

Residential Building Electrical Fires

These short topical reports are designed to explore facets of the U.S. fire problem as depicted through data collected in USFA's National Fire Incident Reporting System (NFIRS). Each topical report briefly addresses the nature of the specific fire or fire-related topic, highlights important findings from the data, and may suggest other resources to consider for further information. Also included are recent examples of fire incidents that demonstrate some of the issues addressed in the report or that put the report topic in context.

Findings

- Annually, an estimated 28,300 residential building electrical fires cause 360 deaths, 1,000 injuries, and \$995 million in direct loss.
- Fifteen percent of residential building electrical fires start in bedrooms.
- Nearly half (47%) of the residential building electrical fires where equipment was involved were caused by the building's wiring.
- Twenty-two percent of residential building electrical fires occur during December and January.

Electricity is a basic part of residential life in the United States. It provides the energy for most powered items in a contemporary home, from lights to heating systems to televisions. Today it is hard to imagine a residence without electricity. It is a part of our homes and our activities that most of us take for granted. We rarely think how powerful electricity is.

Yet, using electricity can have dangerous consequences. Electrical fires are pervasive throughout the United States, causing injury, claiming lives, and resulting in large losses of property. Faulty electrical systems cause many fires. Even more electrical fires result from inappropriate wiring installations, overloaded circuits, and extension cords. Based on the latest available data for 2003 to 2005, an estimated 28,300 residential building electrical fires occur annually and cause 360 deaths, 1,000 injuries, and losses of \$995 million.^{1,2,3} Electrical fires accounted for 7% of all residential building fires in this 3-year period.

Fire Rates Attributed to Residential Electrical Building Fires

Electrical fires in residential buildings result in more damage and higher death rates per 1,000 fires on average than nonelectrical residential fires (Table 1). Dollar loss per fire for residential building electrical fires is more than double

that for nonelectrical residential building fires; deaths per 1,000 fires is about 70% higher for residential building electrical fires. The injury rates resulting from residential building electrical and nonelectrical fires, however, are roughly the same, at 28 to 29 injuries per 1,000 fires.

Table 1. Loss Measures for Residential Building Electrical Fires (3-year average, 2003-2005).

Loss Measure	Residential Building Electrical Fires	All Nonelectrical Residential Building Fire Causes
Loss per fire	\$25,126	\$10,635
Injuries per 1,000 fires	28.5	28.2
Deaths per 1,000 fires	6.3	3.7

Source: NFIRS 5.0

Note: Loss per fire is computed only for those fires where loss and cause information was available.

The Electrical Fire Problem

Despite their prevalence, electrical fires are not always noted as such. When fire is severe, it can be difficult, for example, to discern whether an electric appliance started the fire or if a poorly wired plug was the cause. Heat-producing electrical equipment (e.g., hair dryers, portable heaters, cooking

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appliances, and the like) tend to use more power than other electrical equipment. Devices like these may overload a circuit, especially one that is already reaching its maximum amperage allowance. Coupled with a faulty circuit breaker, this overload can cause the products to overheat and possibly to catch fire. Moreover, electrical fires that start in walls can smolder for some time. By the time the fire is detected, most likely it already has spread within the walls, unseen. There are over three times more residential building electrical fires than nonresidential building electrical fires, so the problem is particularly important for each of us in our homes.

Electrical fires can be particularly tricky to put out. Since they involve electricity, and water conducts electricity, using water to put out the fire can cause electrocution. Chemical powders can cause the fire to smolder rather than extinguish, setting the stage to reignite. Turning power off to the residence is an important step, if it is possible to do so.

While new construction is not immune from electrical fires caused by faulty wiring, there are many older homes with outdated wiring that is deteriorating, inappropriately amended, or insufficient for the electrical loads of a typical household in the 21st Century.

According to Underwriters Laboratories (UL), over 30 million homes—more than one-third of all U.S. housing—are more than 50 years old.⁴ Consider the expansion in the number of appliances used by residents in the past half-century, and it is quickly obvious that overloaded wiring and circuitry is likely in these structures. Overloading will heat up wiring that already could be deteriorating, crumbling, and no longer a good insulator.

