



RESEARCH

A photograph showing a white wall outlet on a green wall. A black power cord is plugged into the outlet, and bright orange and yellow flames are erupting from the outlet. The background is dark and blurry, suggesting a fire scene.

Home Fires Caused by Electrical Failure or Malfunction

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Key Findings

- Local fire departments responded to an estimated average of 46,700 home fires involving electrical failure or malfunction each year in 2015–2019.
- Home fires involving electrical failure or malfunction caused an estimated average of 390 civilian deaths and 1,330 civilian injuries each year in 2015–2019, as well as an estimated \$1.5 billion in direct property damage per year.
- Electrical distribution, lighting, and power transfer equipment accounted for half (49%) of home fires involving electrical failure or malfunction, followed by cooking equipment (15%), heating equipment (9%), fans (6%), air conditioners (3%), and clothes dryers (3%).
- Three in ten fires (30%) involving electrical failure or malfunction occurred in the cold weather months from November through February.
- Fires involving electrical failure or malfunction were less likely to occur in the overnight hours between midnight and 8 a.m. (22% of total), but fires during this period accounted for over half (54%) of the civilian deaths.

Home Fires Involving Electrical Failure or Malfunction

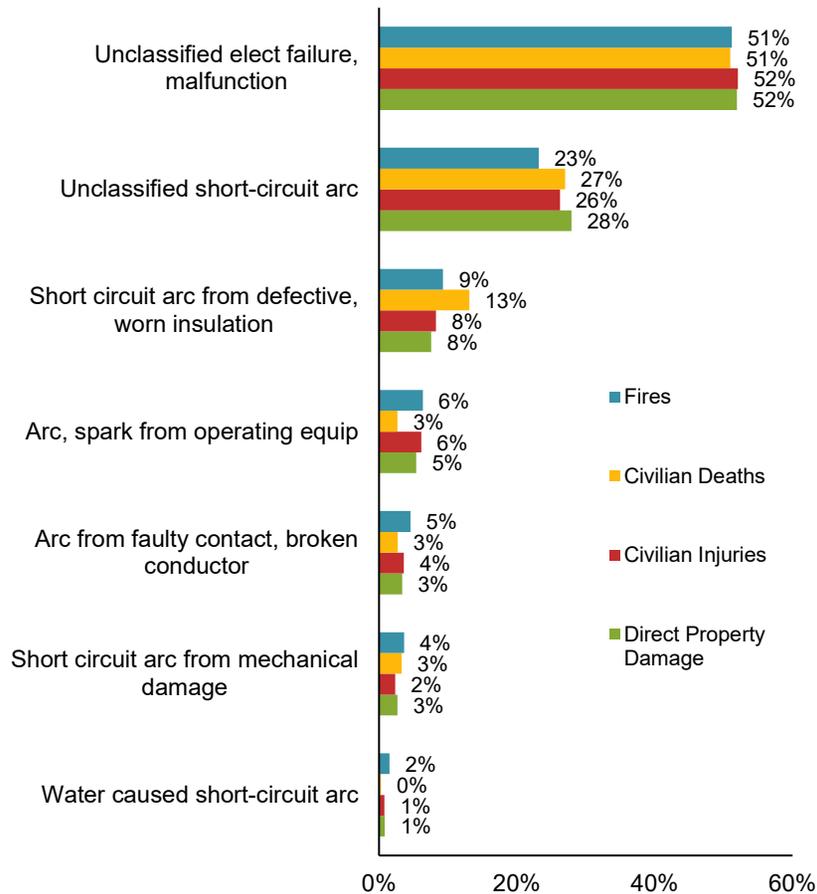
Electrical failures or malfunctions were responsible for 13 percent of US home structure fires in 2015–2019. These fires also accounted for 15 percent of civilian deaths, 12 percent of civilian injuries, and accounted for the greatest share of direct property damage (21%) over this period.

Types of Electrical Failure or Malfunction Contributing to Home Fires

As shown in Figure 1, home fires due to electrical failure or malfunction primarily involve some form of arcing, which results from an unintentional discharge of electrical current between conductors. Given sufficient time and level of current, arc faults can produce enough heat to ignite a fire. Arc faults can be produced by worn out receptacle contacts, damaged conductors and connectors, frayed appliance cords, loose connections in junction boxes or on electrical devices, as well as from faulty switches and receptacles. Arc faults may originate in different areas of home or virtually any electrical fixture or equipment.

