Table A-1.
Source and Type of Incident
in 281 Investigated Incidents of Electrical
Appliance Cord Failure

Source	Total		Type of Incident			
			Fire		Nonfire	
	No.	%	No.	%	No.	%
Total	281	100	94	100	187	100
Unsolicited	126	45	78	83	48	26
Complaint	52		18		34	
News Clipping	42		39		3	
Fire Dept.	22		16		6	
Other	10		5		5	
Solicited	155	55	16	17	139	74
News Article	60		8		52	
TV, Radio Spot	45		3		42	
Paid Ads	27		2		25	
Posters/Flyers	16		2		14	
Other Promotion	7		1		6	

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

Table A-3.
Product by Source of Incident for 281
Investigated Incidents of Electrical Appliance
Cord Failure

Appliances	Total	Unsolicited				Solicited
		Consumer Complaints	News Clips	Fire Dept.	Other	
Total	281	52	42	22	10	155
Large Appliances	12	2	2	4	1	3
Refrigerators/Freezers	3	--	1	1	1	--
Clothes Dryers	4	--	1	1	--	2
Ranges	2	--	--	1	--	1
Other	3	2	--	1	--	--
Small Kitchen Appliances	67	11	1	4	2	49
Coffee Makers	20	3	--	3	1	13
Ovens/Broilers	14	4	--	--	1	9
Toasters	10	1	1	1	--	7
Frying Pans	9	1	--	--	--	8
Other	14	2	--	--	--	12
Other App. Producing Heat	112	28	4	5	3	72
Heaters	28	3	4	3	2	16
Electric Blankets	5	--	--	2	--	3
Irons	38	8	--	--	--	30
Hair Dryers	26	11	--	--	1	14
Curling Irons	12	4	--	--	--	8
Other	3	2	--	--	--	1
Other App. Not Producing Heat	90	11	35	9	4	31
Table/Floor Lamps	14	1	9	1	--	3
Other Lighting	7	2	1	2	--	2
Fans	15	1	12	--	1	1
Stereos, TV's, Radios	14	--	8	1	2	3
Air Conditioners	7	1	3	2	--	1
Vacuums	20	5	--	--	--	15
Other	13	1	2	3	1	6

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

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APPENDIX B
ESTIMATION METHODOLOGY

Data Sources:

1. National Fire Protection Association (NFPA)

   NFPA makes national estimates of losses from residential structural fires based on an annual sample survey of public fire departments.

2. National Fire Incident Reporting System (NFIRS)

   Operated by the U.S. Fire Administration, NFIRS consists of computerized fire incident reports of fires attended by public fire departments. For 1987, NFIRS contained over 220,000 residential structural fires from 41 states. Although it is not a randomly selected probability sample, it is a very large comprehensive data source on fires involving products. In view of its size, we assumed that it is representative of the U.S. fire problem.

3. CPSC Electrical Fire Incident Data Base - 1985

   This data base consisted of 11,333 incident reports of residential structural electrical fires from 19 states and the District of Columbia for 1985. With the cooperation of the National Fire Information Council and the U.S. Fire Administration, we asked participating jurisdictions to send us copies of their incident reports for all residential fires involving electrical forms of heat. These incident reports were reviewed and coded for consumer product involvement in addition to retaining the usual NFIRS equipment codes. Again, this data base is not a randomly selected sample of jurisdictions, but is believed to be representative of the electrical fires occurring. Data are included from the following:

Alaska	Minnesota
District of Columbia	New York
Delaware	Ohio
Florida	Oregon
Hawaii	South Carolina
Iowa	South Dakota
Idaho	Texas
Kansas	Utah
Massachusetts	Wisconsin
Maine	Wyoming

Estimation Methodology

All product estimates are based on NFIRS distributions extrapolated to the NFPA estimates of residential structural fire losses. We performed an additional procedure to estimate specific product involvement for products that are grouped in general NFIRS codes. Using the 1985 CPSC electrical fire data base that included specific product coding, we identified a primary NFIRS reporting code for a product. We then applied the proportion of the NFIRS code that involved that product to the estimate for the primary NFIRS code and adjusted that figure to include additional product fires which were reported in other NFIRS codes. The estimation methodology for deaths, injuries and property loss involving these products assumed that they occurred in the same proportions as the fires.

