

HOME FIRES INVOLVING HEATING EQUIPMENT
CHIMNEY AND CHIMNEY CONNECTORS

John R. Hall, Jr.
January 2009



National Fire Protection Association
Fire Analysis and Research Division

Abstract

In 2006, heating equipment was involved in an estimated 64,100 reported home structure fires, 540 civilian deaths, 1,400 civilian injuries, and \$943 million in direct property damage.

In 2006, most home heating fire deaths (73%) and, injuries (43%) and half (51%) of associated direct property damage involved stationary or portable space heaters.

Space heating poses a much higher risk of fire, death, injury, and loss per million users than central heating. Comparisons of risk among different types of space heaters or different types of central heating show no clear, consistent, significant differences.

Keywords: Heating, space heater, water heater, furnace, wood stove, heat tape, fireplace, creosote, chimney, fire statistics, home fires, residential fires.

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities who 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.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

For more information about the National Fire Protection Association, visit www.nfpa.org or call 617-770-3000. To learn more about the One-Stop Data Shop go to www.nfpa.org/osds or call 617-984-7443.

Copies of this analysis are available from:
National Fire Protection Association
One-Stop Data Shop
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org
e-mail: osds@nfpa.org
phone: 617-984-7443

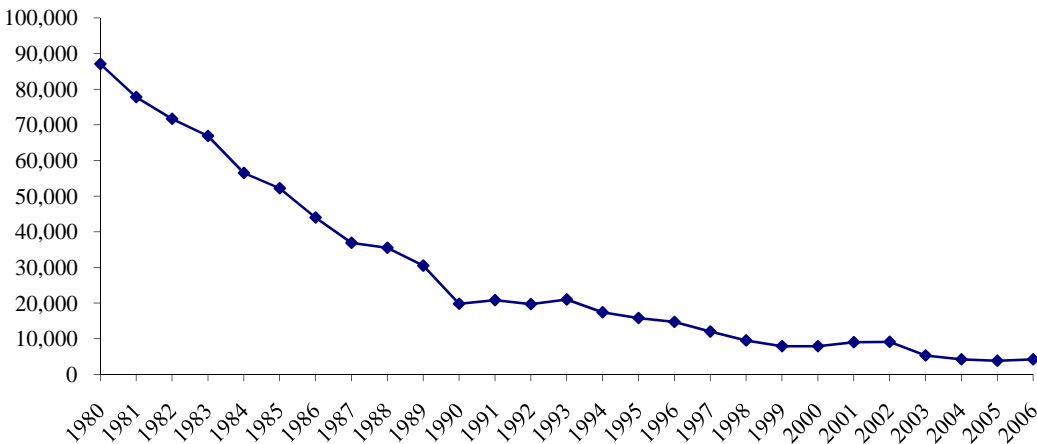
NFPA No. USS09P
Copyright © 2008, National Fire Protection Association, Quincy, MA

Chimney and Chimney Connectors

In 2006, an estimated 4,200 reported home structure fires involving chimneys or chimney connectors resulted in 10 civilian injuries (to the nearest ten) and \$54 million in direct property damage.

Civilian deaths rounded to zero to the nearest ten in 2006, but averaged 20 to the nearest ten in 2003-2006. Estimated fires declined sharply from the early 1980s to the late 1990s. The apparent decline from 1998 to 2006 is probably due to the diversion of fires to the category of unclassified or unknown fireplace or chimney as well as confined chimney fires with no equipment involved in ignition. Despite this diversion, among fires with chimney reported as equipment involved in ignition, confined fires greatly outnumber non-confined fires.

Home Fires Involving Chimneys or Chimney Connectors, 1980-2006, by Year



Chimneys accounted for 1,040 injuries reported to hospital emergency rooms in 2006. For specific devices, unspecified fireplaces accounted for 670 injuries, metal chimneys 270 injuries, and brick, stove, or masonry chimneys 90 injuries.*

Creosote is a major problem for chimneys.

