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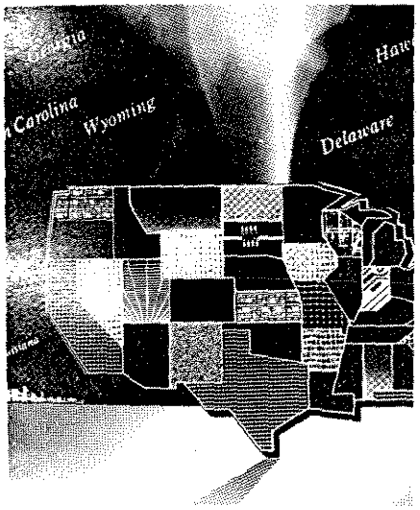

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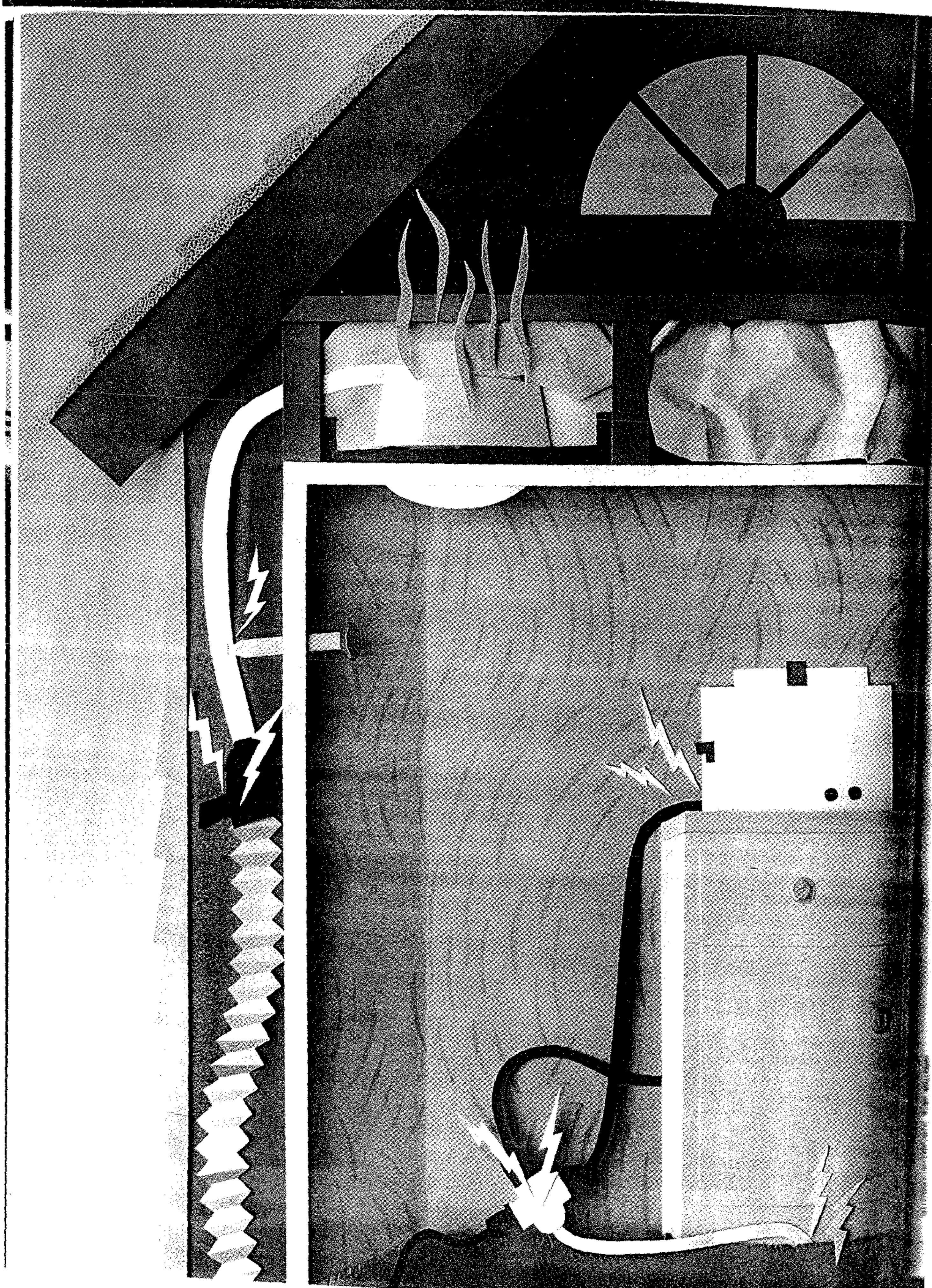
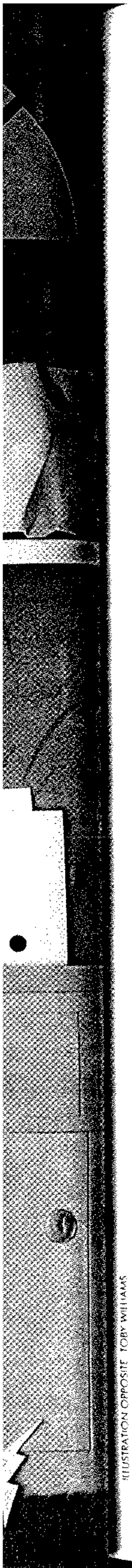