As a result of this procedure, we estimated that in 1985, extension cords were involved in about one-half of the fires in the NFIRS group "cords, plugs". The remainder involved a variety of appliance and equipment cords. Estimates for 1986 and 1987 assumed that this distribution remained the same. Among the appliances listed in Table 3, this procedure was also used to produce estimates for all except heaters, lighting equipment, air conditioners, and consumer electronics equipment.

APPENDIX C
SUPPLEMENTAL TABLES

Table C 1a
Cord Failure Point in Fires, by Product,
Investigated Incidents of Electrical
Appliance Cord Failure

Appliance	Total	Failure Point: Appliance End: Appliance/ Cord Conn.	Appliance End: Strain Relief	Appliance End: Female Conn.	Appliance End: Cord Entry to Female Conn.	Along Cord Length	Attachment Plug End: Cord Conn. to Plug	Attachment Plug End: Attach. Plug	Attachment Plug End: Plug/Wall Receptacle Interface	Attachment Plug End: Plug/ Ext. Cord Inter.	Integ.* Male/ Female Conn.
Total Known	**81**	**9**	**16**	**--**	**1**	**37**	**8**	**4**	**2**	**3**	**1**
Large Appliances	**7**	**1**	**--**	**--**	**--**	**6**	**--**	**--**	**--**	**--**	**--**
Clothes Dryers	3	1	--	--	--	2	--	--	--	--	--
Refrigerators/Freezers	3	--	--	--	--	3	--	--	--	--	--
Ranges	--	--	--	--	--	--	--	--	--	--	--
Other	1	--	--	--	--	1	--	--	--	--	--
Small Kitchen Appliances	**10**	**2**	**--**	**--**	**1**	**2**	**4**	**1**	**--**	**--**	**--**
Coffeemakers	7	2	--	--	1	1	2	1	--	--	--
Ovens/Broilers	--	--	--	--	--	--	--	--	--	--	--
Toasters	3	--	--	--	--	1	2	--	--	--	--
Frying Pans	--	--	--	--	--	--	--	--	--	--	--
Other	--	--	--	--	--	--	--	--	--	--	--
Other Appliances; Producing Heat	**29**	**4**	**16**	**--**	**--**	**5**	**1**	**1**	**1**	**1**	**--**
Irons	13	1	10	--	--	2	--	--	--	--	--
Heaters	5	1	--	--	--	1	--	1	1	1	--
Hair Dryers	5	--	4	--	--	--	1	--	--	--	--
Curling Irons	4	2	1	--	--	1	--	--	--	--	--
Electric Blankets	2	--	1	--	--	1	--	--	--	--	--
Other	--	--	--	--	--	--	--	--	--	--	--
Other Appliances; Not Producing Heat	**35**	**2**	**--**	**--**	**--**	**24**	**3**	**2**	**1**	**2**	**1**
Vacuum Cleaners	2	--	--	--	--	--	--	1	--	--	1
Fans	8	1	--	--	--	7	--	--	--	--	--
TV, Radio, Phono.	7	--	--	--	--	6	1	--	--	--	--
Table/Floor Lamps	7	1	--	--	--	6	--	--	--	--	--
Other Lighting	3	--	--	--	--	1	2	--	--	--	--
Air Conditioners	4	--	--	--	--	1	--	1	1	1	--
Other	4	--	--	--	--	3	--	--	--	1	--

* Refers to a construction where the cord is in two separable sections.

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

Table C-1b
Cord Failure Point in Nonfires, by Product,
Investigated Incidents of Electrical
Appliance Cord Failure

