removing the suspect load and resetting the device. A device integral to the power cord does not allow such a test. *AHAM* is concerned that substituting a replacement cord for the protective device will be performed on such equipment as a substitute for proper diagnosis and repair. Further investigation of the fire incident data contained in Annex A indicates a number of power cords were altered by users, and that spliced cords were the ultimate cause of those fires. It is a significant concern of *AHAM's* that when an air conditioner is too valuable to throw out, and too expensive or inconvenient to professionally repair, the power cord will be subject to hazardous alteration.

**Solution:**

Panel mounted AFCI's are a proven technology, but most importantly they are readily available as branch circuit protection devices thanks to the requirements of Section 210.12(B). At this time, the requirements of Section 210.12(B) address 120 volt, 15 and 20 ampere branch circuits, which have caused 120 volt AFCI's to become a familiar installation item for electricians.

The proposed implementation date is only found in this TIA proposal, not in the equivalent proposal submitted by *AHAM*. A delayed effective date allows industry to complete development and make available 208/240-volt AFCIs in a time frame approximately equal to a code cycle, and avoids the complication of having AHJs attempt to apply a new Code requirement before the required equipment is readily available.

**5. ■ This TIA 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 TIA Proposal is not original material; its source (if known) is as follows:** _____

**If you need further information on the standards-making process, please contact the Standards Administration Department at 617-984-7249. For technical assistance, please call NFPA at 617-770-3000.**

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*I hereby grant the NFPA the non-exclusive, royalty-free rights, including non-exclusive, royalty-free rights in copyright, in this proposal and I understand that I acquire no rights in any publication of NFPA in which this proposal, in this or any other similar or analogous form, is used.*

_____

Signature (Required)

# To All NEC-P11Members and Other Interested Parties:

This document is:

## Annex A for two proposals to revise Section 440.65 Of the 2002 National Electrical Code®

**As submitted by William Keezer, representing the Association of Home Appliance Manufacturers (AHAM)**

October 31, 2002

**This document contains the following:**

1. The biography of Dr. Edward J. Heiden, President of Heiden Associates, Inc.

2. Heiden Associates report on the *Involvement of Unit Cords or Plugs in Room Air Conditioner Fires*, as provided to the Association of Home Appliance Manufacturers (AHAM) on October 28, 2002

**BIOGRAPHY**
**Dr. Edward J. Heiden**
**President, Heiden Associates, Inc.**

Dr. Heiden received his Ph.D. in Economics from Washington University in St. Louis, specializing in industrial organization. He was a member of the economics faculty at the University of Wisconsin – Madison, where he was a Director of the Center for Research in Firm and Market Behavior and taught graduate and undergraduate courses.

As president of Heiden Associates since 1981, Dr. Heiden has conducted numerous economic impact assessments on product safety, health, and environmental regulatory issues, as well as antitrust, trade regulation, and industry studies, serving both private and government clients. He has conducted numerous analyses of hazards and risks associated with particular consumer products. He has testified frequently in product liability and antitrust cases and has appeared as an expert witness before a number of federal and state courts, the U.S. Court of Claims, and the U.S. Court of International Trade. Dr. Heiden has also appeared in proceedings before Congress, the Consumer Product Safety Commission, the Occupational Safety and Health Administration, the California Air Resources Board, and the Virginia State Corporation Commission.

Prior to forming Heiden Associates, Dr. Heiden held a number of senior economic regulatory positions in the federal government. As Director and Chief Economist for Policy Planning and Evaluation at the Federal Trade Commission, he had primary responsibility for assessing the economic impact and cost of many of the FTC's most significant antitrust and consumer protection cases and projects. In addition, he served as Director of Strategic Planning at the Consumer Product Safety Commission, and was Director of Economic Planning at the White House Office of Consumer Affairs.

Dr. Heiden has published widely on diverse economic topics, including product safety data bases and systems, economic risk and impact analysis for consumer products, the impact of regulation on pharmaceutical and chemical industry costs and innovation, regulatory delay, and conglomerate mergers.

He is the recipient of the Federal Trade Commission's Distinguished Service Award, the agency's highest professional honor, and was a Woodrow Wilson scholar at Harvard University. He is a member of a number of professional societies, including the American Economic Association and the American Statistical Association.