Linda E. Smith and
Dennis McCoskrie

What Causes WIRING FIRES in Residences?



Fires that originate in the electrical distribution system of a building consistently account for about eight percent of all residential fires reported nationwide. Based on data from the US Fire Administration and the NFPA, we estimate that about 50,400 such fires occurred annually from 1983 to 1987, inclusive, and that they resulted in approximately 440 civilian deaths, 1,400 civilian injuries, and $500.9 million in property loss annually.

Nevertheless, when researchers try to pinpoint the causes of electrical distribution system fires, they confront a multitude of reports that cite merely "failure of electrical wiring" or something similar. For the most part, the destructive nature of the fires, compounded by the difficulties of reconstructing the interconnected features of the electrical system, prevent in-depth analysis of the electrical causes of fires, except in unusual circumstances. When reconstructions are done, they often focus on large-scale losses, such as hotel fires, rather than on residential fires—and it is residential fires that continue to contribute the most to overall US fire losses. It is here that prevention must begin if we are to reduce these losses.[1]

In pursuit of its mission to reduce deaths and injuries related to consumer products, the US Consumer Product Safety Commission (CPSC) first sponsored a project to identify the causes of residential fires involving the electrical distribution system in 1980. At that time, CPSC contracted with the US Fire Administration to present a three-day training course on such systems to selected fire departments, which conducted the investigations using a special study questionnaire. When possible, the departments also called on local electrical inspectors for assistance. The National Bureau of Standards, now the National Institute of Standards and Technology, analyzed these investigations in December 1983.[2]

To augment this effort, CPSC sponsored a second phase of data collection in additional cities in 1984 and 1985. This second phase used the same data collection criteria and questionnaire as the first phase, but a different contractor delivered the training. Overall, 16 fire departments participated in the study and contributed 149 fire investigations that met the criteria for the project. This article presents the results of these combined efforts.

How the Study Was Conducted

Fire departments were chosen to participate in the study on the basis of whether they were likely to attend a sufficient number of fires of this nature and their willingness to devote a substantial number of extra hours to such investigations. They were reimbursed for the time they spent on each investigation that met the scope of the project—that is, on each investigation of a residential fire that was found to have begun in a component of the residential electrical distribution system. Such components include branch circuits, panel boxes, receptacle outlets, and cords and plugs.

The departments were instructed to investigate every such fire, but their investigations met the scope of the project only if there was enough physical evidence to substantiate that the electrical distribution system was involved. This criterion excluded many larger-loss fires, as well as all hotels, and included apartment buildings only if there were an individual meter for each apartment. This resulted in a smaller percentage of apartment fires and a larger percentage of single-family dwelling fires, compared with US Fire Administration's National Fire Incident Reporting System (NFIRS) data.

It is important to recognize that the local fire departments decided for themselves which fires they would investigate for this project. Those decisions involved a number of factors, including the availability of investigators. The effect of these factors on the study results is not known.