Creosote is a likely explanation for the 25% of home heating fires, confined or non-confined, with failure to clean as factor contributing to ignition (16,500 fires per year). Creosote is also a possible explanation for the 34% of home eating fires (22,700 fires per year), confined as non-confined, with item first ignited coded as unclassified item (12,700 fires, or 19% of total), film or residue (5,300 fires or 8%), unclassified organic material (3,700 fires, or 5%), or waste or trash (1,100 fires, or 2%).

Heat source too close to combustibles was cited as a factor contributing to ignition in one-fourth (23%) of the non-confined home chimney fires.

Failure to clean was cited for 20% of non-confined chimney fires but for 60% of fires reported as confined to chimney or flue. Leak or break was cited for 80% of associated civilian deaths. This is evidence of the importance of good design and installation and regular inspection.

Home chimney and chimney connector non-confined fires nearly all begin with ignition of fixed combustibles involved in the structure, led by structural member or framing (48%).

For fires confined to chimney or flue, the four leading items first ignited all could be codes for creosote deposits – unclassified item first ignited (37%), creosote or other film or residue (22%), unclassified organic material (14%), and waste or trash (4%).

The majority of non-confined home fires started by chimneys or chimney connectors began in concealed or structural spaces.

These include wall assembly or concealed space (22%), attic or other space above top story (20%), ceiling/floor assembly or other space between stories (8%), unclassified structural area (5%), and exterior roof surface (5%).

Safe Heating Behaviors

Messages regarding fireplaces from NFPA Educational Messaging Advisory Committee

General heating-related messages

- Have a three-foot kid-free zone around open fires.
- Supervise children when open fires are being used and install a non-combustible screen around the appliance to prevent burns which are even more common than fire injuries.
- All heaters need space. Keep things that can burn, such as paper, bedding or furniture, at least 3 feet away from heating equipment.
- Make sure all fuel-burning equipment is vented to the outside to avoid carbon monoxide poisoning. CO is created when fuels burn incompletely. CO poisoning can cause illness and even death. Make sure the venting for exhaust is kept clear and unobstructed. This includes removal of snow around the outlet to the outside.
- Install and maintain carbon monoxide alarms to avoid risk of carbon monoxide poisoning.
- Maintain heating equipment and chimneys by having them cleaned and inspected annually by a qualified professional.

Fireplaces

- Allow ashes to cool before disposing. Dispose of ashes in a tightly covered metal container and keep the ash container at least 10 feet away from the home and any other nearby buildings. Douse and saturate with water. Chimneys and vents need to be cleaned and inspected at least once a year.
- Have a sturdy screen on a fireplace.
- Burn only dry, seasoned wood.

* Statistics from National Electronic Injury Surveillance System, at www.cpsc.gov.

- Use artificial logs according to manufacturer's recommendations.
- Use only newspaper and kindling wood or fire starters to start a fire. Never use flammable liquids, such as lighter fluid, kerosene or gasoline to start a fire.
- Chimneys and vents need to be cleaned and inspected at least once a year.

Additional safe behaviors for fireplaces and chimneys

- Make sure your choice of heating equipment is permitted by law in your community. For example, chimineas and firepits are not allowed in all communities.
- Check for product recalls at www.cpsc.gov.
- For wood-burning fireplaces, burn only wood that has been split, stacked, and allowed to dry for 12 months. Do not use green wood, trash, or any other combustibles that could burn unevenly, resulting in flare-ups, or burn incompletely, resulting in deposits of creosote, an oily, sticky, combustible byproduct of incomplete burning of wood. When adding wood to a working fire, wear only short, tight-fitting sleeves to reduce the risk of igniting your clothing if the fire flares up during the refueling.
- The annual inspection can best be timed for just before the beginning of a new heating season. Inspection is also warranted if you move into a new home or begin use of your equipment after a period of non-use.
- For wood-burning fireplaces, the annual inspection needs to address potential build-up of creosote in heating equipment and associated chimneys and chimney connectors.