Appliance	Total	Failure Point: Appliance End: Appliance/ Cord Conn.	Appliance End: Strain Relief	Appliance End: Female Conn.	Appliance End: Cord Entry to Female Conn.	Along Cord Length	Attachment Plug End: Cord Conn. to Plug	Attachment Plug End: Attach. Plug	Attachment Plug End: Plug/Wall Receptacle Interface	Attachment Plug End: Plug/ Ext. Cord Inter.	Integ* Male/ Female Conn.
Total	**182**	**22**	**29**	**17**	**6**	**20**	**45**	**22**	**15**	**3**	**3**
Large Appliances	**4**	--	**1**	--	--	**1**	--	**2**	--	--	--
Clothes Dryers	**1**	--	--	--	--	--	--	**1**	--	--	--
Refrigerators/Freezers	--	--	--	--	--	--	--	--	--	--	--
Ranges	**1**	--	--	--	--	**1**	--	--	--	--	--
Other	**2**	--	**1**	--	--	--	--	**1**	--	--	--
Small Kitchen Appliances	**55**	**6**	--	**14**	**4**	**2**	**14**	**6**	**5**	**2**	**2**
Coffeemakers	**13**	--	--	**3**	--	**1**	**7**	**2**	--	--	--
Ovens/Broilers	**12**	**3**	--	**2**	**1**	--	**1**	**1**	**1**	**2**	**1**
Toasters	**7**	**1**	--	--	--	**1**	**3**	**1**	**1**	--	--
Frying Pans	**9**	--	--	**3**	**3**	--	--	**1**	**2**	--	--
Other	**14**	**2**	--	**6**	--	--	**3**	**1**	**1**	--	**1**
Other Appliances; Producing Heat	**79**	**5**	**27**	**1**	**1**	**3**	**23**	**10**	**8**	**1**	--
Irons	**24**	**2**	**10**	--	--	**2**	**10**	--	--	--	--
Heaters	**21**	--	--	--	--	**1**	**2**	**10**	--	**1**	--
Hair Dryers	**21**	**1**	**10**	--	--	--	**9**	--	**1**	--	--
Curling Irons	**8**	**1**	**6**	--	--	--	**1**	--	--	--	--
Electric Blankets	**3**	--	**1**	--	**1**	--	**1**	--	--	--	--
Other	**2**	**1**	--	**1**	--	--	--	--	--	--	--
Other Appliances; Not Producing Heat	**44**	**11**	**1**	**2**	**1**	**14**	**8**	**4**	**2**	--	**1**
Vacuum Cleaners	**16**	**3**	--	**1**	--	**4**	**3**	**3**	**1**	--	**1**
Fans	**3**	**1**	--	--	--	**1**	**1**	--	--	--	--
TV, Radio, Phono.	**6**	--	--	--	**1**	**3**	**2**	--	--	--	--
Table/Floor Lamps	**5**	**2**	--	--		**2**	--	**1**	--	--	--
Other Lighting	**4**	**4**	--	--	--	--	--	--	--	--	--
Air Conditioners	**2**	--	--	--	--	--	**1**	--	**1**	--	--
Other	**8**	**1**	**1**	**1**	--	**4**	**1**	--	--	--	--

* Refers to a construction where the cord is in two separable sections.

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

Table C-2
Failure Point by Age of Product Involved for
234 Investigated Incidents of Electrical Appliance
Cord Failure

Failure Point	Total		Age of Product (Years)									
			Less than 1		1-5		6-10		11-15		Over 15	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total Known	234	100%	42	18%	113	48%	47	20%	13	6%	19	8%
Appliance End	91	100%	20	22%	44	48%	17	19%	4	4%	6	7%
Appliance/Appliance Cord Connection	28	100%	11	39%	12	43%	3	11%	--	--	2	7%
Strain Relief	42	100%	8	19%	23	55%	9	21%	2	5%	--	--%
Female Connector	14	100%	1	17%	6	43%	3	21%	2	14%	2	14%
Cord Entry to Female Connector	7	100%	--	--	3	*	2	*	--	--	2	*
Along Cord Length	40	100%	9	22%	15	38%	9	22%	1	3%	6	15%
Attachment, Plug End	99	100%	13	13%	53	54%	19	19%	7	7%	7	7%
Cord Entry to Plug	52	100%	2	4%	33	63%	8	15%	5	10%	4	8%
Attachment Plug	25	100%	7	28%	10	40%	5	20%	--	--%	3	12%
Plug/Wall Receptacle Interface	16	100%	3	19%	7	44%	4	25%	2	12%	--	--%
Plug/Extension Cord Interface	6	100%	1	*	3	*	2	*	--	--	--	--
Integral Male/Female Connection**	4	100%	--	--	1	*	2	*	1	*	--	--

* Less than 5 percent.