The results of this study were com-

ILLUSTRATION OPPOSITE: TOBY WILLIAMS

TABLE 1

Ratio of Residential Electrical Distribution System Fires to Housing Population by Age of Dwelling

Age of Dwelling	Percentage of All[1] Dwellings in Study Areas	Percentage of Investigated[2] Electrical Distribution System Fires	Index-Ratio[3] of Fires to Dwellings
≤10 years	19.8	6.4	0.32
11 to 20 years	17.3	8.5	0.49
21 to 40 years	28.7	29.1	1.01
Over 40 years	34.2	56.0	1.64
Total	100.0	100.0	1.00

[1] Distributions of occupied housing units are based on 1980 Census figures. For the cities included in Phase II (1984), the distributions have been adjusted to include housing units built between 1980 and 1984, based on a survey of 1986 occupied housing units by Donnelly Demographics. Cities that reported only one study fire during a time period were excluded.

[2] Consumer Product Safety Commission study of 149 investigated fires in the residential electrical distribution system in 16 cities. These investigations do not constitute a statistically representative sample. This distribution is based on 141 fires. It excludes five fires where the age of the dwelling was unknown and three fires in cities where only one fire was submitted in a study period. The latter were excluded on the theory that it would not be appropriate to include all housing units in an area to accommodate one fire.

[3] This index indicates how much higher or lower than the overall fire rate was the fire rate for a particular building age group.

Source: US Consumer Product Safety Commission

pared with data contained in NFIRS to evaluate how well the study reflected residential distribution system fires nationwide. Although there were some differences, a comparison of electrical components and areas of origin indicates that the study fires were generally representative of those reported in NFIRS.

The Age of the Dwelling Was a Factor

One significant factor the study revealed was that the age of the dwelling seemed to contribute to the likelihood that it would experience a fire. A comparison of the ages of the 149 dwellings involved in the study fires with the dwelling populations in the study cities indicates that the fire rate increased as the age of the dwelling increased. The index-ratio of fires to housing units shown in Table 1 reveals the relative fire rate for particular housing age groups compared to the overall fire rate. For example, the rate of fire in dwellings over 40 years old was 1½ times that of dwellings 21 to 40 years old and about 3 times that of dwellings 11 to 20 years old.

Older dwellings also exhibited different electrical system characteristics than newer dwellings. For instance, circuit breakers were installed in all the study dwellings that were 20 years old or less, but they were found in only about half the dwellings that were over 20 years old. Fuses were employed in the remainder. In addition, none of the dwellings 20 years old or less had knob-and-tube or armored-cable wiring systems, whereas knob-and-tube systems were common in dwellings over 40 years old.

Failure Modes, Components, and System Areas

The study also revealed the frequencies of the various failures found in the 149 fires investigated (see Table 2). Accounting for 21 of these fires are components such as service drops, weather heads, service entrance cables, and distribution panels that convey power from the utility distribution system to the branch circuits.

Ground faults were the most common fire hazard in this area; they tended to be very destructive because the utility company's overcurrent protection, which is intended to protect their power lines, switches, and transformers rather than the residential wiring, was the only protection present. Problems such as friction wear of cable by aluminum siding, loosening of aluminum conductor connections at a service panel, or gradual deterioration of a cable were not detected until they caused a ground fault.

Although not identified as such in Table 2, many failures in other components were caused, in part, by the misuse of service panels. About one-third of the residences in this study still used the older-type, Edison-base plug fuses. Many were overfused, a situation that was possible because all Edison-base fuses fit in the same socket, regardless of current rating. If newer S-type fuse sockets had been used, only fuses of appropriate ampere rating would have fit.

Associated with 50 of the investigated fires, the branch-circuit wiring connects the receptacle outlets, switches, lighting fixtures, and directly wired appliances to the branch-circuit fuses and/or the circuit breakers. In many of the older homes involved in these fires, two or three different kinds of wiring were found. The oldest was knob-and-tube wiring, which was rated to carry 25 amperes in size 14 AWG copper wire. Later, non-metallic sheathed (NM) and armored (BX) cable came into use, both for new construction and for extending electrical systems originally constructed with knob-and-tube wiring.