For more information about Dr. Edward J. Heiden and his firm Heiden Associates, Inc., please visit the web site at www.heideninc.com.

2101 L Street, NW
Suite 200
Washington, DC 20037
(202) 463-8171

October 28, 2002

To: Association of Home Appliance Manufacturers (AHAM)

From: Edward J. Heiden, PhD

Re: Involvement of Unit Cords and Plugs in Room Air Conditioner Fires

At the request of the Association of Home Appliance Manufacturers (AHAM), Heiden Associates obtained, reviewed, and analyzed data from consumer injury and fire incident databases to develop an assessment of the relative contribution of unit cords and plugs to the overall number of fires involving room air conditioners. Our work included use of coded fields on the databases to identify potentially relevant incidents, followed by detailed review of incident descriptions and other characteristics to determine if there was actually confirmed or possible involvement of the A/C unit cord or plug.

The most important results of this analysis are presented in a Summary Exhibit below. Highlights are as follows:

1. There are about 800 fires associated with room air conditioners annually, according to U.S. Consumer Product Safety Commission (CPSC) estimates of residential structure fires associated with electrical equipment.

2. The unit cord or plug has been reportedly involved in 5.6 to 6.1 percent of the room air conditioning fire incident records available for review from the National Fire Incident Reporting System (NFIRS) residential structure fire database.

3. In room A/C unit fires with reported cord/plug involvement that were investigated by the CPSC, this involvement was confirmed in only 18 percent of the cases. Unit cords/plugs may possibly have been involved in another 18 percent of these incidents.

4. We estimate that **there are between 8 and 18 fire department attended fires annually that are actually or potentially attributable to air conditioner cords and plugs that have not been spliced or inserted into extension cords or overloaded/ malfunctioning home wiring systems. In contrast, extension cords, outlets and receptacles, and other cords and plugs collectively account for about 9,000 fires annually.**

Our analysis and incident rate estimates rely on the incident descriptions provided in the relevant USFA and CPSC databases. However, it should be noted that these incident descriptions

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are usually preliminary, and in some instances, contain significant factual errors. Subsequent investigation often indicates that factors other than those cited in the incident report actually were responsible for the ignition. This problem is especially pronounced for the CPSC Injury and Potential Injury Incidents (IPII) database reports, which are based primarily on news clips and other second- and third-hand sources. For purposes of statistical risk assessment, however, these databases represent the best currently available sources of information on the *relative* magnitudes of various electrical fire hazards.



**SUMMARY EXHIBIT**
**ESTIMATES OF ROOM AIR CONDITIONER FIRES**
**WITH UNIT CORD/PLUG INVOLVEMENT**

| | | Lower Estimate | Upper Estimate |
|---|---|---|---|
| (1) | Room Air Conditioner Fires in 1998 | 800 | 800 |
| (2) | Percent with Cord/Plug Involvement Reported | 5.6% | |
| (2a) | Percent with Cord/Plug Involvement Reported or Possibly Reported | | 6.1% |
| (3) | Percent of Reported Cord/Plug Fires Attributable to the Unit Cord/Plug | 18% | |
| (3a) | Percent of Reported Cord/Plug Fires Possibly Attributable to the Unit Cord/Plug | | 36% |
| (4) | ***Estimated Number of A/C Fires with Unit Cord/Plug Involvement, 1998*** | **8** | **18** |

Sources:

(1) CPSC "1998 Residential Fire Loss Estimates"
(2) & (2a) Heiden Associates analysis of 1989-1998 NFIRS Equipment File incidents
(3) & (3a) Heiden Associates review of CPSC Accident Investigation summaries
(4) = (1) * (2) * (3) for lower bound estimates; (4) = (1) * (2a) * (3a) for upper bound estimate

A detailed presentation of the data sources reviewed, analysis performed and the derivation of the fire incidence rate in this report is provided below.

**Data Sources Reviewed**

We reviewed national estimates of fire incidents, injuries and fatalities from the U.S. Consumer Product Safety Commission (CPSC) 1998 Residential Fire Losses report. These

estimates are based on application of extrapolation factors developed from National Fire Protection Association (NFPA) annual surveys to the incident reports contained in the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS).