** Refers to a construction where the cord is in two separable sections.

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

Table C-3
Cord Wire Gauge and Incident Type in Investigated Incidents Involving Electrical Appliance Cord Failure

Wire Gauge	Incident Type		
	Total	Fire	Nonfire
Total Reported	141	28	113
10	3	1	2
14	3	2	1
16	52	6	46
18	81	18	63
27	2	1	1

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

Table C-4
Failure Point and Wire Gauge in
Investigated Incidents Involving
Electrical Appliance Cord Failure

Failure Point	Total	Wire Gauge (AWG) 10	14	16	18	27
Total Reported	138	3	3	52	78	2
Appliance End	59	1	--	18	39	1
Connection to Appliance	18	1	--	3	13	1
Detach Female Connector/Cord Entry	13	--	--	9	4	--
Strain Relief	28	--	--	6	22	--
Along Cord Length	15	--	1	3	10	1
Attachment Plug End	62	2	2	29	29	--
Attachment Plug/Conn.to Plug	48	2	1	17	28	--
Plug Conn. to Wall Receptacle/ Extension Cord	14	--	1	12	1	--
Other	2	--	--	2	--	--

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

Table C-5
Cord Insulation and Incident Type in
Investigated Incidents Involving Electrical
Appliance Cord Failure

Insulation Type	Incident Type		
	Total	Fire	Nonfire
Total Reported	140	20	120
SPT-1	16	3	13
SPT-2	25	1	24
SVT	4	1	3
SJT	1	1	--
HPN	76	8	68
Fabric	12	4	8
Other	6	2	4

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

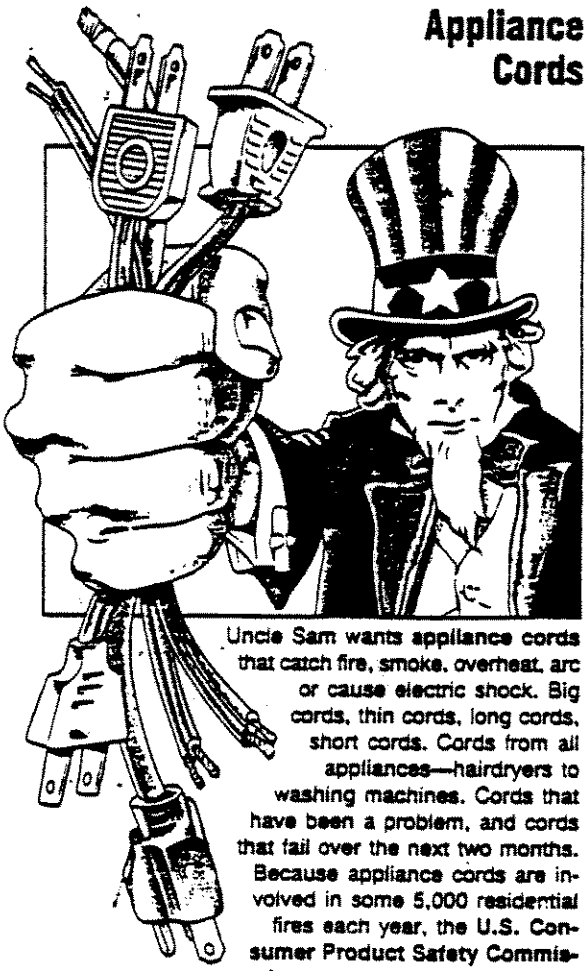
Table C-6
Failure Point and Cord Insulation Type in Investigated Incidents Involving Electrical Appliance Cord Failure

Failure Point	Total	Insulation Type				
		SPT-1	SPT-2	HPN	Fabric	Other
Total Reported	138	16	25	75	12	10
Appliance End	65	13	12	28	7	5
Conn. to Appliance	18	7	2	6	1	2
Detach Fem. Connector /Cord Entry	15	1	1	12	--	1
Strain Relief	32	5	9	10	6	2
Along Conductors	7	1	1	4	--	1
Attachment Plug End	65	2	12	42	5	4
Attachment Plug/Conn. to Plug	52	2	10	32	5	3
Plug Conn. to Wall Receptacle/Extension Cord	13	--	2	10	--	1
Other	1	--	--	1	--	--