Because NM and BX cable incorporate two active conductors while knob-and-tube wiring is installed as individual wires, NM and BX are rated to carry only 15 amperes in size 14 AWG copper conductors. The two conductors are located beside one another for their entire length, so two-conductor cable cannot dissipate as much heat as two separate insulated conductors under the same conditions. In some residences, this led to inadequate protection of the NM and BX cable connected to the knob-and-tube wiring because the old 25-ampere fuses were left in service.

Even worse, because these older fuse panels were fitted with Edison-base fuse sockets, even higher ampere rating fuses could be, and were, installed when system overloads caused frequent fuse failures. The ampere ratings of all of these branch-circuit conductors were determined in free air, so that an unanticipated stress was placed upon existing wiring if it were covered later by insulation. In two fires, pennies had been placed under fuses, thereby removing all overcurrent protection.

Careless installation of NM cable contributed to some fires. Overdriven staples or misplaced hammer blows caused high resistance "short circuits" between the cable conductors, which, in turn, caused localized overheating of the cable and deterioration of the insulation. Inadequate connections between parts of the system caused other overheating problems, and overloading the cable or encapsulating it in thermal insulation later caused final failure. In other fires, the connection between the neutral wire and the earth-ground was inadvertently opened so that substantial currents were conducted through the armored, or BX, cable to other household equipment that was independently grounded. The resultant overheating of the BX cable's armor ignited combustible materials that were in contact with the armor.

Fires Related to Receptacle Outlets

Twenty-six of the 29 investigated fires were attributed to electrical system components associated with receptacle outlets. Where a cause could be determined, the most frequent problem cited was "loose connection," which was either a loose fit between the outlet contacts or a loosening of the wire connection to the outlet. Both the screw-clamp variety and push-in, back-wired connections were involved.

When a plug-outlet combination overheats, it is often difficult to determine which product was primarily responsible for the failure, particularly if the overheating led to a fire. Mechanical damage or wear can reduce outlet contact pressure to the point where glowing or arcing will produce severe overheating. Overheating or mechanical damage to outlet components composed of insulating materials can facilitate arcing or arc-tracking, the erosion of electrical insulation by electrical arcing.[3] Several fire reports attributed the poor connections to the properties of aluminum wiring, which tends to loosen because of the differing thermal and mechanical properties of aluminum and the metals used in outlet contacts.[4] Other reports noted that copper wires were inadequately secured during initial installation so as to cause subsequent deterioration and overheating.

Accounting for another 29 of the investigated fires were cords and plugs, including extension cords and appliance cords, which convey electric power from the receptacle or some other outlet to lights, appliances, and the like. Many reported failures were the direct result of mechanical damage and the indirect result of misuse. Cords were run in moldings and otherwise misapplied in ways that crushed and scuffed the insulation. This resulted in conductor damage, such as broken strands, that reduced the current-carrying capacity of the cord set. As a result, sufficient current flowed to cause severe overheating without reaching a level that would cause the fuse or circuit-breaker to shut off the current.

TABLE 2

Failure Modes Involved in Residential Electrical Distribution System Fires by Component

Component	Number	Percent
Service equipment	21	14%
Ground fault (water-deteriorated insulation)	8	
Mechanical damage or improper installation	4	
Gutter touching bare SE conductors	2	
Loose connection	1	
Equipment overload	1	
Miscellaneous failures at distribution box	5	
Branch-circuit wiring	50	34
Mechanical damage/improper installation	15	
Poor or loose splice	11	
Ground fault	6	
Use of improper wiring in circuit	3	
Knob-and-tube encapsulated	3	
Miscellaneous overload	6	
Failure of twist-on connector	1	
Unknown	5	
Receptacle outlets and switches	29	19
Loose or poor connection	17	
Mechanical damage	3	
Overloaded	1	
Failure of neutral connector	1	
Malfunction of switch	1	
Miscellaneous	2	
Unknown	4	
Cords and plugs	29	19
Mechanical damage/poor splice	10	
Overloaded extension cord	7	
Overloaded plug	2	
Damaged plug	2	
Miscellaneous—plug	3	
Miscellaneous—cord	4	
Unknown	1	
Lighting fixtures and lamps	19	13
Loose or poor connection	7	
Combustibles too close	7	
Overlamped	3	
Switch failure	1	
Other	1	
Transformer	1	*
Improperly installed	1	
Total	149	100%

* Less than 1 percent.

