

Heating Fires in Residential Buildings

Findings:

- The decline in the incidence of heating fires has been dramatic. Over the past 20 years, the estimated number of residential building heating fires has fallen from 200,000 to 49,000 in 2004.
- Heating fires are the second leading cause of all residential building fires (behind cooking fires).
- Confined heating fires, those fires confined to chimneys, flues, fuel boxes, or boilers, account for 86% of residential building heating fires.
- Heating fires due to electrical failures are more prevalent in multifamily homes than in one- and two-family residences.
- Over one-quarter of residential building heating fires result from improper maintenance of heating equipment, specifically the failure to clean the equipment.

Between 2002 and 2004, an annual average of 49,100 heating fires occurred in residential buildings and were responsible for an estimated 125 civilian fire deaths, 575 injuries, and \$232 million in property loss.^{1,2} The term heating fires applies to those fires that are caused by functioning or malfunctioning central heating units, fixed or portable local heating units, fireplaces, heating stoves, chimneys, and water heaters.³ This topical report examines the causes and characteristics of heating fires that occur in residential buildings.

Data from the National Fire Incident Reporting System (NFIRS) (2002-2004) show losses from residential building

heating fires are lower than those averaged across all building fires (Table 1).⁴ When the small-loss, confined-heating fires are segregated out, the loss per fire for non-confined heating and non-confined, nonheating fires is nearly equal; deaths and injuries per thousand fires, however, are slightly higher for non-confined heating fires (Table 2). For confined heating fires in residential buildings – those fires confined to a chimney, chimney flue, fuel burner, or boiler malfunction – the loss per fire is nearly twice that of residential building, nonheating confined fires, while the injury rate is quite small (Table 3). As deaths are a rare occurrence in confined fires, the death rates across these groupings are minimal and virtually indistinguishable.

Table 1. Loss Measures for Building Fires (buildings, 3-year average 2002-2004)

Measure	All Building Fires	Residential Building Fires		
		All Fires	Nonheating Fires	Heating Fires
Loss per Fire	\$19,011	\$15,334	\$16,849	\$5,027
Injuries per 1,000 Fires	29.9	32.7	36.1	10.6
Deaths per 1,000 Fires	5.3	6.2	6.9	2.0

Note: Loss per fire is computed for only those fires where loss information was provided

Source: 2002-2004 NFIRS 5.0 data

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Table 2. Loss Measures for Non-confined Building Fires⁵ (buildings, 3-year average 2002-2004)

Measure	All Non-confined Building Fires	Residential Non-confined Building Fires		
		All Fires	Nonheating Fires	Heating Fires
Loss per Fire	\$30,349	\$25,872	\$25,872	\$25,884
Injuries per 1,000 Fires	44.4	51.5	51.2	59.8
Deaths per 1,000 Fires	9.0	11.2	11.1	13.9

Note: Loss per fire is computed for only those fires where loss information was provided

Source: 2002-2004 NFIRS 5.0 data

Table 3. Loss Measures for Confined Building Fires⁶ (buildings, 3-year average 2002-2004)

Measure	All Confined Building Fires	Residential Confined Building Fires		
		All Fires	Nonheating Fires	Heating Fires
Loss per Fire	\$469	\$349	\$282	\$531
Injuries per 1,000 Fires	8.9	9.2	11.4	2.6
Deaths per 1,000 Fires	0.1	0.1	0.1	0.1

Note: Loss per fire is computed for only those fires where loss information was provided