Just how big this problem is remains to be seen. The Residential Electrical System Aging Research project was launched by the Fire Protection Research Foundation to study how the age of wiring, outlets, junctions, and other connectors affects the pattern of electrical fires in homes.^{5,6} One objective of the study is to make improvements to the National Electrical Code® (NEC) (National Fire Protection Association (NFPA) 70) and through the building codes adopted by local and State jurisdictions around the country. Already, changes in wiring practices dictated by better electrical codes and the required use of smoke alarms have made new construction safer.⁷

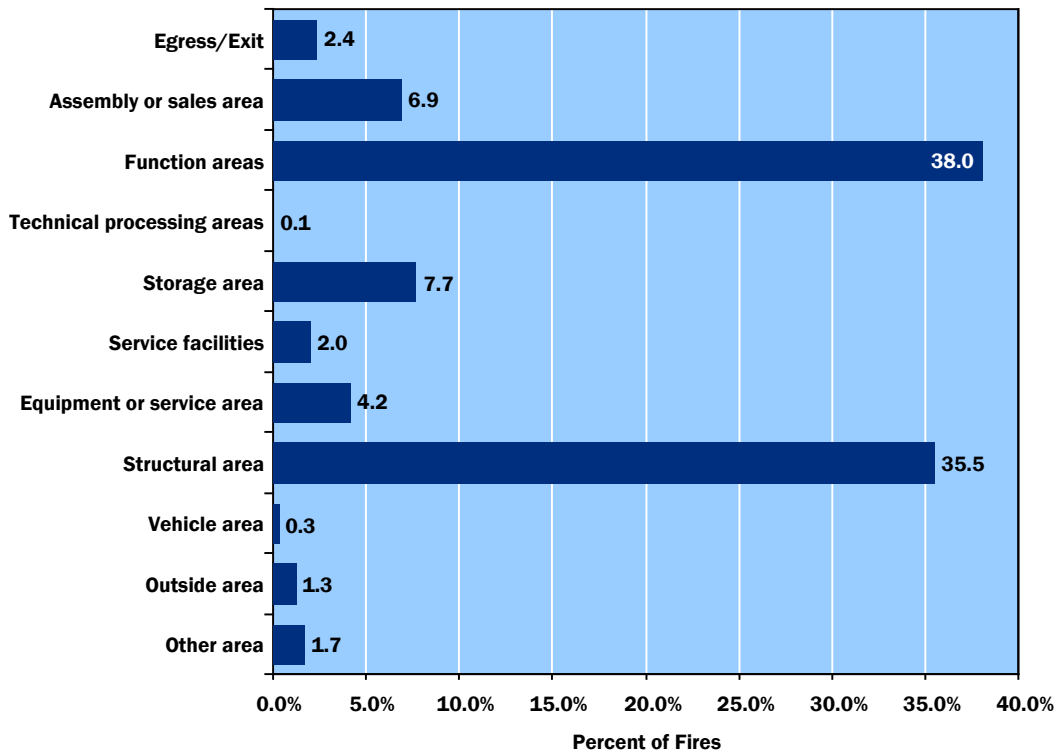
Residents demand higher levels of electrical energy to power their homes and appliances than they did in the past, and new homes are built to meet this demand for multiple televisions, phones, hairdryers, microwaves, washers and dryers, etc. As the consumers' electrical demands increase, so does their expectation that their homes will supply adequate power to meet these. They meet their needs by adding more circuitry (and circuit breakers in blank spots on the breaker panel, or even another circuit breaker box) and outlets to accommodate their purchases. If an outlet is added to an existing circuit, then the load easily can be more than the wiring originally was designed to conduct—perhaps decades ago.⁸

What these consumers really do is create unseen hazards in their homes. Inside the walls, wiring is heating and damaging its own insulation, wood frames are being charred by high-wattage light bulbs too close to ceilings, and fixture wattage ratings are being exceeded. But as long as the lights come on and the appliances start, the consumer remains unaware of the danger—until a fire starts.⁹

Where Residential Building Electrical Fires Occur

The functional and structural areas of the home are the most likely to experience electrical fires (Figure 1). Included in the functional category are bedrooms, dining rooms, kitchens, bathrooms, laundry areas, and the like. Fifteen percent of residential building electrical fires start in a bedroom (Table 2). The bedroom also is the leading area of fire origin for fires with injuries and dollar loss—bedrooms account for 30% of residential building electrical fires that result in injuries and 16% of residential building electrical fires that result in dollar loss. Structural areas of the home include areas such as crawl spaces, attics, walls, porches, and roofs. Attics, the second leading area of fire origin, account for 11% of residential building electrical fires. Over a quarter of all residential electrical fires start in these two areas. While fewer residential electrical fires start in lounge areas (family rooms, living rooms, and the like), these fires result in nearly a third of the deaths (31%).