Source: Consumer Product Safety Commission study of 149 investigated fires in the residential electrical distribution system. These fires do not constitute a probability sample.

Many of the fire reports cited "poor splices," some of which should not have been made in the first place. Extension cord receptacles were cut off and the insulation removed from the stranded wires so that they could be wrapped around the solid conductors of knob-and-tube or NM wiring. Some were taped and others were left bare, but they were not soldered or fastened with twist-on connectors.

Of the 19 fires attributed to lighting devices, 12 involved incandescent lights, which inherently generate more heat than fluorescent lights. The most common problem in lighting fixtures and lamps was poor workmanship, as evidenced by loose or otherwise defective connections that caused wires and insulation to overheat. Another contributor to overheated fixture wiring was the addition of thermal insulation in the ceiling or wall where the fixture was mounted. With portable lamps, the most frequently cited cause of fire was "combustibles too close."

Contributing Factors

Once the equipment and failure characteristics were identified, it was still necessary to determine how these fires occurred and how they might have been prevented. An in-depth review of the fire reports revealed a number of contributing factors, which are shown in Table 3, along with the ages of the dwellings.

Among these factors was improper alteration, a contributor to 37 percent of the fires. Improper alterations are adverse changes made to the electrical system or to other elements of a residence after its initial construction. Improper initial installation contributed to 20 percent of the fires. This factor is defined as the failure of an improperly executed installation. Deterioration due to aging contributed to another 17 percent, fires that began when a component failed with the passage of time. In some cases, other factors such as overheating, moisture, or ultraviolet radiation contributed to the deterioration.

Improper use was a contributing factor in 15 percent of the fires investigated, fires that resulted from using equipment in a way other than it was intended to be used. Inadequate electrical capacity contributed to another 15 percent, fires that resulted from subjecting equipment to currents that exceeded its rating. And faulty products contributed to the 11 percent of the fires that involved equipment failure attributable to a defect. These groups represent the predominant causal factors in the 149 fires investigated in the study. Other factors were also present in many of the fires, but they were considered to be less important than these six categories. Multiple factors considered to be of equal importance were involved in 31 of the investigated fires.

Older inadequate electrical systems were common to several of these groups of fires. Some consumers tried to modify their systems in a manner that resulted in fires; these improper changes contributed to 55 fires. Others chose to use extension cords to extend their systems without increasing the systems' capacities; such improper use of equipment contributed to 23 fires. Some consumers overloaded their systems by placing increased demands upon them; inadequate capacity contributed to 22 fires. Still others merely continued to use systems that had deteriorated to the point that they could not safely handle their rated loads; deterioration due to aging contributed to 25 fires. As a combined group, these accounted for 125 of the 181 factors cited, or 103 of the 149 fires. Approximately one-half of the 103 dwellings were over 40 years old, and about two-thirds were over 30 years old. Let's take a closer look at each of these contributing factors.

Improper Alterations

Improper alterations, the factor most frequently identified in these fire reports, consisted principally of wiring system changes that led to a fire hazard. In most cases, the work seems to have been performed without observing *National Electrical Code® (NEC)* requirements. There were instances in which non-electrical changes, such as adding thermal insulation or aluminum siding close to the service cables, eventually resulted in a fire hazard. In general, though, fires caused by improper alterations originated from overextension of the original electrical system, "do-it-yourself" electrical installation, non-observance of the *NEC*, and faulty connections.

There are several examples of fires in which improper alterations were the major contributing factor. On June 30, 1984, for instance, an electrical fire damaged the second floor and attic of a 50-year-old frame house. The fire began in a clos space above a shower stall where a cessed light was encapsulated in cellulos insulation. The fixture overheated wh the light was turned on, and a fire result

In another case, resistance heating arcing started an electrical fire in the ce ing crawl space of a home built in 19 Overheating occurred where a staple h been over-driven and cut through the sulation of an NM cable and where t cable had been spliced into the origin knob-and-tube wiring. These splices we made by wrapping the new conducto around the old without soldering t splices. To make matters worse, t splices were buried in cellulose-fiber sulation so that the heat generated by t over-driven staples and the faulty splic could not be dissipated. The rated c rent—in free air, not covered with ins lation—for the size 14 AWG cable was amperes, but the original 25-ampere fu had been left in place, so that the bran circuit fuse offered little protection.