- Short circuits from defective and worn insulation caused 14% of civilian home fire deaths as shown in Figure 2. This can be caused when cords are pinched by doors or furniture or through repetitive flexing of appliance cords. It can also be due to damaged wiring inside walls from nails, screws, or drill bits that puncture insulation during ordinary activities like hanging a picture. Even electrical cords running under carpets can generate enough heat to produce an arc fault.
- Aging electrical systems in older homes can be a source of arc faults, either through normal wear and tear or because the systems cannot accommodate the greater demands of modern appliances. Circuits can also be overloaded by providing electricity to too many appliances, often through power cords.

Figure 1. Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, 2015–2019



Electrical wiring causes house fire that kills elderly resident

An elderly resident died when degraded electrical wiring ignited combustible material in a wall cavity in the kitchen of his residence.

The fire department was summoned to the scene following a neighbor’s call to 911 at 1:15 a.m., but investigators estimated that the fire had burned for an hour before it was detected.

According to news reports, firefighters found flames shooting from the rear of the house upon arrival, but they located the victim on a couch in a front room and quickly rushed him to the hospital. The victim, who had a mobility disability, succumbed to smoke inhalation injuries shortly afterwards.

Reports indicated that the resident had an unspecified physical disability.

The house was equipped with smoke alarms in the living room, bedroom, and on the second floor, and the engine company indicated that they were activated by the fire. It did not have sprinkler protection.

The house was a two-story building with brick walls, a wooden roof frame, and an asphalt roof deck. It occupied a ground floor area of 700 square feet (65 square meters).

The house, valued at \$80,000, and its contents, with an estimated value of \$50,000, were a total loss.

Source: Richard Campbell, “Firewatch,” *NFPA Journal*, January/February 2017.

Trends in home fires involving electrical failure or malfunction

The number of home fires involving electrical failure or malfunction has followed a distinct downward trend since 1980, despite year-to-year fluctuations. From a peak of 75,000 fires in 1980, the estimated number of fires involving electrical failure or malfunction has fallen to fewer than 60,000 annual fires since 1998 and 50,000 or less each year since 2008. The 40,900 fires in 2012 represent a new low point (Figure 2).

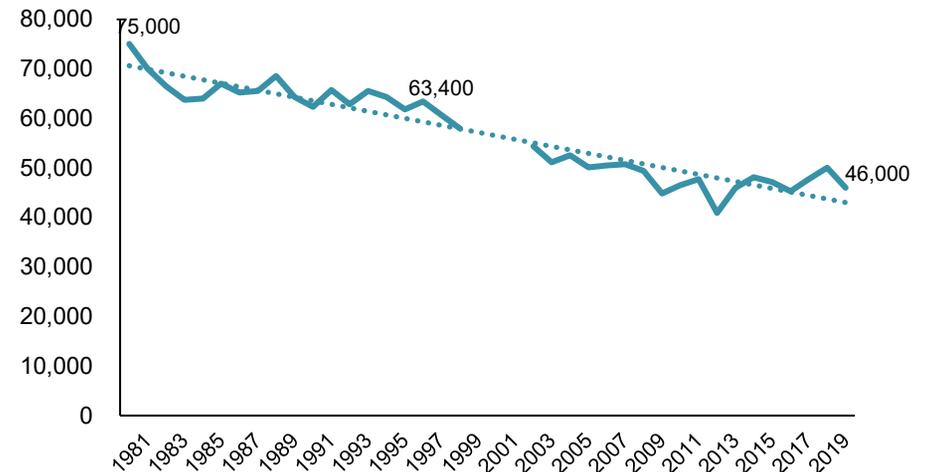
When do home fires involving electrical failure or malfunction occur?

Home fires involving electrical failure or malfunction are less likely to occur in the overnight hours between midnight and 8 a.m. (22% of total), but these fires account for over half (54%) of the civilian deaths, as shown in Figure 3 below. Fires that occur during the night when most people are asleep are more likely to be fatal. Working smoke alarms can provide an early warning of fire and allow additional time for evacuation.

Home fires involving electrical failure or malfunction were most likely to occur in cold weather months of January, February, and December, which accounted for three in ten fires (30%). It is likely that home fires are more prevalent in winter months due to the increased use of space heaters and blankets, or flammable objects being left against electrical baseboard heating units. Greater use of electrical stoves or ranges or the use of holiday lighting on already taxed electrical circuits could also play a role.