Figure 1. General Area of Fire Origin in Residential Building Electrical Fires, 2003–2005.



Source: NFIRS 5.0
 Note: Percentages may not equal 100 due to rounding.

Table 2. Leading Area of Fire Origin in Residential Building Electrical Fires, 2003–2005 (fire-based).

Area of Fire Origin	Fires	Fires with...		
		Deaths	Injuries	Dollar Loss
Bedroom for fewer than 5 people	15.1%	16.6%	29.6%	16.0%
Attic: vacant, crawl space above top story	11.3%	—	—	11.6%
Cooking area, kitchen	9.4%	6.4%	6.2%	9.0%
Wall assembly, concealed wall space	8.4%	5.7%	5.9%	8.2%
Common room, den, family room, living room, lounge	6.8%	31.2%	13.9%	7.1%
Function areas, other	—	8.3%	6.6%	—

Source: NFIRS 5.0

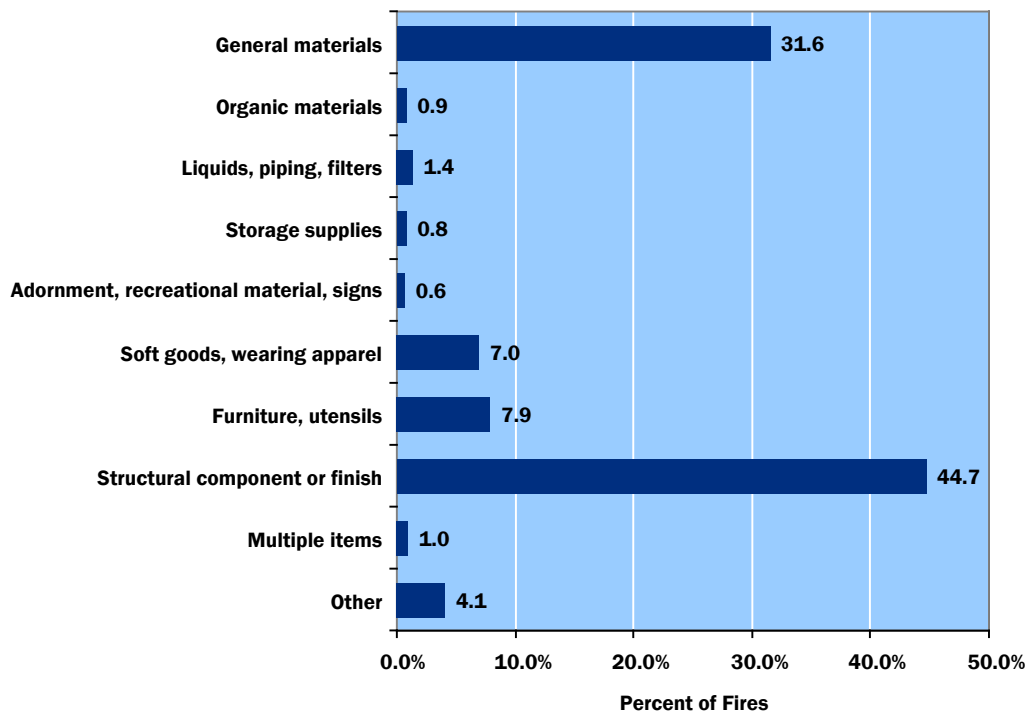
What Ignites

By far, building structural components is the largest category of items first ignited in residential building electrical fires (Figure 2). Structural components include structural member or framing, insulation, trim, wall coverings, flooring, and the like. Of these components, structural framing (usually wood) accounts for 17% of residential electrical fires (Table 3). Insulation and interior and exterior wall coverings (e.g., paneling, wallpaper, siding) account for an additional 18% of residential electrical fires. However, the leading item first ignited in residential electrical fires is the insulation around electrical wires and cables. At 30% of residential electrical fires, it accounts for nearly the entire general materials category.

Together, insulation around electrical wires and structural member/framing account for 38% of all deaths from fires in residential buildings.

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Figure 2. General Items First Ignited in Residential Building Electrical Fires, 2003–2005.