Improper Initial Installations

Defects in initial installations were t second most-frequently identified cat gory of contributing factors in these fi investigations. In a few instances, th classification was used to designate d fects associated with the major rehabi tation of an electrical system or with oth additions too comprehensive to be co sidered merely "changes." The conditio of improper installation most frequent cited in the investigated fires were po workmanship, defective electrical co nections, and damaged electrical insul tion.

One example of a fire that resulted fro such conditions occurred on May 19, 19 when the basement ceiling of a 2½-sto frame dwelling constructed in 19 caught fire after a junction box that su

TABLE 3

Contributing Factors Involved in Residential Electrical Distribution System Fires by Age of Dwelling

	Total		Age of Dwelling (Years)					
Contributing Factors	Number	Percent	≤10	11–20	21–30	31–40	over 40	Unknown
Improper alterations	55	37%	1	2	9	7	29	7
Improper initial installation	30	20	4	4	8	3	7	4
Deterioration due to aging	25	17	2	3		5	9	6
Improper use	23	15	1	1	2	5	13	1
Inadequate electrical capacity	22	15			4	1	16	1
Faulty product	17	11	2	3	2	1	8	1
Unknown	9	6				2	4	3
Total	149	100%	10	13	25	24	86	23

Note: Frequencies add to more than number of investigations, since multiple factors were coded for 31 cases.
Source: Consumer Product Safety Copmmission study of 149 investigated fires in the residential electrical distribution system in 16 cities. These fires do not constitute a probability sample.

ported a light fixture overheated. Four two-conductor size 14 AWG cables had been improperly spliced together in the box, and the wires had been loosely wrapped together and taped. They had not been soldered, and the installation was probably made before twist-on pressure connectors were available. Over time, the contact between the spliced wires loosened, so that resistance heating or arcing caused overheating. After ignition occurred, a short circuit between the wires caused a 30-ampere fuse to open, but this happened too late to prevent the fire. In any event, the fuse should have been a 15-ampere fuse.

Another home, built in 1963, was equipped with a panel board containing circuit breakers mounted on an exterior wall. In 1985, one of the service entrance cable's ungrounded aluminum conductors broke loose from the terminal that connected it to the distribution bus of the panel board and ignited when the bare end of the service-entrance conductor touched the back panel of the service box. Electrical heating and arcing completely destroyed the terminal for that conductor and partially destroyed the terminal for the other ungrounded conductor. It appears that the conductors had not been properly secured mechanically and electrically to the terminals when the service panel was installed. The service panel was labelled for use with either copper or aluminum conductors.

Deterioration Due to Aging

The deterioration of an electrical system component caused by time or the environment is believed to have been the predominant cause of ignition in many of the investigated fires. Incipient failures hidden in the structure, environmental stresses combined with age, and deterioration exacerbated by sudden stress such as rain, lightning, and other phenomena are all examples of the conditions time and the environment can cause. In almost all the cases studied, failure occurred in such basic materials as electrical insulation or conductive materials.

For example, investigators found that a serious fire in an outside wall of a wooden residence more than 50 years old started when high current was transferred through the size 14 wire that was used as a grounding electrode conductor for the dwelling's telephone system. Current was transferred to this wire through a downspout, which touched a service-entrance conductor through its deteriorated insulation. This conductor was exposed to the weather and had probably been abraded by the motion of the downspout.

On January 15, 1981, another fire occurred in a bedroom of a home when a lamp plug connected to an extension cord ignited. It appears that continued insertion and withdrawal of this plug had gradually weakened the plastic body containing the plug's blades until the plastic failed, permitting contact between the live parts within the plug. This contact resulted in overheating and ignition.

> **Deterioration of electrical wiring caused by time or the environment is a predominant cause of ignition.**

Improper Use

As a category of factors contributing to fires in the electrical distribution system, improper use includes electrical devices or components used outside their ratings or misused in some fashion that results in ignition. The majority of fires in this category involved extension cords and incandescent lights.