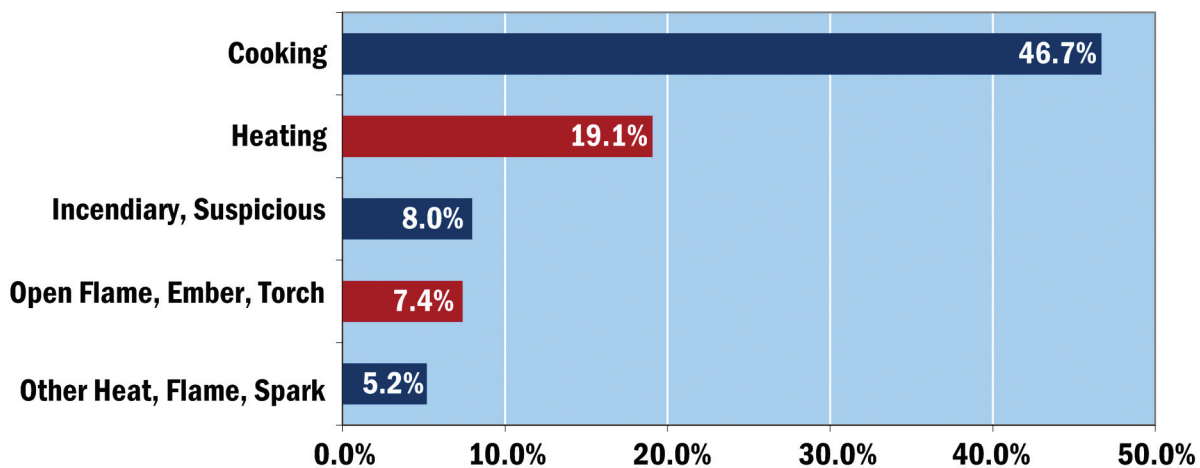
Source: 2002-2004 NFIRS 5.0 data

Leading Causes of Residential Building Fires

Heating (19%) is second only to cooking (47%) as the leading cause of residential building fires (Figure 1). In the late 1970s and early 1980s, heating was actually the leading cause, due to a surge in the use of alternative space heaters and wood heating. This surge was stimulated in large part by an energy shortage and environ-

mental concerns. While the overall number of fires in the Nation has decreased nearly 50% over the past 25 years, the decline in the incidence of heating fires has been dramatic. In 1983, there were nearly 200,000 heating fires⁷; by 2004 that number had fallen to approximately 49,000.⁸

Figure 1. Leading Causes of Residential Building Fires (percent of fires, 3-year average 2002-2004)



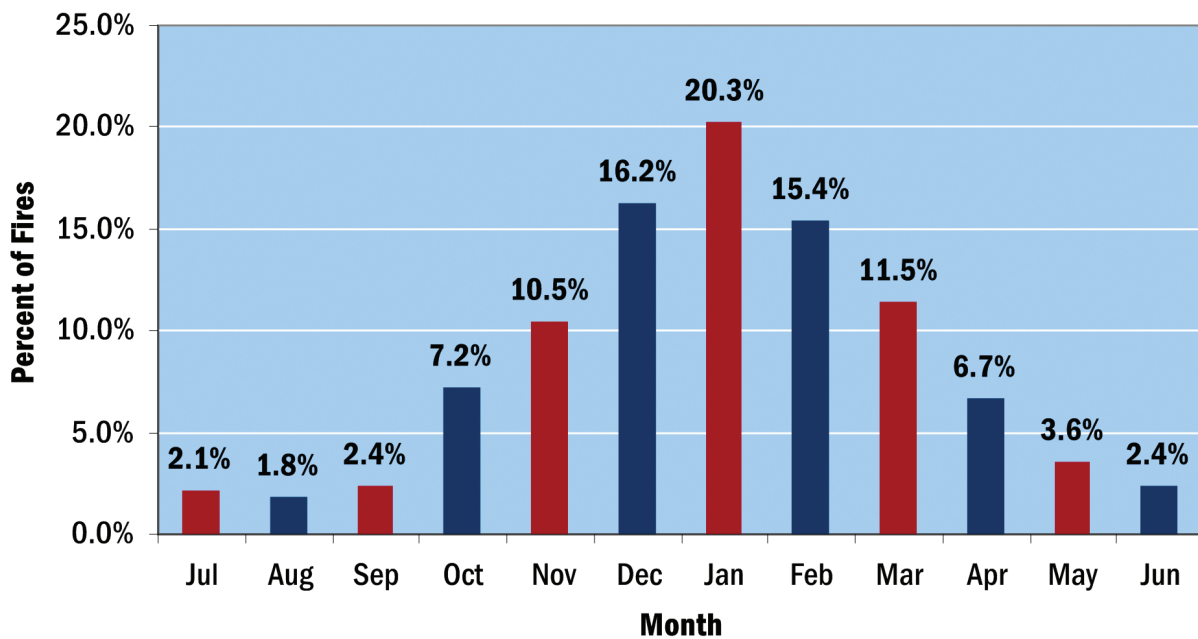
Source: 2002-2004 NFIRS 5.0 data

When Heating Fires Occur

Figure 2 shows the pattern of heating fires throughout the year. As would be expected, heating fires begin to increase during the fall and continue the increase through the winter. They are most prevalent during the winter months of December through February when the use of central heating systems, portable heaters, and fireplaces is most com-

mon. The peak month for residential building heating fires is January, with a decline through the remainder of the winter season and into the early spring. Despite the increased use of heating equipment, heating fires still remain the second leading cause (behind cooking) of residential building fires in the fall and winter months.