The fewest fires involving electrical failure of malfunction occurred in the three-month period from August, September, and October, which accounted for approximately one-fifth (21%) of the annual total. See Figure 4.

Figure 2. Home Fires Involving Electrical Failure or Malfunction by Year, 1980–2019



Note: Because of low participation in NFIRS Version 5.0 during 1999–2001, data from these years is not shown.

Figure 3. Home Fires Involving Electrical Failure or Malfunction by Time of Day, 2015–2019

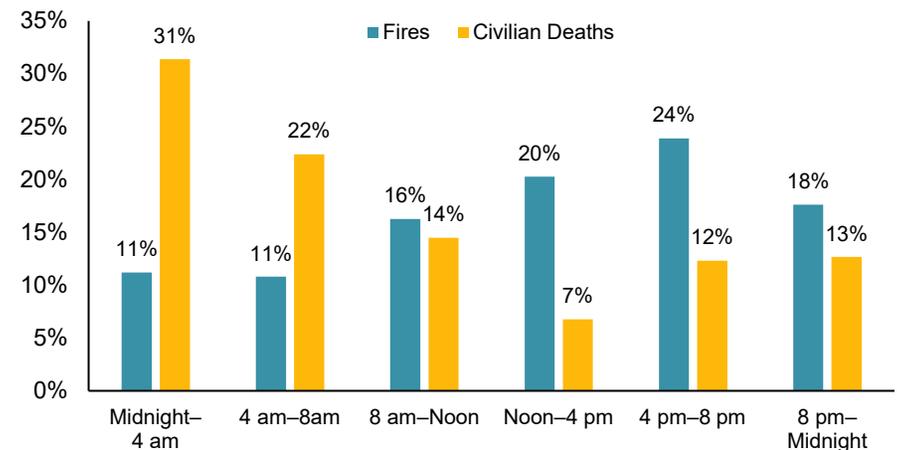
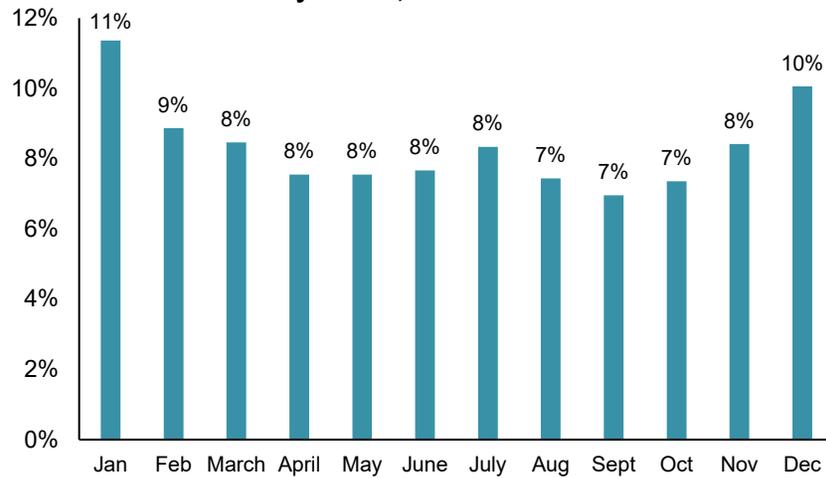


Figure 4. Home Fires Involving Electrical Failure or Malfunction by Month, 2015–2019