We also reviewed and analyzed in detail case-specific data on fires, injuries, deaths, and other incidents involving air conditioners are available from the NFIRS residential structure fires incident and equipment databases and from two major CPSC hazard monitoring databases. Each of these sources has strengths and weaknesses that make it necessary to use them in combination in order to assess the contribution of A/C unit cord and plugs to the overall number of fire incidents involving room air conditioning units.

**The CPSC 1998 Residential Fire Loss Report**

As noted above, the CPSC 1998 Residential Fire Loss Estimates report uses data from the NFIRS residential structure fires database and extrapolation factors developed from annual NFPA surveys to develop estimates of electrical equipment fires, including those involving room air conditioners. Selected estimates are presented in Exhibit 1 below.



**EXHIBIT 1**
**CPSC ESTIMATES OF ELECTRICAL EQUIPMENT FIRES, 1994-1998**

| | Yearly Estimate | | | | | Annual | |
|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 | Average | % |
| *Number of Incidents Reportedly Involving* | | | | | | | |
| **Room Air Conditioners** | **700** | **900** | **700** | **700** | **800** | **760** | **0.5%** |
| Outlets/Receptacles | 4,000 | 4,000 | 4,000 | 3,500 | 3,800 | 3,860 | 2.3% |
| Extension Cords | 3,700 | 3,500 | 2,900 | 2,800 | 2,800 | 3,140 | 1.9% |
| Other Cords/Plugs | 2,200 | 2,300 | 2,400 | 2,400 | 2,400 | 2,340 | 1.4% |
| All Electrical Equipment | 171,500 | 167,400 | 166,400 | 165,700 | 155,900 | 165,380 | |

Source: CPSC "1998 Residential Fire Loss Estimates"

According to the CPSC report, room air conditioners were involved in approximately 800 fires in 1998, which is just above the average of 760 estimated for the five year-period from 1994

to 1998 (the most recent five years for which the NFIRS data are currently available). Because the annual estimates of room air conditioner fires have been relatively stable over the most recent five data-available years, we used the 1998 estimate of 800 room A/C fires as the baseline for our analysis of incidents involving unit cords or plugs.

**National Fire Incident Reporting System (NFIRS) Residential Structure Fire Database**

The National Fire Incident Reporting System (NFIRS) database—the source from which the CPSC fire loss report estimates are derived—can often be used to develop statistically reliable estimates of the number of fires involving a particular product or hazard pattern. However, it lacks the ability of the CPSC hazard monitoring databases discussed below to provide more detailed information on incident sequences (and consequences).

The NFIRS incident database includes an average of 267 room air conditioner fire incident reports annually from 1994 to 1998, the latest five years for which these data are available. However, incidents involving unit cords or plugs cannot be identified from the coded information provided, because cords and plugs are classified as a separate form of equipment involved in ignition (EI) in the NFIRS coding structure.

More extensive information on a subset of fires with equipment involved is provided in the NFIRS equipment database. Extracting *ten* years of these reports to ensure an adequate sample of incidents for review, we were able to identify 1,150 room A/C fires with some information on the make, model or serial number of the unit involved. Using the methodology described below, these incident reports were used to estimate the proportion of room A/C fires that reportedly involve unit cords and plugs.

**CPSC Hazard Monitoring Databases**

The CPSC maintains several databases that provide descriptions of incidents involving product-related hazards. Two of these provide information on fire incidents:

1. One database summarizes the results of accident investigations ("in-depth" investigations, or IDI's) conducted by CPSC staff or contractors. The IDI database does not provide a statistically representative sample of all room air conditioner fire incidents, but the investigation summaries provide more detailed descriptions of accident sequences and conditions than are available from any other source. We therefore relied on this data only to determine what proportion of fires in which cord/plug involvement was cited should more properly be attributed to other factors.

2. A second source of information on fire incidents is provided by the CPSC Injury and Potential Injury Incidents database (the IPII file). Most of these reports are from news

clips (82 percent of the cases for air conditioner fires) and consumer complaints. While few of these reports have detailed descriptions of the accident sequences, there are a much larger number of incident reports in this database than in the IDI file. While we did not ultimately rely on the IPII data to estimate the prevalence of room A/C fires involving unit cords or plugs, we reviewed these incident reports for air conditioners to assist in identifying relevant hazard patterns and other factors involved in such fires.