Home Fires Involving Chimneys or Chimney Connectors, by Year Structure Fires Reported to U.S. Fire Departments

Year	Fires	Civilian		Civilian		Direct Property Damage (in Millions)	
		Deaths	Injuries	As Reported	In 2006 Dollars		
1980	87,100	140	290	\$148	\$362		
1981	77,800	170	150	\$128	\$283		
1982	71,700	110	150	\$160	\$334		
1983	66,900	90	180	\$136	\$276		
1984	56,500	40	170	\$130	\$251		
1985	52,200	80	100	\$164	\$306		
1986	44,000	60	140	\$118	\$217		
1987	36,900	70	150	\$110	\$195		
1988	35,500	60	200	\$126	\$215		
1989	30,500	20	140	\$146	\$238		
1990	19,800	90	140	\$105	\$161		
1991	20,800	20	140	\$143*	\$212*		
1992	19,700	60	150	\$92	\$133		
1993	21,000	20	90	\$109	\$152		
1994	17,400	10	60	\$99	\$134		
1995	15,800	10	90	\$116	\$154		
1996	14,700	50	90	\$102	\$132		
1997	14,300	20	100	\$102	\$128		
1998	12,000	10	40	\$83	\$102		
1999	9,500	(3,900)	0 (0)	90 (90)	\$112 (\$106)	\$136 (\$128)	
2000	7,900	(3,600)	0 (0)	180 (180)	\$120 (\$118)	\$140 (\$138)	
2001	9,000	(2,900)	40 (40)	0 (0)	\$90 (\$88)	\$103 (\$101)	
2002	9,100	(2,800)	20 (20)	30 (30)	\$68 (\$66)	\$76 (\$74)	
2003	5,300	(1,700)	90 (90)	50 (50)	\$78 (\$76)	\$85 (\$83)	
2004	4,200	(1,800)	0 (0)	50 (50)	\$83 (\$82)	\$89 (\$87)	
2005	3,800	(1,600)	0 (0)	60 (60)	\$75 (\$73)	\$77 (\$75)	
2006	4,200	(1,500)	0 (0)	10 (10)	\$54 (\$54)	\$54 (\$54)	

*All 1991 home fire property damage figures are inflated by estimation problems related to the handling of the Oakland fire storm.

Note: Multiple entries are allowed, resulting in more factor entries than fires. Numbers in parentheses exclude confined fires. Confined fires are fires reported as confined to chimney, flue, fuel burner, or boiler and involving heating equipment; they are analyzed separately. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and civilian injuries are expressed to the nearest ten and direct property damage is rounded to the nearest million dollars. Figures reflect a proportional share of home fires with equipment involved in ignition unknown or reported as heating or air conditioning equipment of undetermined type. Fires reported as "no equipment" but lacking a confirming specific heat source (codes 40-99) are also treated as unknown equipment and allocated. *Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution.* Inflation adjustment to 2005 dollars is done using the consumer price index.

Source: Data from NFIRS Version 4.1 (1980-1998) and Version 5.0 (1999-2006) and from NFPA survey.

Home Chimney or Chimney Connector Fires, by Factor Contributing to Ignition
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Excluding Fires Reported as Confined Fires)

Factor	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Heat source too close to combustibles	400	(23%)	4	(20%)	13	(32%)	\$16	(24%)
Failure to clean	300	(20%)	4	(20%)	7	(17%)	\$12	(17%)
Installation deficiency	300	(20%)	0	(0%)	2	(5%)	\$9	(13%)
Leak or break	200	(11%)	18	(80%)	11	(27%)	\$9	(13%)
Construction deficiency	200	(9%)	0	(0%)	2	(6%)	\$4	(6%)
Worn out	100	(6%)	0	(0%)	0	(0%)	\$5	(7%)
Unclassified mechanical failure or malfunction	100	(5%)	0	(0%)	2	(6%)	\$7	(10%)
Unclassified factor contributed to ignition	100	(5%)	0	(0%)	5	(11%)	\$5	(7%)
Unclassified design, manufacturing, or installation deficiency	100	(4%)	0	(0%)	3	(6%)	\$3	(5%)
Unclassified operational deficiency	100	(3%)	0	(0%)	0	(0%)	\$2	(2%)
Design deficiency	100	(3%)	0	(0%)	0	(0%)	\$3	(4%)
Other known factor	200	(10%)	0	(0%)	2	(5%)	\$8	(11%)
Total fires excluding confined fires	1,600	(100%)	22	(100%)	41	(100%)	\$70	(100%)
Total factor entries	1,900	(119%)	27	(120%)	48	(116%)	\$83	(119%)