Source: Epidemiologic Investigation Reports
Consumer Product Safety Commission/Division of Hazard Analysis

WANTED

Appliance Cords



Uncle Sam wants appliance cords that catch fire, smoke, overheat, arc or cause electric shock. Big cords, thin cords, long cords, short cords. Cords from all appliances—hairdryers to washing machines. Cords that have been a problem, and cords that fail over the next two months. Because appliance cords are involved in some 5,000 residential fires each year, the U.S. Consumer Product Safety Commission wants to study your cord to find out how and why it failed. If CPSC can use your cord, they will reimburse you for it or replace it.

If you have such an appliance cord, call your local CPSC office:

C

HUMAN FACTORS ANALYSIS

ASSESSMENT OF CONSUMER BEHAVIOR AROUND ELECTRICITY

February 1990

Marie Bellegarde

U.S. CONSUMER PRODUCT SAFETY COMMISSION

Directorate for Epidemiology
Division of Human Factors/EPHF

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Executive Summary

This analysis was performed to assess consumer behavior around electricity by reviewing investigated cases involving failed cords of household electrical appliances. The findings of this analysis reveal that consumers sometimes failed to observe warning signs exhibited by failing appliance cords posing a fire or electrical shock hazard. A review of the literature on people's perceptions of electrical safety helps to explain the behavior exhibited by consumers in the investigated cases. People perceive electricity as being safe since it works well and seldom fails. Consequently, electricity is taken for granted and common electrical appliances are considered nonhazardous. Familiarity with the electrical appliances involved also increase the perceived safety of these appliances. The findings of this analysis support the need to increase people's awareness of electrical safety as well as the need to consider the intended and foreseeable use of these appliances in the home.

I. Introduction

The Electrical Hazards Team initiated the appliance cord project to address incidents involving cord and plug failures of household electrical appliances. Investigations of the failed appliance cord incidents were analyzed by the Division of Hazard Analysis. Samples of failed cords from the investigated cases were analyzed by the Directorate for Engineering Sciences to determine technical failure modes.

This report examines how consumers' perception and knowledge of electrical safety affect their use of household electrical appliances. This will be based on consumers' use of the appliances as analyzed in the investigated cases as well as a review of the technical literature on their perception of electrical safety.

A total of 281 in-depth investigations (IDIs) were reviewed. Consumer use patterns with the appliances prior to the incidents, awareness of hazards associated with electrical appliances, and awareness of accompanying instructions/warning labels were considered in the analysis of the IDIs. Incident characteristics which placed the consumer at an increased risk of being injured were identified.

II. Analysis of Incidents

A broad range of household appliances was involved. As discussed in the Engineering Sciences report, the appliances were sorted into two types: appliances intended to be used while attended and those intended to be used unattended (Table 1). The term "unattended" was used to designate an appliance that is usually or frequently left in operation without someone's presence; e.g., an air conditioner. "Attended" refers to an appliance which usually required the presence of an operator; e.g., an iron. The hazard patterns as well as the incident scenarios differed between the two types of appliances. The consumer's involvement in interrupting operation of the appliance at the time of the incident and consequently the result of the incident (fire or nonfire) also differed between the two types of appliances.[1]

Table 1

1. Attended Appliances

Broilers, Rotisserie, etc.
Coffeemakers, Percolators
Curlers, Curling irons
Fryers, skillets
Hairdryers
Irons
Kettles, Teapots, etc.
Mixers
Toasters, Toaster ovens
Vacuum cleaners

2. Unattended Appliances

Air conditioners
Blankets
Clothesdryers
Fans
Space heaters
Lamps
Radios
Refrigerators

Source: McCoskrie, D.: Technical Analysis of Failing Cords and Plugs, Division of Electrical Engineering, Directorate for Engineering Sciences. CPSC, September 1989.

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A. Appliance Use

1. Attended Appliances

Consumers tended to be in the same room where these appliances were used or had to physically handle the appliance to use it; e.g., a hairdryer or a curling iron. Therefore, the consumer was immediately aware of the fire hazard and was able to interrupt operation of the appliance and usually stopped using it. High-damage fires usually did not result from these incidents.[1] These appliances were also frequently used by consumers, often on a daily basis.