Figure 2. Residential Building Heating Fires by Month of Occurrence
(residential buildings, 3-year average (2002-2004) NFIRS 5.0 data)



Note: Adjustments were made for heating stoves: NFIRS 5.0 data on item first ignited (cooking materials) suggested the equipment involved in ignition was a cooking stove. These 558 incidents were excluded from this analysis.

Source: 2002-2004 NFIRS 5.0 data

Residential building heating fires are lowest in the early hours of the morning (Figure 3). As people awaken to begin their daily activities, heating fires increase and hold constant during the morning and midday. As twilight approaches

and outside temperatures decrease, heating equipment and systems are used more heavily. Correspondingly, residential building heating fires increase in the late afternoon and peak between 6 p.m. and 8 p.m.

Where Heating Fires Occur – Type of Residence and Type of Incident

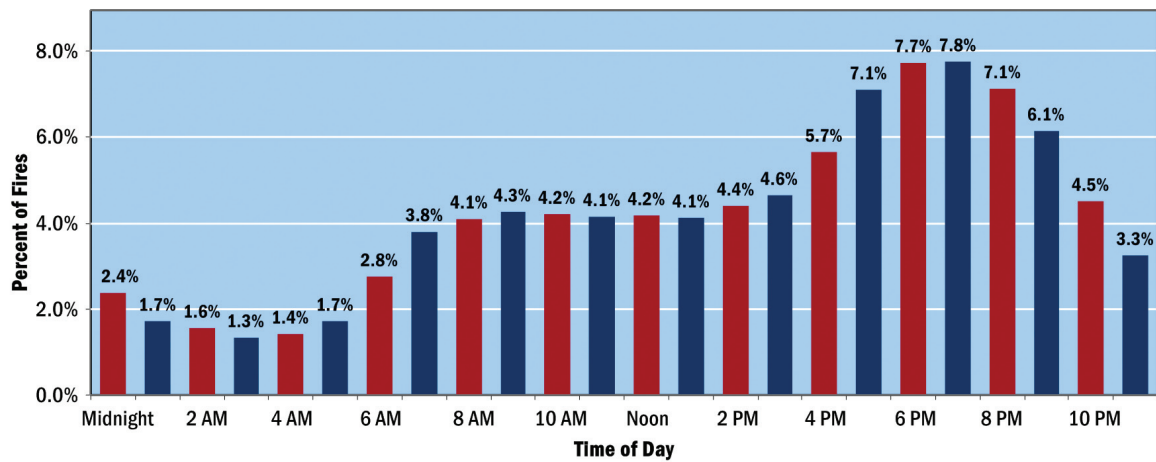
One- and two-family residences are disproportionately represented in residential building heating fires. Heating fires in one- and two-family residences account for 81% of residential building heating fires while only 68% of current U.S. housing stock is single family housing.⁹ Multifamily dwellings, 32% of the housing stock, account for an additional 15% of these heating fires. That most multifamily dwellings (apartments, condominiums, and the like) have profes-

sionally maintained heating systems may account for these differences in fire incidence. The remainder of residential building heating fires (4%) occur in hotels, dormitories, and other miscellaneous residential properties.

Eighty-six percent of residential building heating fires are confined heating. These are fires that are confined to a chimney or flue or are the result of a fuel burner or boiler

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Figure 3. Residential Building Heating Fires by Time of Day
(residential buildings, 3-year average (2002-2004) NFIRS 5.0 data)



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Source: 2002-2004 NFIRS 5.0 data

malfunction and are contained to the fuel burner or boiler.¹⁰ Confined residential building heating fires occur in roughly the same proportion across the major residential property types (86% for one- and two-family and 87% for multi-

