Topical Fire Report Series
Volume 10, Issue 2 / January 2010

Heating Fires in Residential Buildings

These topical reports are designed to explore facets of the U.S. fire problem as depicted through data collected in the U.S. Fire Administration's (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

- An estimated 54,500 heating fires occur each year in the United States.
- Heating is the second leading cause of all residential building fires following cooking.
- Residential building heating fires peak in January and February; this peak accounts for 34 percent of fires.
- Confined heating fires, those fires confined to chimneys, fuels, fuel boxes, or boilers, account for 87 percent of residential building heating fires.
- Thirty-one percent of the nonconfined residential building heating fires occur because the heat source is too close to combustibles.
- Residential building heating fires peak in the early evening hours between 5 p.m. and 9 p.m. with the highest peak between 6 p.m. and 8 p.m. This 4-hour period accounts for 30 percent of all residential building heating fires.
- The percent of residential building heating fires declines to the lowest point during the summer months from June to August. Heating fires during these months tend to be confined fuel burner/boiler malfunction fires (64 percent) or involve water heaters (10 percent).

From 2005 to 2007, an estimated average of 54,500 heating fires in residential buildings occurred in the United States each year. Heating fires account for 14 percent of residential building fires responded to by fire departments across the Nation.[1,2,3] These fires resulted in an average of 190 deaths, 625 injuries, and $286 million in property loss. The term *heating fires* applies to those fires that are caused by central heating units, fixed or portable local heating units, fireplaces, heating stoves, chimneys, and water heaters.[4] This topical report addresses the characteristics of residential building heating fires reported to the National Fire Incident Reporting System (NFIRS) between 2005 and 2007.

For the purpose of this report, the term "residential heating fires" is synonymous with "residential building heating fires" as residential heating fires commonly mean those fires caused by heating that occur in buildings. "Residential heating fires" is used throughout the body of this report; the findings, tables, charts, headings, and footnotes reflect the full category "residential building heating fires."

Between 2005 and 2007, heating fires were the second leading cause of all residential building fires. Previously, especially during the late 1970s and early 1980s, heating fires were by far the leading cause of residential building fires. Stimulated in part by an energy shortage, this surge in heating fires was the result of the sudden increased use of alternative heating, particularly wood heating stoves and space heaters. Since then, the overall numbers of heating fires have substantially decreased. In 1983, there were 200,000 heating fires, but by 2007, that number had fallen to approximately 54,000.[5]

Type of Fire

Building fires consist of two major categories of incidents: fires that are confined to specific types of equipment or objects (confined fires) and those that are not (nonconfined fires). Confined building fires are small fire incidents that are limited in scope, confined to noncombustible containers, rarely result in serious injury or large content losses, and are expected to have no significant accompanying property losses due to flame damage.[6] Eighty-seven percent of residential heating fires are confined fires as shown in Table 1. By comparison, just under half (47 percent) of all residential fires are confined fires.

continued on next page

Table 1. Residential Building Heating Fires by Type of Incident (2005–2007)

Incident Type	Percent
Nonconfined fires	13.0
Confined fires	87.0
Chimney or flue fire, confined to chimney or flue	53.0
Fuel burner/boiler malfunction, fire confined	34.0
Total	100.0

Source: NFIRS 5.0.

Loss Measures

Table 2 presents losses, averaged over this 3-year period, for residential building fires and heating fires reported to NFIRS.[7]

Table 2. Loss Measures for Residential Building Heating Fires (3-year average, 2005–2007)