As Exhibit 2 shows, we were able to identify a total of 29 A/C fires on the IDI database during the period from January 1992 through June 2002 that involved unit cords and/or plugs. These cases represent 26 percent of the 113 air conditioner fire investigations conducted by CPSC over the past ten years. By contrast, extension cords were cited in 21 fires; another 16 fires involved receptacles, outlets or other components of the home wiring system.



**EXHIBIT 2**
**AIR CONDITIONER FIRE INCIDENTS**
**IN THE CPSC HAZARD MONITORING DATABASES**

| Fires Associated with Air Conditioners | In-Depth Investigations (IDI) Jan. 1992 – June 2002 Total | Avg./Yr. | % | Injury and Potential Injury Incidents (IPII) Jan. 1997 – June 2002 Total | Avg./Yr. | % |
|---|---|---|---|---|---|---|
| *Fires Reportedly Involving* | | | | | | |
| Cords/Plugs | 29 | 2.8 | 26% | 68 | 12.4 | 13% |
| Extension Cords | 21 | 2.0 | 19% | 83 | 15.1 | 16% |
| Outlets/Receptacles/Wiring | 16 | 1.5 | 14% | 44 | 8.0 | 8% |
| Other/Unspecified Components | 47 | 4.5 | 42% | 335 | 60.9 | 63% |
| Total Reported Air Conditioner Fires | 113 | 10.8 | | 530 | 96.4 | |

Sources:
(1) Heiden Associates tabulations of CPSC Accident Investigations database
(2) Heiden Associates tabulations of CPSC Reported Incidents database

We were also able to identify 68 A/C fire or fire hazard incidents reported in the IPII database during the period from January 1997 through June 2002 that involved unit cords and/or plugs. These cases represent 13 percent of the 530 total A/C fire incidents reported for this five-year interval. Extension cords were cited in 83 A/C fires; another 44 incidents involved receptacles, outlets or other components of the home wiring system.

**Determining the Proportion of A/C Fires Involving Unit Cords or Plugs**

From these data sources we were able to identify incident reports for fires that reportedly involved A/C/ unit plugs or cords. We then conducted a detailed review of these incident reports to determine the proportion of all fire incidents associated with room A/C units in which unit cord or plug involvement could actually be confirmed. More specifically:

1. Based on our review of make, model and serial number information provided in the NFIRS equipment database, we developed lower- and upper-bound estimates of the proportion of all room air conditioner fires in which the unit cord or plug was cited.

2. Based on our review of the incident descriptions in the CPSC IDI database records, we developed lower-bound and upper-bound estimates of the proportion of these incidents that were actually or potentially attributable to unit cords or plugs.

Applying these two estimated proportions to the CPSC Residential Fire Losses report estimate of 800 room air conditioner fires in 1998 yields lower-bound and upper-bound estimates of the annual number of fires in which the unit cord is either a confirmed or possible factor contributing to ignition. Each step of this analysis is described in more detail below.

*The Proportion of A/C Fires Reportedly Involving Unit Cords or Plugs*

In the case of air conditioner fires involving plugs and cords, analysis of the NFIRS fire incident database is complicated by the fact that cords and plugs—including those from appliances such as room air conditioners—are classified as a separate category of equipment involved (EI) in ignition. Most of the reports of interest for our analysis therefore had the air conditioner or its cord—but not both—reported as the equipment involved. Accordingly, the fires of interest for our analysis had to be identified using a two-step process:

1. First, room air conditioner (EI code 35) fire records were extracted from the NFIRS equipment fire database, which provides data on make, model and serial number for a subset of the NFIRS incident file records. This information was reviewed to develop a list of "valid A/C identifiers". We were able to identify 1,085 such records in the 1989-1998 NFIRS equipment database. Only five of these also reported unit cord/plug involvement.

2. This list of valid A/C identifiers was then matched against the NFIRS equipment fire database records that cite a cord or plug (EI code 47) as the equipment involved in ignition. This match allowed us to identify 65 additional incidents that were reported as having actually or potentially involved room air conditioners.