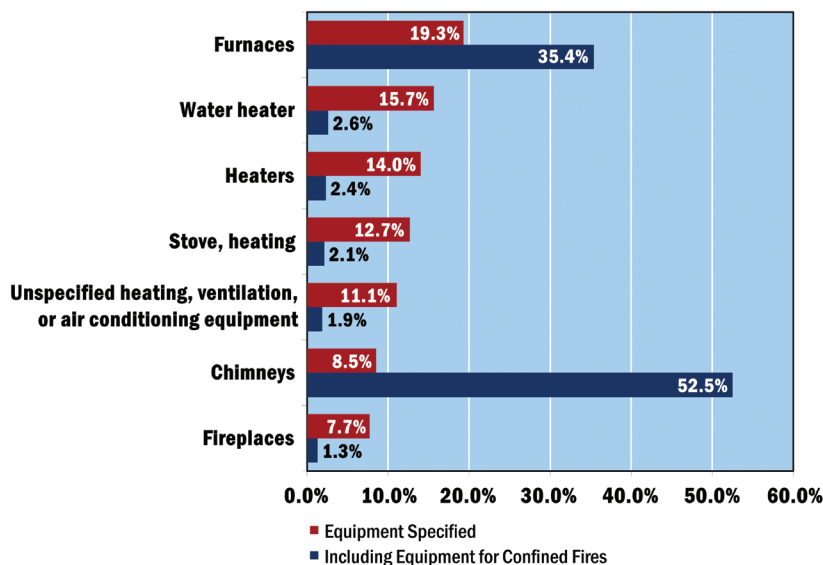
family) but because heating fires in one- and two-family residences dominate the numbers of fires, these confined fires occur primarily there.

Equipment Involved in Heating Fires

Figure 4 illustrates the leading types of equipment involved in residential heating fires. When small, confined fires are included, chimneys are by far the largest source of residential heating fires, accounting for more than half of these fires

(53%). Furnaces, both central heating units and local room units, account for 35% of residential heating fires. When these small fires are excluded, furnace fires are the largest proportion of heating fires.

Figure 4: Leading Equipment Involved in Ignition of Residential Building Heating Fires
(residential buildings, 3-year average (2002-2004) NFIRS 5.0 data)



Note: Adjustments were made for heating stoves: NFIRS 5.0 data on item first ignited (cooking materials) suggested the equipment involved in ignition was a cooking stove. These 558 incidents were excluded from this analysis.

Source: 2002-2004 NFIRS 5.0 data

What is Ignited?

When specific information is provided, the leading items ignited in heating fires are structural framing; film, residue, including paint and resin; and electrical wire (Table 4). There are variations, however, depending on the particular heating equipment involved. For example, fires involving heaters are more likely to involve bedding than other heating sources, and masonry chimneys are more likely to involve residues of resin, also known as creosote.

Table 4. Item First Ignited in Residential Building Heating Fires
(where data provided, residential buildings, 3-year average (2002-2004) NFIRS 5.0 data)

Item First Ignited	Percent
Structural member or framing	10.2
Film, residue, including paint and resin	9.9
Electrical wire, cable insulation	6.6

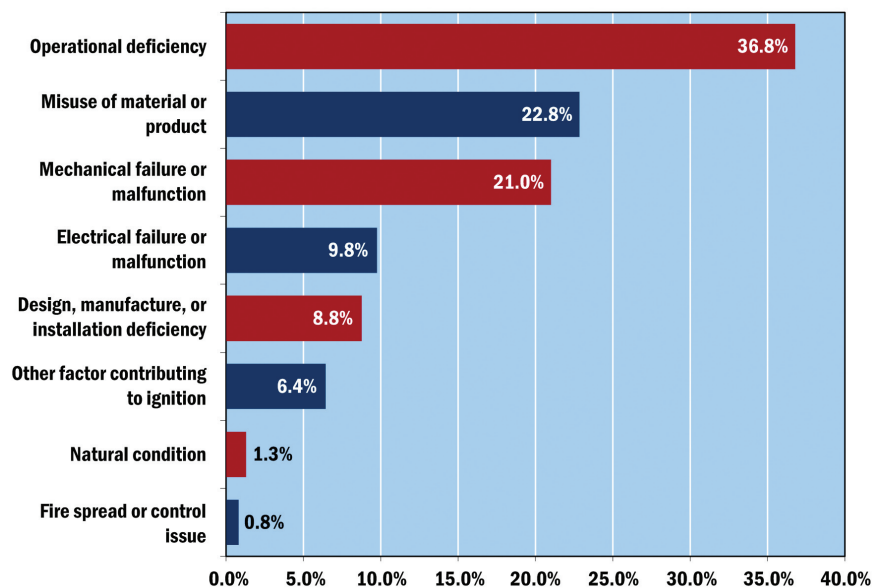
Note: Adjustments were made for heating stoves: NFIRS 5.0 data on item first ignited (cooking materials) suggested the equipment involved in ignition was a cooking stove. These 558 incidents were excluded from this analysis.