Source: NFIRS 5.0
 Note: Percentages may not equal 100 due to rounding.

Table 3. Leading Items First Ignited, Electrical Fires, 2003–2005.

Item First Ignited	Percent of Fires
Electrical wire, cable insulation	30.2%
Structural member or framing	17.1%
Thermal, acoustical insulation within wall, partition, or floor/ceiling space	7.0%
Interior wall covering excluding drapes, etc.	6.5%
Exterior sidewall covering, surface, finish	4.7%

Source: NFIRS 5.0

When Residential Building Electrical Fires Occur

Heating, lighting, and cooking activities are highest in winter and so, too, are the occurrence of indoor fires stemming from electrical problems. Throughout most of the year, the pattern of residential electrical fires is consistent, but occurrences peak in December and January, accounting for 22% of all such fires (Figure 3). In the winter months, the relative humidity within the walls of a typical home can be very, very low and can turn wood wall framing into

kindling, easily ignited by an arcing current. Fire deaths also are high in these months, but March and October, still dry months, both have similar peaks. Summertime has the lowest incidence of deaths resulting from electrical fires in the home. Figure 4 shows that late afternoon and evening are the most likely time for electrical fires to occur in residences. But it is the hours before dawn, between 3 and 6 in the morning, when deaths are most frequent.

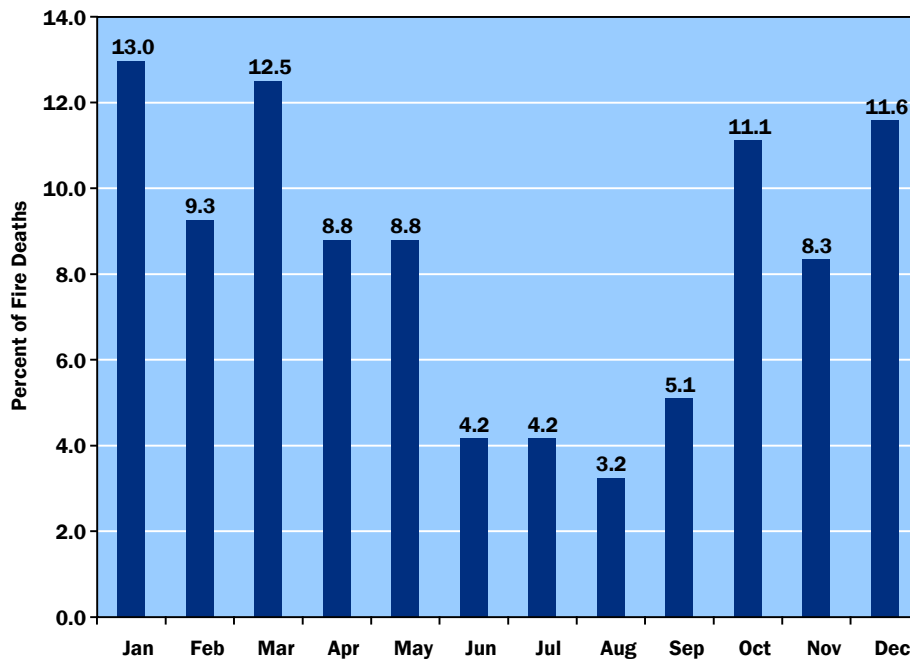
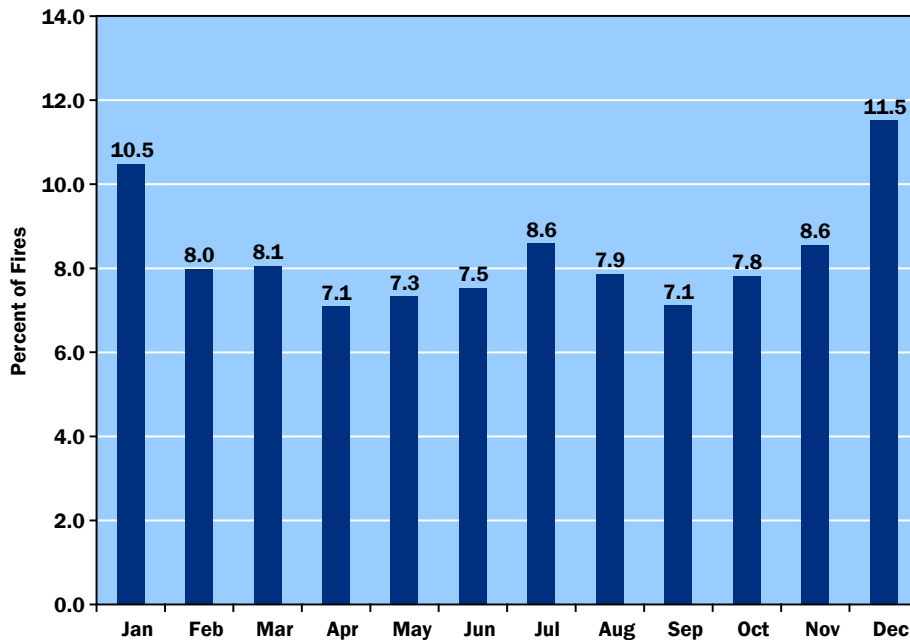
Equipment Involved in Residential Building Electrical Fires