As Exhibit 3 shows, our subsequent review confirmed that at least 59 of the 65 cord/plug fire records extracted in step 2 appear to have involved room air conditioners. For the remaining six incidents, the equipment involved may have been another type of product manufactured by a producer of air conditioners. We have therefore developed and used both lower-bound (confirmed only) and upper-bound (all confirmed and possible) estimates of the proportion of A/C fires that reportedly involved unit cords or plugs. These estimates include the five additional reported cord/plug fires identified directly in the first-stage (EI code 35) match, as shown in Exhibit 3 below.



**EXHIBIT 3**
**HEIDEN ASSOCIATES ANALYSIS OF ROOM AIR CONDITIONER FIRES IN THE 1989-1998 NFIRS EQUIPMENT DATABASE**

| | | |
|---|---|---|
| Room A/C (EI 35) incident reports with make/model/serial information, 1989-1998 | 1,085 | |
| Cord/plug (EI 47) incident reports with definite/possible room A/C involvement | 65 | |
| Total room A/C fire incident reports with make/model/serial information, 1989-1998 | 1,150 | |
| | | |
| Number of room A/C (EI 35) fires with cord/plug involvement reported | 5 | 0.4% |
| Number of reported cord/plug (EI 47) fires with A/C confirmed | 59 | 5.1% |
| **Confirmed A/C unit fires with cord/plug involvement reported** | **64** | **5.6%** |
| | | |
| Number of reported cord/plug (EI 47) fires with A/C possible | 6 | 0.5% |
| **Confirmed/possible A/C unit fires with cord/plug involvement reported** | **70** | **6.1%** |

Based on this procedure, we estimate that unit cords or plugs are reportedly involved in the ignition of between 5.6 and 6.1 percent of all department-attended fires involving room air conditioners. However, as our analysis of the CPSC injury incident databases demonstrates, these reports often attribute other ignition factors to the unit cord or plug.

*The Proportion of Cord/Plug Fires Actually or Potentially Attributable to Other Factors*

As we noted above, the most detailed reports of fire incidents available are provided by the CPSC accident investigation (IDI) summaries. For our analysis, we had identified 29 fires involving air conditioners in which unit plugs or cords (but not extension cords) were mentioned.

Review of these 29 incident reports indicated that seven of the fires were not within the scope of our analysis. Four involved other products; one was an electrocution that occurred during installation; and two did not actually cite the cord or plug in the accident summary.

The remaining 22 cases were reviewed to determine if the reported involvement of the unit cord or plug was confirmed or ruled out by the CPSC investigation. The results of this review are summarized in Exhibit 4 below.



**EXHIBIT 4**
**HEIDEN ASSOCIATES ANALYSIS OF REPORTED A/C CORD/PLUG FIRES IN THE CPSC ACCIDENT INVESTIGATIONS DATABASE**

| | # of Cases | % | |
|---|---|---|---|
| **Total cases identified from IDI database** | **29** | | |
| *Fires excluded from analysis* | | | |
| Not room/room air conditioner | 4 | 14% | |
| Unit being installed | 1 | 3% | *24%* |
| Cord/plug not actually cited as factor | 2 | 7% | |
| **Fires with cord/plug involvement described** | **22** | **76%** | |
| *Hazards other than unit cords/plugs* | | | |
| Spliced cords | 8 | 36% | |
| Overloaded circuits* | 3 | 14% | *64%* |
| Materials on cord ignited** | 3 | 14% | |
| *Possible cord/plug involvement* | | | |
| Damaged/frayed cords | 2 | 9% | |
| Cord or unit involved | 1 | 5% | *18%* |
| Cord overheating (no fire) | 1 | 5% | |
| **Confirmed cord/plug involvement** | **4** | **18%** | |

Notes:
* Description indicates the initial point of ignition was beyond the A/C cord/plug.
** Ignition would have required a cord longer than used on most room A/C units.

As Exhibit 4 shows, in the majority of these 22 cases, the investigation attributed the fire to factors other than to unaltered unit cord or plugs. Spliced cords accounted for the largest number of fire incidents (eight incidents, or 36 percent of the cases reviewed). Circuit or outlet overloading was cited in three cases. This hazard pattern is more likely to be attributable to problems further upstream in the circuit, rather than with the cord or plug itself. Another three incidents involved ignition of materials on top of the cord that would be more consistent with use of an extension cord than the unit cord itself.