Note: Multiple entries are allowed, resulting in more factor entries than fires. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars. Damage has not been adjusted for inflation. Figures reflect a proportional share of home fires with equipment involved in ignition unknown or recorded as heating or air conditioning equipment of undetermined type. Fires reported as "no equipment" but lacking a confirming specific heat source (codes 40-99) are also treated as unknown equipment and allocated. Home heating fires with this equipment and factor contributing to ignition listed as unknown, unreported, none, or blank have also been allocated proportionally. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA survey.

Home Chimney or Chimney Connector Fires, by Item First Ignited
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Excluding Fires Reported as Confined Fires)

Item First Ignited	Fires		Civilian		Civilian		Direct Property	
			Deaths	Injuries	Injuries	Damage (in Millions)		
Structural member or framing	800	(48%)	9	(40%)	20	(49%)	\$40	(57%)
Exterior wall covering or finish	100	(9%)	0	(0%)	0	(0%)	\$4	(5%)
Insulation within structural area	100	(8%)	0	(0%)	3	(6%)	\$4	(6%)
Unclassified structural component or finish	100	(6%)	9	(40%)	5	(12%)	\$6	(9%)
Interior wall covering	100	(5%)	0	(0%)	4	(10%)	\$3	(4%)
Interior ceiling covering	100	(4%)	0	(0%)	0	(0%)	\$3	(5%)
Unclassified item first ignited	100	(4%)	0	(0%)	0	(0%)	\$2	(2%)
Unclassified organic material	100	(4%)	0	(0%)	3	(6%)	\$1	(2%)
Exterior roof covering	100	(3%)	0	(0%)	0	(0%)	\$3	(4%)
Other known item	200	(10%)	4	(20%)*	7	(16%)	\$4	(6%)
Total fires excluding confined fires	1,600	(100%)	22	(100%)	41	(100%)	\$70	(100%)

* Leading item for fire deaths not shown above is creosote or other film or residue (20% of deaths).

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars. Damage has not been adjusted for inflation. Figures reflect a proportional share of home fires with equipment involved in ignition unknown or recorded as heating or air conditioning equipment of undetermined type. Fires reported as “no equipment” but lacking a confirming specific heat source (codes 40-99) are also treated as unknown equipment and allocated. Home heating fires with this equipment and item first ignited unknown have also been allocated proportionally. Totals may not equal sums because of rounding.

Source: Data from NFIRS Version 5.0 and NFPA survey.

Home Chimney or Chimney Connector Fires, by Area of Origin
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Excluding Fires Reported as Confined Fires)

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Wall assembly or concealed space	400	(22%)	0	(0%)	9	(23%)	\$13	(19%)
Attic or other space above top story	300	(20%)	0	(0%)	9	(23%)	\$17	(25%)
Living room, den, or family room	200	(11%)	4	(20%)	6	(14%)	\$8	(12%)
Ceiling/floor assembly or space between stories	100	(8%)	0	(0%)	3	(7%)	\$5	(7%)
Exterior wall surface	100	(6%)	0	(0%)	0	(0%)	\$2	(2%)
Unclassified structural area	100	(5%)	0	(0%)	0	(0%)	\$5	(7%)
Exterior roof surface	100	(5%)	0	(0%)	4	(9%)	\$4	(5%)
Unclassified function area	100	(3%)	18	(80%)	4	(9%)	\$2	(4%)
Other known area of origin	300	(20%)	0	(0%)	6	(15%)	\$14	(20%)
Total fires excluding confined fires	1,600	(100%)	22	(100%)	41	(100%)	\$70	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars. Damage has not been adjusted for inflation. Figures reflect a proportional share of home fires with equipment involved in ignition unknown or recorded as heating or air conditioning equipment of undetermined type. Fires reported as “no equipment” but lacking a confirming specific heat source (codes 40-99) are also treated as unknown equipment and allocated. Home heating fires with this equipment and area of origin unknown have also been allocated proportionally. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA survey.