Wiring and electrical components have a life expectancy that does not always equal the life cycle of the building. As the electrical equipment wear out, fires are more probable. Electrical wiring with its various components is by far the major culprit in residential building electrical fires. Lamps and other lighting and cords and plugs also present severe problems (Figure 5).

Fire Spread

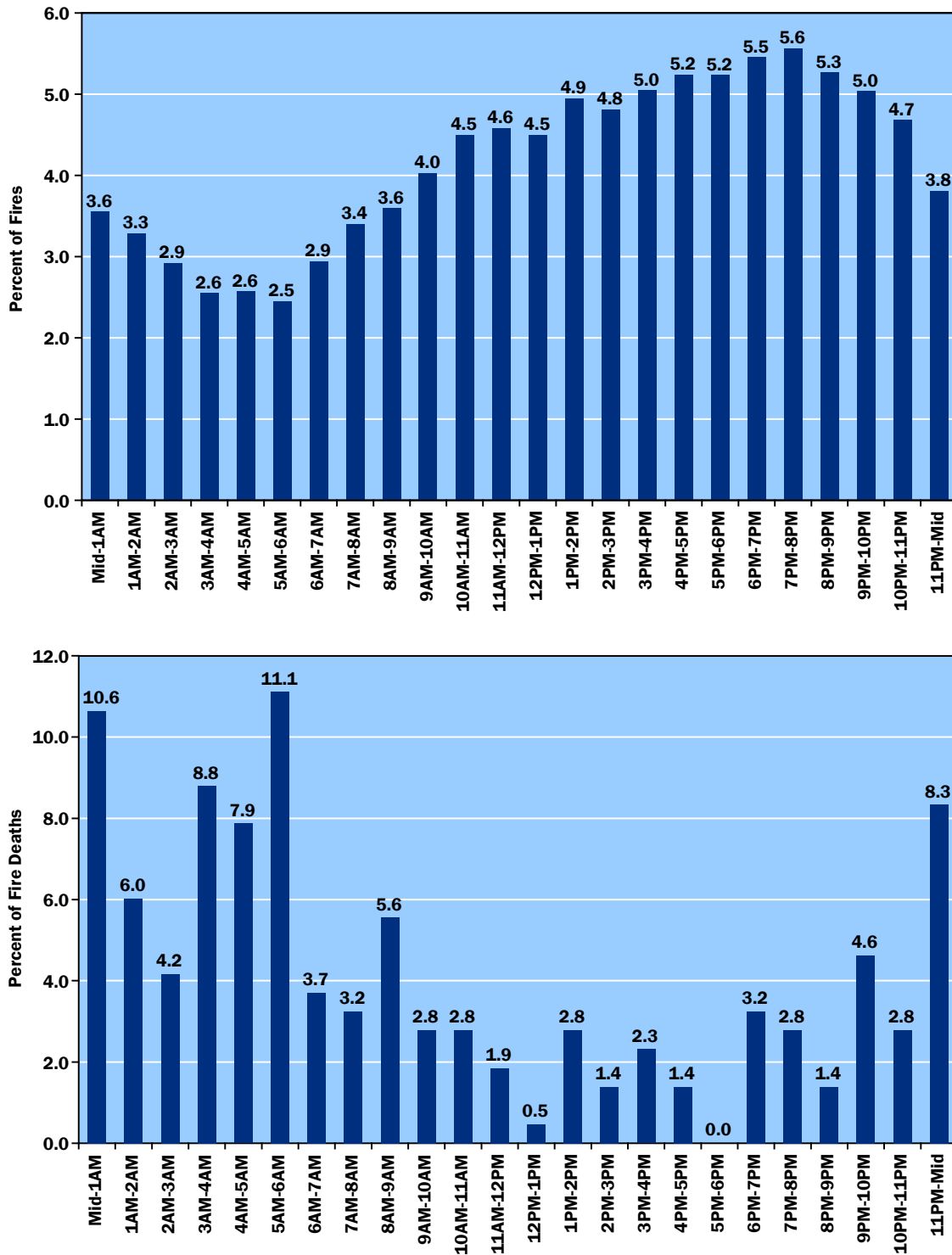
Most residential building fires are confined to the object of origin (62%) with 38% of fires spreading through the residence and beyond (Figure 6). Fire spread from residential building electrical fires, however, has nearly the opposite