There were only four instances in which the CPSC investigator actually attributed ignition of the fire to the unit cord or plug. In the remaining four cases, cord or plug involvement could not be ruled out. We therefore used the proportion of cases with confirmed involvement of the unit cord/plug (18 percent) for our lower-bound estimate and the proportion of cases with confirmed or possible involvement of the unit cord/plug (36 percent) for our upper-bound estimate

**Computing a National Estimate of A/C Plug/Cord Fires**

The results from these NFIRS and CPSC database analyses were then combined to develop an estimate of the number of 1998 room air conditioner fires that actually or potentially involved unit cord or plugs. The calculations are shown in the Summary Exhibit above.

Because of the difficulty in associating cord/plug fires with air conditioners (or any other type of electrical equipment) on the NFIRS database, we developed lower-bound and upper-bound estimates of the prevalence of these fires. Based on the methodology utilized, **we estimate that there are between 8 and 18 fires annually that can be properly attributed to A/C cords or plugs. This hazard therefore accounts for between 1.0 to 2.25 percent of the estimated 800 fire incidents annually involving room A/C units.**

In contrast, as we noted above, the CPSC 1998 Residential Fire Loss report estimates that there were about 3,800 residential structure fires involving electrical outlets or receptacles; 2,800 fires involving extension cords; and 2,400 fires involving other cords and plugs in 1998.

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**Date** 10/31/2002 **Name** William Keezer **Tel. No.** 508-655-4094

**Company** WJ Keezer Associates, Inc.

**Street Address** 94 Prospect Street, Sherborn, MA 01770-1301

**Please Indicate Organization Represented (if any)** Association of Home Appliance Manufacturers (AHAM)

**1. Section/Paragraph** 440.64

**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: i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).

**Revise 440.64 as noted:**

**440.64 Supply Cords.**

Where a flexible cord is used to supply a room air conditioner the following conditions shall be met:

(A) Length of Cord. The length of such cord shall not exceed 3.0 m (10 ft) for a nominal, 120 volt rating or 1.8 m (6 ft) for a nominal, 208- or 240-volt rating.

(B) Cord Types. The cord shall be listed or approved for hard usage or extra hard usage as specified in Table 400.4

**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.)

**Problem:**
There is a perception that room air conditioner power cords require improved resistance to mechanical damage due to the number of installation and storage cycles to which some units are likely to be subjected in the course of the product's life. This proposal specifically requires adoption of more robust cord construction than is currently permitted by *UL 484 Room Air Conditioners*.

**Substantiation:**

Paragraph 1.2.4 of UL 484 tabulates all permitted cord types. Many of these are categorized as suitable for hard usage or extra hard usage. Currently, SP-3, SPE-3, and SPT-3 are the types most commonly used but their use is "limited to use in general-use cord sets that are not likely to be subjected to frequent flexing." (UL-817, Table 44.1). This proposed change in the requirements would prohibit the continued use of those cordage types. By adoption of the proposal, all permitted cord types would be of jacketed construction –providing two layers of mechanical protection for all electrical conductors. The cord types that would no longer be acceptable use a single layer of material, serving as both insulator and mechanical protection. *AHAM* believes this change represents a significant increase in the required mechanical integrity of home air conditioner cordage, but does not prohibit the use of even more robust cordage (extra hard usage) when the particular application, as determined by the manufacturer and UL, requires it. The practical result of this change is to prohibit the use of non-jacketed cords.

*AHAM* further contends that this proposal achieves the intent of 440.65 without the attendant complexity, lack of field experience, and concerns for reliability and safety. *AHAM* recommends the concurrent adoption of a proposal to delete paragraph 440.65, which has been submitted by the same submitter.

**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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**Revise Paragraph 440.65 as follows:**

**440.65 Leakage Current Detection and Interruption (LCDI) and Arc Fault Circuit Interrupter (AFCI).**

Branch circuits supplying single-phase cord-and-plug-connected room air conditioners shall be provided with ~~factory-installed~~ LCDI or AFCI protection. ~~The LCDI or AFCI protection shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug~~. The LCDI or AFCI shall also meet the requirements of 440.62 of this Article.