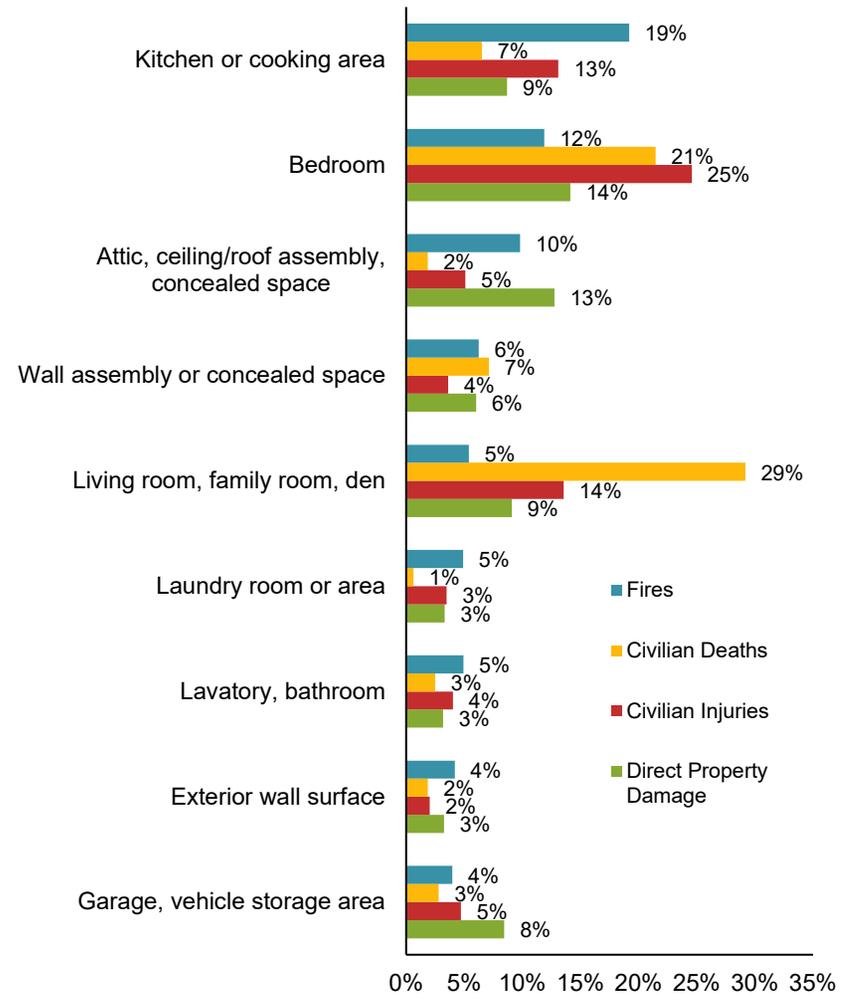


Area of origin for home fires involving electrical failure or malfunction

One in five home fires (19%) involving electrical failure or malfunction originated in a kitchen or cooking area, with another 12% originating in a bedroom and 10% originating in an attic or ceiling/roof assembly or concealed space. Electrical failures or malfunctions within the wall assembly or concealed space is the fourth leading area of origin for these fires.

Fires originating in a living room, family room, or den accounted for a disproportionately large share of civilian deaths, with five percent of fires and nearly three in ten deaths (29%), as well as fourteen percent of injuries. Fires originating in a bedroom also accounted for disproportionately large shares of civilian deaths (21%) and injuries (25%).

Figure 5. Home Fires Involving Electrical Failure or Malfunction by Area of Origin*, 2015–2019

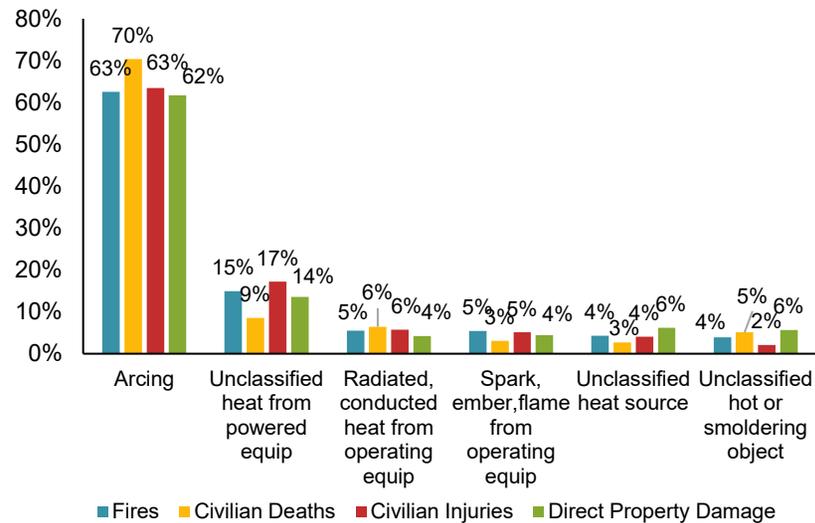


*Only leading areas of origin shown.