Examples of fires caused by improper use include a blaze in a 1930 single-family home at a ceiling light fixture that a resident had installed shortly before the fire. The primary cause of the blaze was the use of 100-watt bulbs, instead of the 60-watt bulbs called for by the rating label. This recessed fixture was also being operated without the insulating shield supplied with the fixture to protect the lamp connections and the structural wood from the heat of the bulbs. Its absence contributed to the fixture's overheating, which ignited the wood ceiling that supported the light.

A single-story home approximately 40 years old was the scene of another fire started by the improper use of an electrical component. This fire began in a bedroom, where an extension cord and a radio power cord were fastened to the wall with nails. The fire investigators concluded that the nails had come in contact with both conductors of the cords so as to form conductive paths that caused overheating at the contact points between the nails and the wires. A shirt that had been hung on the two nails ignited and dropped to the floor in flames, igniting the mattress and bedding.

Inadequate Electrical Capacity

A number of the fires investigated during the study were the result of inadequate electrical capacity, a category that includes a variety of problems and defects caused by too little current-carrying capacity or inadequate distribution of accessible power through the living spaces. Inadequate electrical capacity results in several conditions that contributed to many of the fires in this group. Among these conditions are overfusing, overloading and physical abuse of extension cords permanently installed to distribute power, and the substitution of portable electric heaters for gas heat on an already overloaded system.

An example of a fire caused by ove
fusing occurred in a row house built in th
1920s. The fire started in the attic above
second-floor bedroom when a branch-ci
cuit cable broke down internally betwee
its conductors, overheating and igniti
the ceiling stud. This particular branc
supplied a number of appliances, inclu
ing a 100-watt ceiling light, a clock-radi
a portable television, and a portable ele
tric heater. The fuse panel of this hom
had four 30-ampere fuses, and a coppe
penny was found under one of them. Th
rated capacity of each of the four branc
circuits was only 15 amperes, and fuses
this rating should have been installed.

In another instance, a single-fami
home constructed about 1916 expe
enced a fire that ignited the dining-roo
carpet while the owners were away
vacation. Investigators concluded that
size 18 AWG extension cord that supplie
power to a refrigerator overheated an
ignited the carpet. The cord was plugge
into another extension cord which,
turn, was run through a wall and plugge
into a cube tap in a kitchen outlet. All th
branch circuits of this home were co
nected through fuses rated at least 25 am
peres, although all but one branch wa
size 14 AWG fabric-jacketed rubber cabl
rated 15 amperes. Cube taps and exte
sion cords were used extensively throug
out the rest of the house to extend th
permanent wiring system. This incide
thus involved both an inadequate syste
and improper use of extension cords.

Faulty Products

Fires attributed to faulty products we
generally caused by devices or comp
nents that were defective, either becau
of some inherent characteristic or b
cause of some unique defect in the pa
ticular product involved in the fire. Fa
ures most often associated with defecti
products were overheating of plugs,
ceptacle outlets, and extension cord
ceptacles, as well as failing connectors
appliances.

An example of a fire caused by a faul
product occurred in a two-story fram
house that was about 23 years old. The fi
began in the basement in a faulty elect
cal service panel. Defective factory-mad
connections to the service panel bus ba
resulted in overheating damage to th
holder for the dryer fuse, and this ove
heating damaged the panel insulatio
Over time, the damage resulted in ele
trical arcing between the bus bars, whic
eventually started the fire in the servic
cabinet.

(Continued on page 69

Wiring Fires

(Continued from page 24)

In another case, the plug of a 12.5-ampere rated electric heater ignited a fire in a two-story frame house. The plug had been replaced twice because overheating had damaged it and the wire insulation, and the replacement plug was rated to [illegible] 15 amperes. The plastic insulation of the plug and the cord ignited and burned, causing arcing across the male plug.

Why Things Reached the State They Did

Many of these electrical distribution system fires were the result of failure to update a dwelling's original electrical system to meet increased electrical demand.

Fires in electrical distribution systems contribute significantly to the US fire problem, accounting for a consistent portion of the problem year after year.

By and large, the fire investigation reports did not include information from the owners or occupants about their reasons for introducing the changes in their wiring systems that eventually caused the fire. However, some reports did indicate that the economic status of the households involved was low, so it is probable that the occupants could not afford a skilled electrician to completely rehabilitate their systems.