Appendix A.

How National Estimates Statistics Are Calculated

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. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit <http://www.nfirs.fema.gov/>. Copies of the paper forms may be downloaded from http://www.nfirs.fema.gov/documentation/design/NFIRS_Paper_Forms_2008.pdf.

NFIRS has a wide variety of data elements and code choices. The NFIRS database contains coded information. Many code choices describe several conditions. These cannot be broken down further. For example, area of origin code 83 captures fires starting in vehicle engine areas, running gear areas or wheel areas. It is impossible to tell the portion of each from the coded data.

Methodology may change slightly from year to year.

NFPA is continually examining its methodology to provide the best possible answers to specific questions, methodological and definitional changes can occur. *Earlier editions of the same report may have used different methodologies to produce the same analysis, meaning that the estimates are not directly comparable from year to year.*

NFPA's fire department experience survey provides estimates of the big picture.

Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are sent to all municipal departments protecting populations of 50,000 or more and a random sample, stratified by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per

department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; 3) the number and nature of non-fire incidents; and (4) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results. The results of the survey are published in the annual report *Fire Loss in the United States*. To download a free copy of the report, visit <http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf>.

Projecting NFIRS to National Estimates

As noted, NFIRS is a voluntary system. Different states and jurisdictions have different reporting requirements and practices. Participation rates in NFIRS are not necessarily uniform across regions and community sizes, both factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second database -- the NFPA survey -- is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific fire problems and circumstances are obtained by multiplying the NFIRS data by the scaling ratios. Reports for incidents in which mutual aid was given are excluded NFPA's analyses.

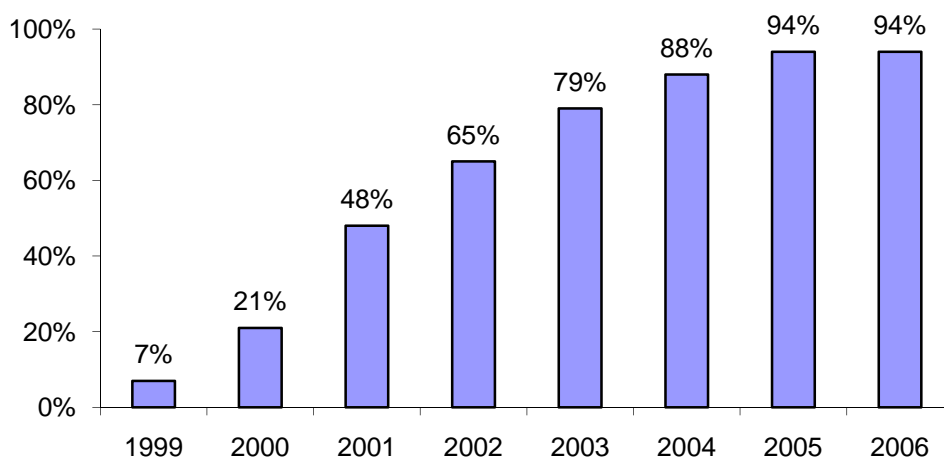
Analysts at the NFPA, the USFA and the Consumer Product Safety Commission developed the specific basic analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates. A

copy of the article is available online at <http://www.nfpa.org/osds> or through NFPA's One-Stop Data Shop.

Version 5.0 of NFIRS, first introduced in 1999, used a different coding structure for many data elements, added some property use codes, and dropped others. The essentials of the approach described by Hall and Harwood are still used, but some modifications have been necessary to accommodate the changes in NFIRS 5.0.

Figure 1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

Figure 1. Fires Originally Collected in NFIRS 5.0 by Year



For 2002 data on, analyses are based on scaling ratios using only data originally collected in NFIRS 5.0:

$$\frac{\text{NFPA survey projections}}{\text{NFIRS totals (Version 5.0)}}$$

For 1999 to 2001, the same rules may be applied, but estimates for these years in this form will be less reliable due to the smaller amount of data originally collected in NFIRS 5.0; they should be viewed with extreme caution.