Heat source in home fires involving electrical failure or malfunction

Arcing served as the heat source in over three in five fires (63%) of home fires involving an electrical failure or malfunction in 2015–2019. Unclassified heat from powered equipment served as the heat source for another 15 percent of fires, followed by radiated or conducted heat from operating equipment, a spark ember of flame from operating equipment, unclassified heat sources, and unclassified hot or smoldering objects, as shown in Figure 6.

Figure 6. Home Fires Involving Electrical Failure or Malfunction by Heat Source*, 2015–2019



*Only leading heat sources shown.

Equipment involved in the ignition of home fires involving electrical failure or malfunction

Home fires caused by electrical failure or malfunction can start in wiring, electrical distribution systems and lighting equipment, and any equipment powered by electricity, including household appliances and electronics.

Figure 7 shows the types of equipment most often involved in home fires in 2015–2019. As indicated, electrical distribution and lighting equipment accounts for nearly half of these fires (49%), and these fires were responsible for two-thirds of the deaths, just over half of injuries, and most of the direct property damage. Cooking equipment was the second leading type of equipment involved in home fires caused by electrical failure or malfunction, with 15 percent of fires and almost one in ten injuries (9%). Heating equipment, fans, air conditioners, and clothes dryers were involved in smaller shares of fires.

Item first ignited in home fires involving electrical failure or malfunction

Electrical wire or cable insulation was the item first ignited in one-third (33%) of home fires involving an electrical failure or malfunction in 2015–2019, with appliance housing or casing serving as the item first ignited in another 9 percent of fires (Figure 8). The second most common item first ignited by electrical failures or malfunctions was a structural member or framing, accounting for 13 percent of the total and unclassified structural components or finishes accounted for 4 percent of fires. Insulation within structural areas was ignited in 5 percent of fires caused by electrical failure or malfunction. Interior wall coverings were ignited in 5 percent of the fires and exterior wall coverings in another 4 percent of fires.

Figure 7. Home Fires Involving Electrical Failure or Malfunction by Equipment Involved in Ignition, 2015-2019

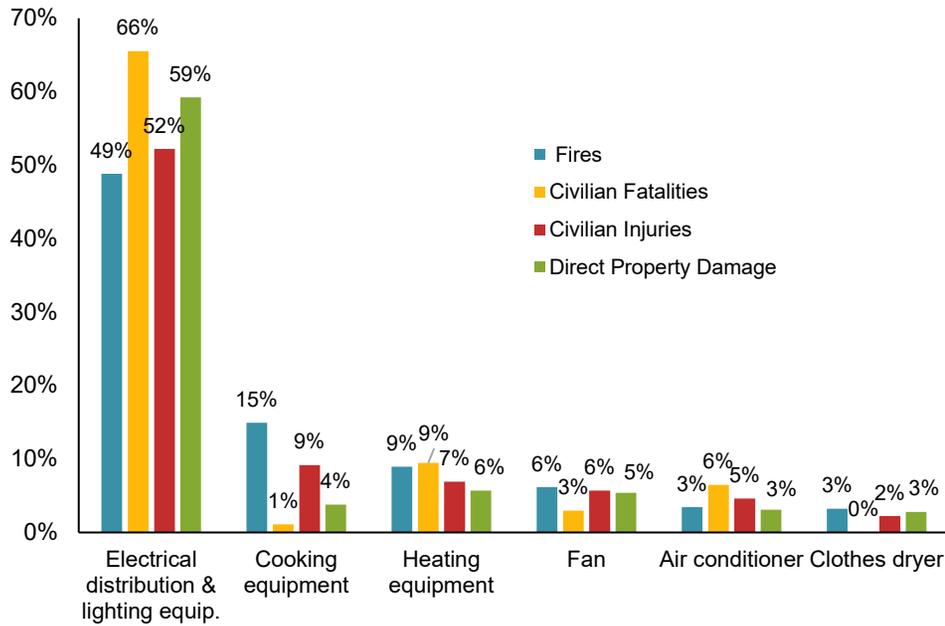
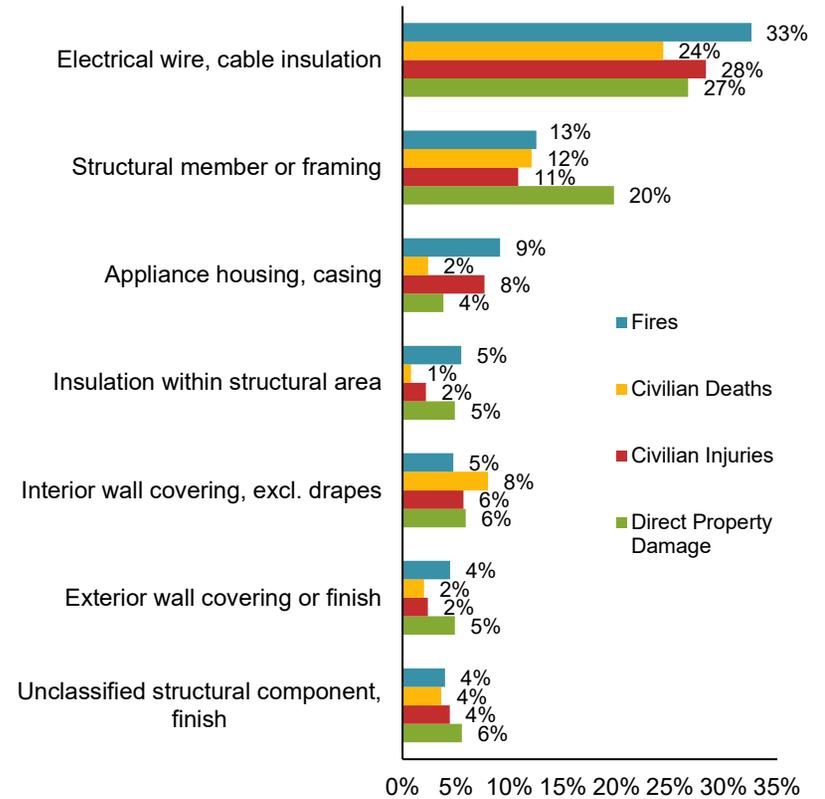