Source: 2002-2004 NFIRS 5.0 data

Why Does the Fire Start?

As illustrated in Figure 5, three factors play a leading role in the ignition of residential building heating fires – operational issues, misuse of the heating equipment, and mechanical failures. Thirty-seven percent of residential building heating fires are attributed to some form of operational deficiency. Failure to clean heating equipment (primarily chimneys, fireplaces, and fireplace and heating stoves) accounted for nearly three-quarters (73%) of this category, or slightly over a quarter of all residential heating fires (27%). Misuse of heating equipment accounted for an additional 23% of residential heating fires. Placing combustible items too close to the heat source (primarily portable heaters and water heaters) accounted for the majority (71%) of this misuse. Twenty-one percent of residential building heating fires were the result of mechanical failures or malfunctions, over half of which (53%) were unspecified failures or malfunctions.

Figure 5. Factors Contributing to the Ignition of Residential Building Heating Fires
(where data provided, residential buildings, 3-year average (2002-2004) NFIRS 5.0 data)



Note: Adjustments were made for heating stoves: NFIRS 5.0 data on item first ignited (cooking materials) suggested the equipment involved in ignition was a cooking stove. These 558 incidents were excluded from this analysis.

Source: 2002-2004 NFIRS 5.0 data

Approximately one-third of heating fires that specify factors contributing to the ignition of the fire involve some kind of mechanical or electrical failure (31%). The reason for that failure varies, depending on the type of residential property involved in the fire. In both one- and two-family residences and multifamily residences, 20 to 26 percent of heating fires are due to mechanical problems (20% for one- and two-family; 26% for multifamily). In contrast, electrical problems are more prevalent in multifamily residences (22% versus 8% for one- and two-family residences).

Civilian Fatalities

Heating is the fourth leading cause of overall residential building civilian fire deaths, following arson, smoking, and open flame. When analyzed further, however, heating fires in residential buildings, along with children playing fires, are more likely to have multiple fatalities than other causes of fatal fires. In the case of residential building heating fires, half these fatal fires occur between midnight and 6 a.m., when the victims were sleeping.

Alternative Heat Sources

Some fires are not necessarily coded as heating fires. A deadly phenomenon is that of fires caused when people use alternative sources of heat (such as a stove) to keep warm. This practice may be more common in impoverished areas where people may not be able to afford heating fuel and, instead, rely on space heaters or even open fires to heat their homes. In addition to posing a potential fire hazard, these practices can lead to the accumulation of dangerous carbon monoxide fumes, which are as deadly as fire.

Examples

Recent examples of heating fires:

- October 2006: One man was hospitalized and a mobile home was destroyed in a fire that began in the mobile home's hallway near the furnace. The local fire chief noted that the fire appeared to be accidental and due to a sudden cold snap early in the season. The resident was in bed, asleep, at the time of the fire.¹¹
- February 2005: Firefighters were called to a working chimney fire with embers coming from the chimney and smoke showing from the masonry. It was determined that the fire may have extended between the stove pipe

and the inside of the chimney. Firefighters on the exterior worked on containing the chimney fire while the interior crews checked for any extensions and hidden fires.¹²

- October 2004: An electric space heater placed too close to a mattress caused a fire that killed a 65-year-old man. Arriving at 12:59 a.m., firefighters found a small fire involving a futon mattress. They brought it under control in less than 5 minutes, according to fire officials. The victim had been sleeping in the trailer when the fire broke out.¹³
- December 2002: Investigators from the State Fire Marshal's Office say an unlined chimney was the cause of a predawn house fire that took the life of a 47-year-old man. Firefighters noted that the unlined chimney had eroded over the years and the heat from a wood-burning stove appeared to have ignited the fire.¹⁴

Conclusion

While declining in numbers, heating fires in residential buildings continue to occur. Many such fires can be prevented through proper maintenance and proper use of heating equipment. With the large percentage of chimney fires currently reported in NFIRS, most occurring due to lack of proper cleaning, the importance of proper maintenance cannot be overstated. Both furnaces and chimneys should be professionally inspected annually and cleaned as necessary. Chimney tar (creosote) build-up is a common cause of chimney fires.