**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.)

**Problem:** *AHAM* supports legitimate concern for the safety of circuits and cordage used for room air conditioners, but it believes that those concerns are better addressed using currently available and proven technology. It further believes that there are reasons to expect a substantial safety and reliability risk if room air conditioners are designed to accommodate devices such as those required by this Section. We also believe a significant reduction in fire incidents attributed to room air conditioners can be achieved if the entire branch circuit is protected; an achievement not possible with the current Code requirement.

**Substantiation:**

1) There are no devices such as those required in this Section that have been produced in numbers adequate to insure their long-term reliability or safety in this application. We are concerned that the incorporation of a device with an unproven record of reliability can actually decrease the inherent safety of a room air conditioner. At this time, there is no manufacturer of an attachment plug or integral cord mounted LCDI or AFCI that can provide documented reliability statistics for these devices in this application. It is well known in the field of statistical failure analysis that the failure rate of any device is significantly increased as a result of the cumulative failure rate of each component. A standard power cord head has 4 components (3 conductors and 1 molded casing). A typical LCDI power cord head consists of more than 25 parts. Even without detailed component failure data

(which is currently unavailable), it should be obvious that a complex electro-mechanical device is inherently more prone to failure than a power cord.

2) Protection of the entire branch circuit is a better way to insure against hazards due to circuit faults than by restricting the protective device to the cordset. **Annex A** (a supporting document submitted with this proposal) has been prepared by a thorough and objective analysis of consumer injury and fire incident databases. It shows that very few fires attributed to room air conditioners are initiated in unmodified power cords and plugs. The vast majority arise through the use of unsuitable extension cords, in cords subject to unauthorized modification by the user, in the receptacle or even within the branch circuit. Better protection from such incidents is provided through protection of the entire branch circuit. Indeed, the majority of fires initially attributed to "room air conditioners" in the Annex A data were, in fact, attributable to branch circuit outlets, receptacles, and wiring, not cords and plugs. In the sub-category of cords and plugs, the two greatest causes of cord and plug fires were cords spliced by the unit owner and the use of extension cords. There is evidence that when these splices were made, it was to extend the length of the cord, not necessarily to repair a damaged one. See **Exhibit 4 of Annex A**.

3) If a device as currently required trips as the result of a legitimate cord fault, through some power supply anomaly, or because it is defective, a trip indication and reset feature must be provided. If the device will not reset, the owner cannot confirm whether the fault is within the power cord, the air conditioner, or the protective device. By way of example only, currently available GFCIs (receptacle and panel mounted) and panel mounted AFCIs can both be tested by removing the suspect load and resetting the device. A device integral to the power cord does not allow such a test. *AHAM* is concerned that substituting a replacement cord for the protective device will be performed on such equipment as a substitute for proper diagnosis and repair. Further investigation of the fire incident data contained in Annex A indicates a number of power cords were altered by users, and that spliced cords were the ultimate cause of those fires. It is a significant concern of *AHAM's* that when an air conditioner is too valuable to throw out, and too expensive or inconvenient to professionally repair, the power cord will be subject to hazardous alteration.

**Solution:**

Panel mounted AFCI's are a proven technology, but most importantly they are readily available as branch circuit protection devices thanks to the requirements of Section 210.12(B). At this time, the requirements of Section 210.12(B) address 120 volt, 15 and 20 ampere branch circuits, which have caused 120 volt AFCI's to become a familiar installation item for electricians.

**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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**Delete Paragraph 440.65 as follows:**

~~**440.65 Leakage Current Detection and Interruption (LCDI) and Arc Fault Circuit Interrupter (AFCI).**~~

~~Single-phase cord-and-plug-connected room air conditioners shall be provided with factory-installed LCDI or AFCI protection. The LCDI or AFCI protection shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.~~

**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.)

**Problems:**

There is a perception that room air conditioner power cords require improved resistance to mechanical damage due to the number of installation and storage cycles to which some units are likely to be subjected in the course of the product's life. This proposal recognizes that if a companion proposal provided by this submitter is adopted which revises the cord requirements for room air conditioners in Section 440.64, then the protective measures required by this section are unnecessary.