Figure 3. Month of Occurrence for Residential Building Electrical Fires and Fire Deaths, 2003–2005.



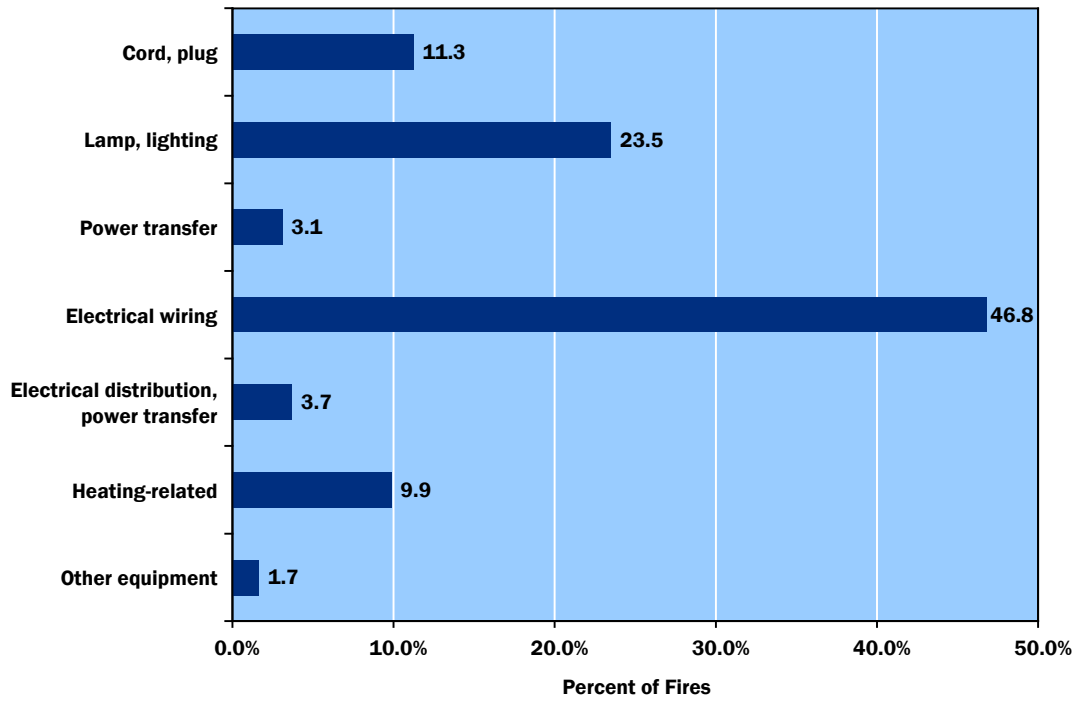
Source: NFIRS 5.0
 Note: Percentages may not equal 100 due to rounding.

Figure 4. Alarm Time for Residential Building Electrical Fires and Fire Deaths, 2003–2005.