2. Unattended Appliances

With these appliances, there was less direct interaction between user and appliance. Many of these appliances were left to operate by themselves; e.g., a lamp or an air conditioner. Due to their function, many of these appliances such as air conditioners or refrigerators were continuously plugged into live outlets, as it would not be appropriate to plug and unplug them. The appliance cords were usually located where they could not be seen, such as behind beds, tables, or couches. Consequently, any overheating or physical damage to the cords was not readily apparent and usually went undetected by the consumer.

It also appears that combustible materials such as newspapers, curtains, upholsteries, or clothes which were close to the appliance cord, ignited and helped to spread the fire. Often the consumer was not in the same room, was asleep, or even was not in the house when these appliances were operating. In a number of cases, although the respondents were at home, they were in a different room than the one where the fire originated. It often was the respondents' neighbors who alerted them of smoke or flames coming from their homes. Since the fires were usually detected at later stages, injuries and deaths as well as damage to the home resulted more frequently from these incidents.[1]

B. Indications of Problems

Two patterns were observed in the IDIs: (1)Consumers often did not heed the warning signs indicating that the appliance cord was defective and possibly posed a fire or electrical shock hazard. (2) In some cases, the appliance cord was used in ways which may have contributed to reported failures.

Some consumers reported that on previous occasions, they had noticed occurrences such as electrical shock, hot cords, and sparks/arcing/smoke.

1. Electrical Shock

A number of consumers did not realize the potential seriousness of problems indicated by the fact that they received an electrical shock. The warning signs ranging from a slight tingle to a burn are indications of a potential electrocution hazard and a defective product that should be repaired or replaced. Electrocution potential depends on a number of factors such as the amount of current flowing through the body, path of current and length of time of shock. The same shock that was only an annoyance on one occasion could be fatal given a slightly different set of conditions. Therefore, even a slight tingle should never be ignored.

Characteristic Examples

- o Consumer had received numerous shocks from base of iron from the first time that it was used. When the intensity of the electric shocks increased, she decided to file a complaint.

- o Consumer had continuously received electric shocks when she plugged in cord of electric blanket in outlet.

2. Hot Cords

A number of consumers were under the impression that it was normal for a cord to get hot. This is a warning sign that the appliance cord is overheating which could lead to insulation damage and create a possible fire hazard. A number of consumers reported that the appliance cord would get hot to the touch, even to the point of having to unplug the cord with a towel. Often these cords had been getting hot for a period of time even from the time of purchase. Very few consumers recognized this as a fire hazard.

Characteristic Examples

- o Consumer stated hairdryer's plug would feel hot to the touch when unplugging after each use but thought that this was normal.

- o Consumer reported rotisserie cord was always hot to the touch but did not relate this to any particular danger with appliance.

- o Consumer reported that for about two years, she noticed clothes dryer's cord became hot after each use. She did not know this was a problem until a friend told her that a hot cord is a sign of a dangerous condition.

3. Sparks, Arcs, Smoke

A number of consumers reported that they had previously observed sparks, flames, or smoke coming from appliance cords where they attach to products or in the plug area. In spite of these signs, consumers often attempted to manipulate the appliance cord to get appliance to work by: pulling on the cord, jiggling/wiggling the cord near attachment area, and pressing/pushing cord against body of product to get it to work. This tended to occur, particularly, in cases where consumers had begun a task and wanted to complete it.

Characteristic Examples

o Consumer stated that plug of oven sparked when inserted or withdrawn from receptacle but she continued to use it. Consumer stated that controls were in "off" position when sparking occurred.

o Consumer stated iron would spark during use and she noticed that the cord was scorched; however, she continued to use it until it finally failed to heat.

o Consumer stated she started to notice small sparks coming from hairdryer. She would shake the dryer to get rid of sparks; however, she stopped when the intensity of sparks increased.

o For about a year, consumer noticed arcing near the male plug end of coffee maker almost everytime she plugged it into outlet.