NFIRS 5.0 introduced six categories of confined structure fires, including:

- cooking fires confined to the cooking vessel,
- confined chimney or flue fires,
- confined incinerator fire,
- confined fuel burner or boiler fire or delayed ignition,
- confined commercial compactor fire, and
- trash or rubbish fires in a structure with no flame damage to the structure or its contents.

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases (typically 10-20%). Some analyses, particularly those that examine cooking equipment, heating equipment, fires caused by smoking materials, and fires started by playing with fire, may examine the confined fires in greater detail. Because the confined fire incident types describe certain scenarios, the distribution of unknown data differs from that of all fires. Consequently, allocation of unknowns must be done separately.

Some analyses of structure fires show only non-confined fires. In these tables, percentages shown are of non-confined structure fires rather than all structure fires. This approach has the advantage of showing the frequency of specific factors in fire causes, but the disadvantage of possibly overstating the percentage of factors that are seldom seen in the confined fire incident types.

Other analyses include entries for confined fire incident types in the causal tables and show percentages based on total structure fires. In these cases, the confined fire incident type is treated as a general causal factor.

For most fields other than Property Use, NFPA allocates unknown data proportionally among known data. This approach assumes that if the missing data were known, it would be distributed in the same manner as the known data. NFPA makes additional adjustments to several fields. *Casualty and loss projections can be heavily influenced by the inclusion or exclusion of unusually serious fire.*

In the formulas that follow, the term “all fires” refers to all fires in NFIRS on the dimension studied.

Factor Contributing to Ignition: In this field, the code “none” is treated as an unknown and allocated proportionally. For Human Factor Contributing to Ignition, NFPA enters a code for “not reported” when no factors are recorded. “Not reported” is treated as an unknown, but the code “none” is treated as a known code and not allocated. Multiple entries are allowed in both of these fields. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Although Factor Contributing to Ignition is only required when the cause of ignition was coded as: 2) unintentional, 3) failure of equipment or heat source; or 4) act of nature, data is often present when not required. Consequently, any fire in which no factor contributing to ignition was entered was treated as unknown.

In some analyses, all entries in the category of electrical failure or malfunction (factor contributing to ignition 30-39) are combined and shown as “electrical failure or malfunction.” 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; and
- 30. Electrical failure or malfunction, other.

Type of Material First Ignited (TMI). This field is required only if the Item First Ignited falls within the code range of 00-69. NFPA has created a new code “not required” for this field that is applied when Item First Ignited is in code 70-99 (organic materials, including cooking materials and vegetation, and general materials, such as electrical wire, cable insulation, transformers, tires, books, newspaper, dust, rubbish, etc..) and TMI is blank. The ratio for allocation of unknown data is:

$$\frac{\text{(All fires – TMI Not required)}}{\text{(All fires – TMI Not Required – Undetermined – Blank)}}$$

Heat Source. In NFIRS 5.0, one grouping of codes encompasses various types of open flames and smoking materials. In the past, these had been two separate groupings. A new code was added to NFIRS 5.0, which is code 60: “Heat from open flame or smoking material, other.” NFPA treats this code as a partial unknown and allocates it proportionally across the codes in the 61-69 range, shown below.

- 61. Cigarette;
- 62. Pipe or cigar;
- 63. Heat from undetermined smoking material;
- 64. Match;
- 65. Lighter: cigarette lighter, cigar lighter;
- 66. Candle;
- 67 Warning or road flare, fuse;
- 68. Backfire from internal combustion engine. Excludes flames and sparks from an exhaust system, (11); and
- 69. Flame/torch used for lighting. Includes gas light and gas-/liquid-fueled lantern.

In addition to the conventional allocation of missing and undetermined fires, NFPA multiplies fires with codes in the 61-69 range by

$$\frac{\text{All fires in range 60-69}}{\text{All fires in range 61-69}}$$

The downside of this approach is that heat sources that are truly a different type of open flame or smoking material are erroneously assigned to other categories. The grouping “smoking materials” includes codes 61-63 (cigarettes, pipes or cigars, and heat from undetermined smoking material, with a proportional share of the code 60s and true unknown data.