Figure 8. Home Fires Involving Electrical Failure or Malfunction by Item First Ignited, 2015-2019



Methodology

The statistics in this analysis are estimates derived from the U.S. Fire Administration’s (USFA’s) [National Fire Incident Reporting System \(NFIRS\)](#) and the National Fire Protection Association’s (NFPA’s) annual survey of U.S. fire departments. Fires reported to federal, or state fire departments or industrial fire brigades are not included in these estimates. Only civilian (non-firefighter) casualties are discussed in this analysis.

NFPA’s fire department experience survey provides estimates of the big picture. NFIRS is a voluntary system through which participating fire departments report detailed factors about the fires to which they respond. To compensate for fires reported to local fire departments but not captured in NFIRS, scaling ratios are calculated and then applied to the NFIRS database using the formula below.

$$\frac{\text{NFPA's fire experience survey projections}}{\text{NFIRS totals}}$$

The NFIRS data element of Factors Contributing to Ignition was used to identify and estimate electrical failures or malfunctions. In this field, the code “none” is treated as an unknown and allocated proportionally. Multiple entries are allowed in this field. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Any fire in which no factor contributing to ignition was entered was treated as unknown.

Entries in the “electrical failure, malfunction” category (factor contributing to ignition 30–39) were grouped together in this analysis. This category includes:

31. Water-caused short circuit arc
32. Short-circuit arc from mechanical damage
33. Short-circuit arc from defective or worn insulation
34. Unspecified short circuit arc
35. Arc from faulty contact or broken connector, including broken power lines and loose connections
36. Arc or spark from operating equipment, switch, or electric fence
37. Fluorescent light ballast
30. Electrical failure or malfunction, other

NFIRS data element Equipment Involved in Ignition (EII) codes 200–263 were used to identify and estimate electrical distribution and lighting equipment as identified by NFIRS.

NFPA noticed that many fires in which EII was coded as None (NNN) have had other causal factors that indicated equipment was a factor or were completely unknown. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40–99 as an additional unknown.

To allocate unknown data for EII, known data is multiplied by

$$\frac{\text{All fires}}{(\text{All fires} - \text{blank} - \text{undetermined} - [\text{fires in which EII = NNN and heat source } \leq 40-99])}$$

In addition, fires and losses associated with code EII 200, “electrical distribution, lighting, and power transfer, other,” were allocated proportionally across specific electrical distribution and lighting codes, EII codes, 211–263. Equipment that is totally unclassified (EII code 000) was not allocated further.

For more information on the methodology used for this report see, [How NFPA’s National Estimates Are Calculated for Home Structure Fires](#).

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities that participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

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