4. Mechanical Damage

Some of the investigated reports stated cord failure was due to the cord being pinched, which caused damage to wire resulting in the insulation breaking and crumbling. Factors contributing to these conditions were appliance cord being crimped or pinched under tables, wheels, mattresses, chairs, etc. resulting in insulation wearing through and exposing wires. This tended to occur mostly with unattended appliances.

Characteristic Examples

o Fire department reported that electrical short was result of constant wear on insulation due to constant closing of door on fan cord.

o Leg of table was sitting on lamp cord and wore through insulation and exposed copper wiring; caused a short which produced heat build-up, ignited insulation and nearby curtains.

o Metal frame of bed had been pushed against portable heater's cord causing insulation to wear through over time, exposing conductors which eventually shorted against bed frame.

o Cord of radio had been wedged between box spring and bed frame resulting in the cord's insulation being worn off and eventually shorting out and igniting box spring and mattress.

III. Discussion

To assess the consumer use patterns observed in the investigations, a review of the literature was conducted to understand people's perception of electrical safety and how it affects their use of electricity. Studies have shown that people's perception of product safety is affected by a number of factors. Factors most likely related to perception of electrical safety are familiarity and knowledge.

Several studies indicate that the more familiar people are with a product, the more confident they are in their ability to use the product safely and the less dangerous a product appears to be.[2,3,4,5] The types of appliances involved in the incidents are used throughout the home. Consequently, consumers are very familiar with them. Electricity and interaction with electrical appliances has become so routine that people tend to overlook the hazards associated with their use.

Accurate understanding of a hazard also affects people's perception of product safety. Lack of understanding of a hazard limits their ability to foresee ways accidents with the product might occurr.[4,6] To perceive the hazards associated with electricity, people must understand how it works; otherwise, factors contributing to fire and shock hazards may not be appreciated by them. In general, people's knowledge of electricity appears to be limited.[7,8] People also are more likely to associate electrical appliances with the risk of electrical shock as opposed to electrical fires.[9]

A study undertaken to assess people's understanding of electricity and behavior with common electrical situations found that the majority of the sample did not consider electricity to

be a hazard. The respondents very seldom thought of electrical hazards and felt safe from receiving electrical shocks and related injuries from electrical appliances.[7]

Another study undertaken to assess consumer attitudes toward product safety, and, in particular, electrical appliances found that the perceived safety of electrical appliances was high. The majority of the respondents classified electrical appliances as "probably safe" or "definitely safe." Although electric irons, lamps, and hairdryers were the appliances most often reported to have caused injuries or fires, respondents most often questioned the safety of microwave ovens. It also appears that a UL listing may increase the perceived safety of electrical appliances. Only one third of the respondents expressed any skepticism regarding the safety of UL-listed appliances. According to the respondents, manufacturers are primarily responsible for product safety, followed by the government, with a very limited degree of responsibility to the user.[8] Therefore people may assume that no special precautions need to be taken when using electrical appliances.

IV. Recommendations

A. Failure Modes

The environment and the way appliance cords can be expected to be used by consumers subjects them to problems of heat, age, environmental factors, and mechanical design flexing.

1. Attended Appliances

The most frequent failure points for these appliances were flexural failure of the appliance's cord at the appliance end or the attachment plug end.[1] These appliance cords are subjected to constant flexing (e.g., curling irons, hairdryers, irons). They are also subjected to turning, twisting, bending, and positioning at various angles especially where cord is attached to appliance.

The manner in which these appliances are used lend support to Engineering Science's recommendation that the testing of the cords should better simulate the stresses that these cords encounter in every day use.[10]

2. Unattended Appliances

The primary reported failure point that resulted in fires was along the cord's length.[1] People tend to place furniture, beds, tables, etc. in front of the receptacle outlets where the appliance cords are plugged-in, probably to keep them out of sight for aesthetic reasons.

In these locations, the cords are not easily accessible either visually or physically and may be subjected to some wear and tear. As a result, affected areas of cords may be hidden and a damaged cord may not be noticed until failure occurs. These appliances tend to be used without consumer presence and are often left to operate by themselves. People may not recognize that when an appliance switch is in the "off" position but plugged into an outlet, it may still be electrically live.