Equipment Involved in Ignition (EII). NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment

malfunctioned or was used improperly. In 2006, the definition was modified to “the piece of equipment that provided the principal heat source to cause ignition.” However, much of the data predates the change. Individuals who have already been trained with the older definition may not change their practices. 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, the known data is multiplied by

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

In addition, the partially unclassified codes for broad equipment groupings (i.e., code 100, - heating, ventilation, and air conditioning, other; code 200- electrical distribution, lighting and power transfer, other; etc.) were allocated proportionally across the individual code choices in their respective broad groupings (heating, ventilation, and air conditioning; electrical distribution, lighting and power transfer, other; etc.). Equipment that is totally unclassified is not allocated further. This approach has the same downside as the allocation of heat source 60 described above. Equipment that is truly different is erroneously assigned to other categories.

In some analyses, various types of equipment are grouped together. (Confined fire incident types are not discussed here)

Code Grouping	EII Co	NFIRS definitions
Central heat	132	Furnace or central heating unit
	133	Boiler (power, process or heating)
Fixed or portable space heater	131	Furnace, local heating unit, built-in
	123	Fireplace with insert or stove
	124	Heating stove
	141	Heater, excluding catalytic and oil-filled
	142	Catalytic heater
	143	Oil-filled heater
Fireplace or chimney	121	Fireplace, masonry
	122	Fireplace, factory-built
	125	Chimney connector or vent connector
	126	Chimney – brick, stone or masonry
	127	Chimney-metal, including stovepipe or flue
Wiring, switch or outlet	210	Unclassified electrical wiring
	211	Electrical power or utility line
	212	Electrical service supply wires from utility
	214	Wiring from meter box to circuit

		breaker
	216	Electrical branch circuit
	217	Outlet, receptacle
	218	Wall switch
Power switch gear or overcurrent protection device	215	Panel board, switch board, circuit breaker board
	219	Ground fault interrupter
	222	Overcurrent, disconnect equipment
	227	Surge protector
Lamp, bulb or lighting	230	Unclassified lamp or lighting
	231	Lamp-tabletop, floor or desk
	232	Lantern or flashlight
	233	Incandescent lighting fixture
	234	Fluorescent light fixture or ballast
	235	Halogen light fixture or lamp
	236	Sodium or mercury vapor light fixture or lamp
	237	Work or trouble light
	238	Light bulb
	241	Nightlight
	242	Decorative lights – line voltage
	243	Decorative or landscape lighting – low voltage
	244	Sign
Cord or plug	260	Unclassified cord or plug
	261	Power cord or plug, detachable from appliance
	262	Power cord or plug- permanently attached
	263	Extension cord
Torch, burner or soldering iron	331	Welding torch
	332	Cutting torch
	333	Burner, including Bunsen burners
	334	Soldering equipment
Portable cooking or warming equipment	631	Coffee maker or teapot
	632	Food warmer or hot plate
	633	Kettle
	634	Popcorn popper
	635	Pressure cooker or canner
	636	Slow cooker
	637	Toaster, toaster oven, counter-top

	broiler
638	Waffle iron, griddle
639	Wok, frying pan, skillet
641	Breadmaking machine

Item First Ignited. In most analyses, mattress and pillows (item first ignited 31) and bedding, blankets, sheets, and comforters (item first ignited 32) are combined and shown as “mattresses and bedding.” In many analyses, wearing apparel not on a person (code 34) and wearing apparel on a person (code 35) are combined and shown as “clothing.” In some analyses, flammable and combustible liquids and gases, piping and filters (item first ignited 60-69) are combined and shown together

Area of Origin. Two areas of origin: bedroom for more than five people (code 21) and bedroom for less than five people (code 22) are combined and shown as simply “bedroom.”

Rounding and percentages. The data shown are estimates and generally rounded. An entry of zero may be a true zero or it may mean that the value rounds to zero. Percentages are calculated from unrounded values. It is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero. The same rounded value may account for a slightly different percentage share. Because percentages are expressed in integers and not carried out to several decimal places, percentages that appear identical may be associated with slightly different values.

Inflation. Property damage estimates are not adjusted for inflation unless so indicated.