Other areas in which homeowners can help prevent heating fires:

- Make sure wood stoves are properly installed, away from combustible surfaces, have the proper floor support, and adequate ventilation.
- Make sure your space heaters and portable heaters have an emergency tip-over shutoff in case they tip over. Never refill a fueled-powered space heater while it is operating or still hot. Refuel outside, away from the house.
- Use a glass or metal screen in front of your fireplace to prevent sparks igniting nearby carpets or furniture.
- Never use the range or oven to heat your home.

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Notes:

¹In 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 nonhabitable structures. As the confined fire incidents may not have the structure type noted, confined fires without a structure type specified are assumed to be buildings. Those that occur on residential properties are then assumed to be residential buildings. Only confined trash fires coded as enclosed building and fixed portable or mobile structure are included in this definition; all other confined trash fires are excluded.

²National estimates are based on native version 5.0 data 2002–04 from the NFIRS, and national 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.

³For purposes of this analysis, residential building heating fires are defined as those residential buildings (defined above) for which the cause of the fire was determined to be heating. However, for the confined fire portion of residential building fires, only those with incident types 114 and 116 were included; all other confined fire types were excluded.

⁴NFIRS 5.0 contains both converted NFIRS 4.1 data and native NFIRS 5.0 data. This topical report includes only native 5.0 data.

⁵Non-confined fires are those fires in the 110 to 112 and 120 to 123 incident type series. Incident type 112 was excluded from this analysis of residential building fires, however, as incident type 112 is defined as “fires in a structure other than a building.”

⁶Confined fires are limited to those fires with incident types 113 to 118, the confined structure fire incident range. Confined heating fires, however, are limited to incident types 114 and 116.

⁷*Fire in the United States 1983–1990*, Eighth Edition, U.S. Fire Administration, Federal Emergency Management Agency, 1991. This publication uses “residential structure” fires as the basis for residential heating fires. In NFIRS 5.0 data, residential buildings comprise 90% of residential structures. A rough equivalent for the 1983 estimate of residential building heating fires then might be 180,000 fires rather than the reported 200,000 residential structure heating fires.

⁸National estimate, 2004 data.

⁹The NFIRS definitions of housing types do not exactly coincide with the U.S. Census Bureau definitions, as there is no Census equivalent for two-family dwellings. NFIRS includes most manufactured homes (the U.S. Census refers to this group as “mobile homes.”) as a one- or two-family home. Single-family detached homes make up 60% of the U.S. housing stock, mobile homes make up 7.6%. For comparison purposes, these two Census groups are used as one- and two-family dwellings. Single-family attached homes (row houses and townhouses) are considered multifamily dwellings in NFIRS, and are included in that category for this comparison. Detailed definitions of NFIRS property use categories can be found in the *National Fire Incident Reporting System 5.0 Complete Reference Guide*, January 2006, at http://www.nfirs.fema.gov/_download/nfirs50crg2006_0328.pdf. U.S. Census housing information can be found at <http://www.census.gov/hhes/www/housing/census/historic/units.html>

¹⁰These confined heating fires are coded as incident types 114 or 116. The full definitions of these incident types can be found in the *National Fire Incident Reporting System 5.0 Complete Reference Guide*, January 2006, at http://www.nfirs.fema.gov/_download/nfirs50crg2006_0328.pdf

¹¹“Fire Officials Suspect Cold Weather Prompted Furnace Fire,” *AccessNorthGa.com*, October 16, 2006, <http://www.access-northga.com/news/hall/newfullstory.asp?ID=107939>

¹²“Virginia Firefighters Extinguish Chimney Fire,” updated February 28, 2005, <http://cms.firehouse.com/content/article/article.jsp?sectionId=45&id=39734>

¹³“Space Heater Causes Fatal Fire In South San Jose,” *Bay City News*, October 12, 2004, <http://abclocal.go.com/kgo/story?section=News&id=2248427&ft=print>

¹⁴“Unlined Chimney Blamed for Fatal Fire,” December 11, 2002, <http://www.deaftoday.com/news/archives/000818.html>

Related Topics:

For additional tips on how to prevent heating fires in your home, please see: www.usfa.dhs.gov/subjects/fireprev/qr/materials/factsheets/ffwfm-5.shtm and www.usfa.dhs.gov/safety/tips/winter.shtm