Intended use and location of these appliance cords in homes support the recommendation in the Engineering Sciences Report that the construction and insulation materials of these appliance cords be able to withstand temperature rise to reduce the chances of nearby materials igniting.[10] The results of the hazard analysis indicates that these appliances seem to be involved in more fire casualties and losses than the attended appliances.

B. Warning Labels

Warnings regarding the use of damaged cords were found in three investigated cases. These warnings were examined as examples of the types of warnings currently being used. They are shown and commented on below:

1. Curling iron

"Never operate this appliance if it has a damaged cord or plug."
"Keep cord away from heated surfaces."

Comment

The results of using damaged cords as well as why cord should be kept away from heated surfaces should be stated.

2. Air conditioner

"Do not alter or change the plug on the power cord of your air conditioner. Changes would make it unsafe, could cause serious damage to the a/c and might void the warranty."

Comment

Message should specify how these changes would make it unsafe.

3. Portable heater

"It is normal for cord and plug to get warm during use. If plug gets hot, please check condition of wall receptacle."

Comment

Although stating that it is normal for cord and plug to get warm is not incorrect, it may be sending a mixed message to consumers since a cord which is too warm or hot may be indicative of overheating and possible fire hazard. Perhaps adding that it is normal for cord to get warm but not uncomfortably warm or hot to the touch might clarify this message to consumers.

The condition of the cord as well as the receptacle should be checked. Should advise consumers how or by whom receptacle and cord should be checked.

If warnings are to be used, the results of ignoring the warning should be stated. This is a key component of any warning label. Therefore, the consequences of using damaged cords should be stated; e.g., result in fires, electrical shock, electrocution. Symbols and pictographs denoting electrocution and fire hazard could be used to reinforce the message to consumers and provide them with some visual cues. Some evidence exists which indicates the use of pictograms and symbols may provide a frame of reference to people and help them recognize the hazards.[12]

Adults often attempt to operate products without looking at instructions or warning labels.[13] Therefore warning labels should be placed where users normally would see them as they begin to use product. In the cases of appliance cords, a permanent hang tag on the cord near plug area might assure that it is seen as the plug is inserted in the outlet. However, in the cases of appliances that are continuously plugged in, the hang tag would most likely only be seen once.

C. Education & Information

A number of utility companies have developed educational and informational campaigns designed to increase people's awareness of electrical safety. Only one has conducted a baseline study.[14] The Arkansas Power & Light Company began a campaign to increase people's knowledge and understanding of power line hazards in 1977. Five years later, it was reported that the number of people who incorrectly believe that power lines were insulated decreased from 87% to 57%. It might prove beneficial for utility companies to mention not only obvious electrical hazards associated with power lines but to include information on electrical safety around the home with household appliances.

Analysis of the investigations as well as the review of the literature provide support to the development of a CPSC Safety Alert. Consumers could be informed of the dangers associated with using damaged cords and of the warning signs indicating that their appliance cords need to be repaired or replaced. The safety alert could include:

Possible types of electrical hazards resulting from use of damaged cords: overheating, melting, smoking, explosions, arcing, and electric shock.

Consumer use patterns which could result in the above-mentioned electrical hazards: pulling cord out of outlets, plugs not being inserted completely and having exposed parts, placing cords in areas where subject to wear and tear, and inappropriate splicings.

Physical conditions which could be detected by periodic visual inspection (especially for unattended appliances) such as: melted/split cord, break in cord, loose plug in outlet, loose cord, exposed wires, frayed cord, and exposed wiring.

IV. Conclusions

In summary, it appears people may not recognize hazards associated with electricity because they are familiar with it. Electricity works well and seldom fails. Its presence is hardly noticeable. People's knowledge of how electricity functions appears to be limited. The results are that hazards associated with electricity are often overlooked or inadequate caution is taken to prevent certain hazardous conditions.

There is evidence that safety measures which require an action by consumers are less effective than those which do not rely on consumers' action.[11,13,15] The literature and investigated cases indicate that in some cases, consumers can be expected to continue to use damaged or defective appliances, even after incidents of shocks or sparks. Consumers also may not read instructions nor heed warning messages because of the familiarity of the appliances. Thus, unless the people's perception of electrical hazards and resultant behaviors can be altered, many of these behaviors would have to be considered reasonably foreseeable.

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