It also seems that many consumers underestimated, or were unaware of, the hazards involved in tinkering with their electrical systems. Perhaps the most obvious example is the practice of installing oversized fuses to accommodate the need for increased capacity at the expense of safety. Another common practice illustrating this situation is the long-term use of extension cords to overcome the lack of receptacle outlets where they are needed.

Other consumers took a more active and seemingly more responsible role in addressing their needs and engaged professionals to make the necessary changes. With very few exceptions, however, the electrical modifications that contributed to the fire were performed by untrained personnel who either did not know good electrical wiring practice or chose not to follow it.

In addition, many consumers apparently were not aware that fires can result from "end-of-life" phenomena. While many fires in this study illustrate this condition, most homeowners do not realize that electrical systems have a finite life.

One of the most obvious methods of reducing electrical fires that stem from these situations is better consumer education. Further improvements of voluntary product standards or of the *NEC* as they affect new construction and major renovations may be expected to have little effect on existing installations.

Other electrical fires are believed to have been related to improper installation, either when the dwelling was built or when a major renovation was carried out. These are different from the fires caused by failure to properly update electrical distribution systems in that the installer was presumed to be a professional and should have been expected to know and follow approved electrical practices. In many jurisdictions, however, the required training or qualifications of electrical workers is not regulated or enforced, so that protection is provided only by inspection during and after the performance of the work. In addition, many districts outside major metropolitan areas effectively have no electrical inspection. Increasing electrical inspections could prevent many fires and provide closer surveillance of work performed by "do-it-yourselfers."

In Conclusion

Available data indicate that fires in electrical distribution systems contribute significantly to the fire problem in the United States, accounting for a consistent portion of that problem year after year. These fires are difficult to evaluate adequately, not only because of the complexity of electrical systems but also because of the difficulty in identifying pertinent details once a destructive fire has occurred. Few fire departments have the time available to devote to such investigations.

The investigations included in this study are not a statistically valid sample. Therefore, the possibility for bias in selection must be considered. Even so, it seems reasonable to assume that the causes identified depict some major part of the residential electrical distribution system fire problem, even if it does not depict the whole problem.

We believe there are a number of ways in which the fire protection community can work to prevent such fires. Of course, their efforts will be most effective if they are pursued both locally and in cooperation with national fire organizations.

Some of these possibilities include developing a rehabilitation guide for the electrical system. This would help consumers decide when they need improvements and would provide guidance for having such improvements done by skilled workers in accordance with the *NEC*, even when available funds are limited. One application that might be considered for such a guide would be mandatory electrical inspection of homes in conjunction with a change of ownership so that hazardous deficiencies of the electrical system could be corrected at that time. Involvement of organizations such as the NFPA, IEEE, NEMA, or some other knowledgeable groups could help provide the necessary expertise to develop such a guide.

Another possibility is the development of a campaign to inform consumers that repairs must be made properly and to help them recognize that electrical systems, like other products, have a finite life. Fire departments could play a major role in disseminating this information during their firesafety campaigns.

Finally, the fire protection community should encourage states and other jurisdictions to provide more resources for electrical inspections. Local fire departments again could contribute to this effort by actively informing their local and state governments of the causes and consequences of the fire problem. Moreover, concerns for lower-income households and the costs of these fires to the community should provide local governments with the impetus they need to become involved in this problem. **FJ**

Linda Smith is a Statistician and Dennis McCoskrie is an Electrical Engineer at the US Consumer Product Safety Commission.

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1. Copies of the report *Residential Electrical Distribution Fires,* December 1987, which provided the basis of this article, can be obtained without charge from the National Injury Information Clearinghouse, Directorate for Epidemiology, US CPSC, Washington, DC 20207.

2. John R. Hall, Jr., et al., *Analysis of Electrical Fire Investigations in Ten Cities,* NBSIR 83–2803, US Department of Commerce, National Bureau of Standards (now the National Institute for Standards and Technology), Center for Fire Research, December 1983.

3. Arcing may be caused by moisture or other conductive deposits on the surface of the insulation.

4. Information about the reliable repair of residential aluminum wiring is contained in a pamphlet *Repairing Aluminum Wiring,* obtainable upon request from the Office of Information and Public Affairs, US CPSC, Washington, DC 20207.