A second problem is caused by the fact that, without a sufficiently advanced effectiveness date, AHJs are already red-tagging new air conditioner installations, while the air conditioner industry has yet to be supplied with sufficient reliability data to insure that air conditioner safety won't be compromised by incorporation of these proposed devices in new products.

A third problem is that as of this date, 208/240-volt devices of either configuration don't exist, except as prototypes. None have achieved production status, nor are any listed.

A fourth problem is that as of this date the cord required for the function of the LCDI is not a type covered in Table 400.4 of the NEC. Additionally there are no cord type AFCI devices available in the marketplace.

**Substantiation:**

1) *AHAM* has submitted to this committee a proposal to restrict the acceptable cord types for room air conditioners to constructions suitable for hard usage or extra hard usage. We believe adoption of this proposal makes the continued existence of 440.65 unnecessary. Paragraph 1.2.4 of UL 484 tabulates all permitted cord types. Many of these are categorized as suitable for hard usage or extra hard usage. Currently, SP-3, SPE-3, and SPT-3 are the types most commonly used but their use is "limited to use in general-use cord sets that are not likely to be subjected to frequent flexing." (UL-817, Table 44.1). This proposed change in the requirements would prohibit the continued use of those cordage types. By adoption of the proposal, all permitted cord types would be of jacketed construction —providing two layers of mechanical protection for all electrical conductors. The cord types that would no longer be acceptable use a single layer of material, serving as both insulator and mechanical protection. *AHAM* believes this change represents a significant increase in the required mechanical integrity of home air conditioner cordage, but does not prohibit the use of even more robust cordage (extra hard usage) when the particular application, as determined by the manufacturer and UL, requires it. The practical result of this change is to prohibit the use of non-jacketed cords. *AHAM* believes this change to the Code and eventually to the UL Standard effectively addresses the original intent of this Section, which was to reduce the potential for fires initiated by damaged cordsets. It does so by utilizing cordage intended to survive hard use, without the addition of a complex and potentially unreliable device. See (2) below.

2) There are no devices such as those required in this Section that have been produced in numbers adequate to insure their long-term reliability or safety in this application. We are concerned that the incorporation of a device with an unproven record of reliability can actually decrease the inherent safety of a room air conditioner for the reasons addressed in (3) below. At this time, there is no manufacturer of an attachment plug or integral cord mounted LCDI or AFCI that can provide documented reliability statistics for these devices in this application. The failure rate of any device is significantly increased as a result of the cumulative failure rate of each component. A standard power cord head has 4 components (3 conductors and 1 molded casing). A typical LCDI power cord head consists of more than 25 parts. Even without detailed failure data (which is currently unavailable), it should be obvious that a complex electro-mechanical device is inherently more prone to failure than a power cord.

3) If a device as currently required trips as the result of a legitimate cord fault, through some power supply anomaly, or because it is defective, a trip indication and reset feature must be provided. If the device will not reset, the owner cannot confirm whether the fault is within the power cord, the air conditioner, or the protective device. By way of example only, please note that currently available GFCIs (receptacle and panel mounted) and panel mounted AFCIs can both be tested by removing the suspect load and resetting the device, then reconnecting the load. A device integral to the power cord does not allow such a test. *AHAM* is concerned that substitution of a replacement cord for the protective device will be performed on such equipment as a substitute for proper diagnosis and repair. Investigation of the fire incident data contained in **Annex A** indicates users altered a number of power cords and that spliced cords were the ultimate cause of those fires. It is a significant concern of *AHAM* that when an air conditioner is too valuable to throw out, and too expensive or inconvenient to professionally repair, the power cord will be subject to hazardous alteration. The high incidence of "spliced cords" resulting in fires is adequate evidence of the willingness of the public to attempt cord alteration, and to ignore the hazards that may result. Every cord-integral LCDI or AFCI that fails to reset creates a candidate for cord alteration.

4) Devices currently on the market will not detect arcing or current faults in a circuit preceding the device. By way of example, extension cords located in the circuit before the LCDI will continue to be identified as a fire cause for air conditioner cords. Replacement cords will continue to be identified as a fire cause for air conditioner cords.

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