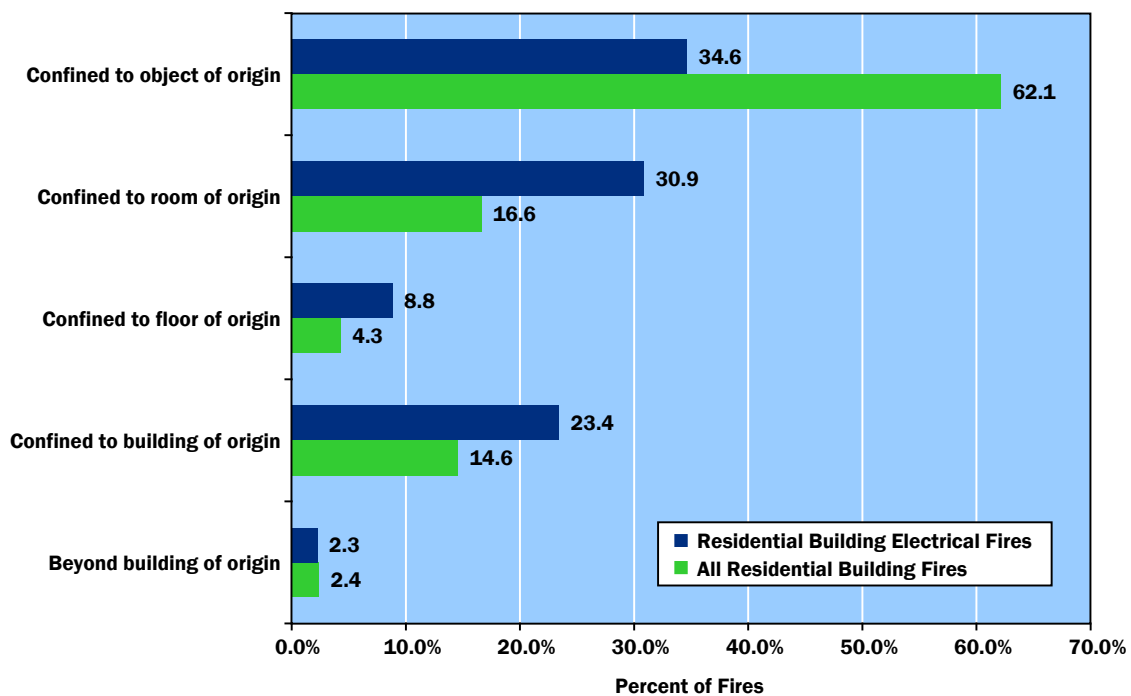
Source: NFIRS 5.0
 Note: Percentages may not equal 100 due to rounding.

Figure 5. General Equipment Involved in Ignition in Residential Building Electrical Fires, 2003–2005.



Source: NFIRS 5.0

Figure 6. Fire Spread in Residential Building Electrical Fires, 2003–2005.



Source: NFIRS 5.0

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profile—these electrical fires are more likely to spread throughout the home. Sixty-five percent of residential building electrical fires spread beyond the initial object that started the fire. Structural members and framing contribute most to flame spread (27%).

Leading Factors Contributing to Residential Building Electrical Fires

Not surprisingly, when a factor was noted as contributing to ignition, some type of electrical failure accounted for 89% of electrical fires in residential buildings. The four leading specific factors, all electrical issues, account for 81% of these electrical failures (Table 4).

Table 4. Leading Factors Contributing to Ignition, Electrical Fires, 2003–2005.

Factor Contributing to Ignition	Percent of Fires
Electrical failure, malfunction, other	35.4%
Unspecified short-circuit arc	26.0%
Short-circuit arc from defective, worn insulation	15.1%
Arc from faulty contact, broken conductor	4.4%
Mechanical failure, malfunction, other	3.8%

Source: NFIRS 5.0

Electrical Safety Devices

Arc Fault Circuit Interrupters (AFCI) or Arc Fault Interrupters (AFI) and Ground Fault Circuit Interrupters (GFCI) or Ground Fault Interrupters (GFI) perform different jobs.¹⁰ A GFCI protects you from electrical shock. An AFCI breaker protects you and your house from a fire caused by electrical arcs.^{11,12}

GFCIs traditionally meet the standard for protecting against electric shock. GFCIs were first implemented as an electrical code requirement in the early 1970s for bathroom outlets. Over time, GFCIs have become required in other areas likely to pose a risk for shock, especially those in potentially wet locations such as kitchens, unfinished basements, garages, outdoors, Jacuzzis, and hot tubs. Although GFCIs are designed to protect people from electrocution, they are not designed to protect against house fires.

AFCIs identify arcing at cords, outlets, and lights and trip breakers before the arcing can start a fire. AFCIs recently

became a requirement for bedrooms in new construction by the NEC in use in many local and State jurisdictions. This technology is better suited for new homes with updated wiring rather than older homes where the grounding for wiring is questionable.

Examples

The following recent examples illustrate typical residential building electrical fire scenarios:

July 2007, Havre, MT: A family lost all of their personal belongings in an electrical fire. The fire, which officials said originated in one of the wall outlets, consumed an 8' x 14' bedroom and its contents. Fire or smoke was not seen although a family member smelled something burning. Bedrooms were checked and, in the corner of one, was a fire. "At first it started small but it went up fast," the young woman observed.¹³

November 2007, Newton, KS: A malfunction in the electric distribution system was determined to be the cause of an apartment complex fire that sent three people to the hospital. The fire originated in an electric box on the outside of the building near the stairwell.¹⁴

December 2007, Salem, OR: Fire blamed on a worn extension cord extensively damaged a house in Salem, OR. Fire investigators noted the fire was caused by an extension cord that had been pinched under the corner of a couch. The investigators expected the house to be a total loss.¹⁵

Conclusion

While the source of an electrical fire can be hard to determine, some known culprits—overloading circuits with heat producing equipment, for example—can lead to items such as the insulation around electrical wires and cables catching fire, either slowly or immediately. With over three times more residential building electrical fires than nonresidential building electrical fires, it is important to ensure that the electrical panels, outlets, switches, and junction boxes in your home are correctly installed and not damaged or modified by unlicensed electricians. Do not use extension cords and multiple plug-in devices as a replacement for new circuits. Since 15% of residential building electrical fires start in a bedroom, upgrade bedrooms with AFIs where possible.

Never use water on suspected electrical fires, and inform your local fire department when you call 9-1-1 that you presume the fire to be electrical.

Notes:

¹ NFIRS 5.0 contains both converted NFIRS 4.1 data and native NFIRS 5.0 data. This topical report includes only native 5.0 data and excludes incident type '110', since it is a 4.1 conversion code.

² National estimates are based on 2003 to 2005 native version 5.0 data from the National Fire Incident Reporting System (NFIRS) and residential structure fire loss estimates from the National Fire Protection Association's (NFPA) annual survey of fire loss. Fires are rounded to the nearest 100, deaths to the nearest 5, injuries to the nearest 25, and loss to nearest \$M.

³ In NFIRS 5.0, a structure is a constructed item of which a building is one type. The term "residential structure" commonly refers to buildings where people live. The definition of a residential structure fire has, therefore, changed to include only those fires where the NFIRS 5.0 structure type is 1 or 2 (enclosed building and fixed portable or mobile structure) with a residential property use. Such fires are referred to as "residential buildings" to distinguish these buildings from other structures on residential properties that may include fences, sheds, and other uninhabitable structures. In addition, incidents that have a residential property use, but do not have a structure type specified are presumed to be buildings.

⁴ "Drawing Wisdom from the Wall," <http://www.ul.com/newsroom/wiring/index.html>

⁵ Ibid.

⁶ Rasdall, Joyce, "Aging Residential Wiring Issues: Concerns for Fatalities, Personal Injuries, and Loss of Property," Education Presentation, Annual Household Equipment Technical Conference, Louisville, KY, Oct. 26-28, 2005, <http://www.esfi.org/educators/documents/AheeAgingResidentialWiringIssues5-05.pdf>

⁷ Ibid.

⁸ Ibid.

⁹ "Drawing Wisdom from the Wall," <http://www.ul.com/newsroom/wiring/index.html>

¹⁰ AFCIs also are known as Arc Fault Interrupters (AFI). GFCIs also are known as Ground Fault Interrupters (GFI).

¹¹ Consumer Product Safety Commission, GFCI Fact Sheet, <http://www.cpsc.gov/cpscpub/pubs/99.html>

¹² Consumer Product Safety Commission, AFCI Fact Sheet, <http://www.cpsc.gov/CPSCPUB/PUBS/afcifac8.PDF>

¹³ "Electrical fire consumes family belongings," Elizabeth Doney, *Havre Daily News*, (Havre, MT), http://www.havredailynews.com/articles/2007/08/07/local_headlines/local.txt

¹⁴ "Accident ruled cause of Nov. 18 blaze," *The Kansan*, http://www.thekansan.com/stories/112707/topstories_112707008.shtml

¹⁵ "Extension cord blamed for fire," *Statesman Journal* (Salem, OR), <http://www.statesmanjournal.com/apps/pbcs.dll/article?AID=/20071213/NEWS/712130324>