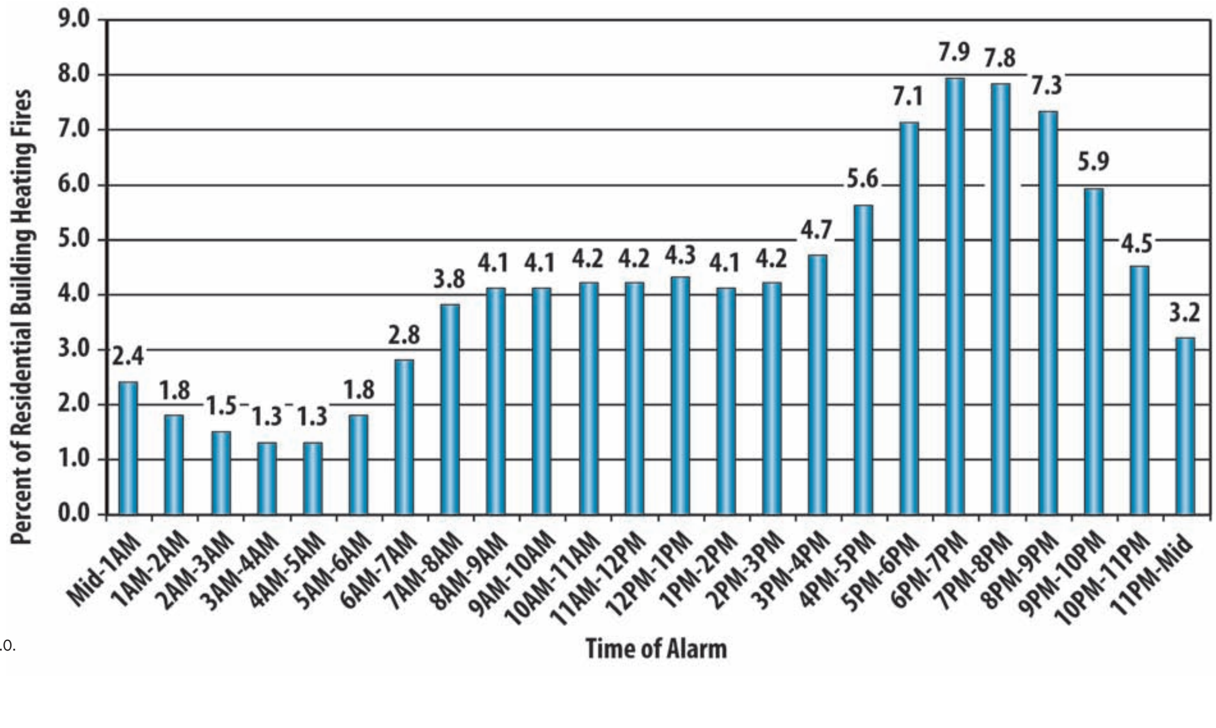
Measure	Residential Building Fires	Residential Building Heating Fires	Confined Residential Building Heating Fires	Nonconfined Residential Building Heating Fires
Average Loss:				
Fatalities/1,000 Fires	5.4	1.9	0.0	14.4
Injuries/1,000 Fires	28.1	9.3	2.7	53.8
Dollar Loss/Fire	$14,560	$3,540	$240	$25,490

Source: NFIRS 5.0.
Notes: 1) One death in a confined fire was reported to NFIRS during 2005–2007; the resulting loss of 0.0 fatalities per 1,000 fires reflects only data reported to NFIRS.
2) Average loss for fatalities and injuries is computed per 1,000 fires; average dollar loss is computed ***per fire*** and is rounded to the nearest $10.

When Residential Building Heating Fires Occur

As shown in Figure 1, residential building heating fires occur mainly in the evening hours, 5 p.m. to 9 p.m., peaking from 6 p.m. to 8 p.m. They decline throughout the night and early morning and reach their lowest point during the morning hours (3 a.m. to 5 a.m.). The 4-hour evening period from 5 p.m. to 9 p.m. accounts for 30 percent of residential building heating fires and the 2-hour morning period between 3 a.m. and 5 a.m. accounts for 3 percent.[8] The small, confined fire incidents dominate the alarm profile and produce the pronounced peaks and valleys; the larger, nonconfined fires, experience an early morning low and an evening peak as well, but less pronounced. In general, they occur more regularly throughout the day.

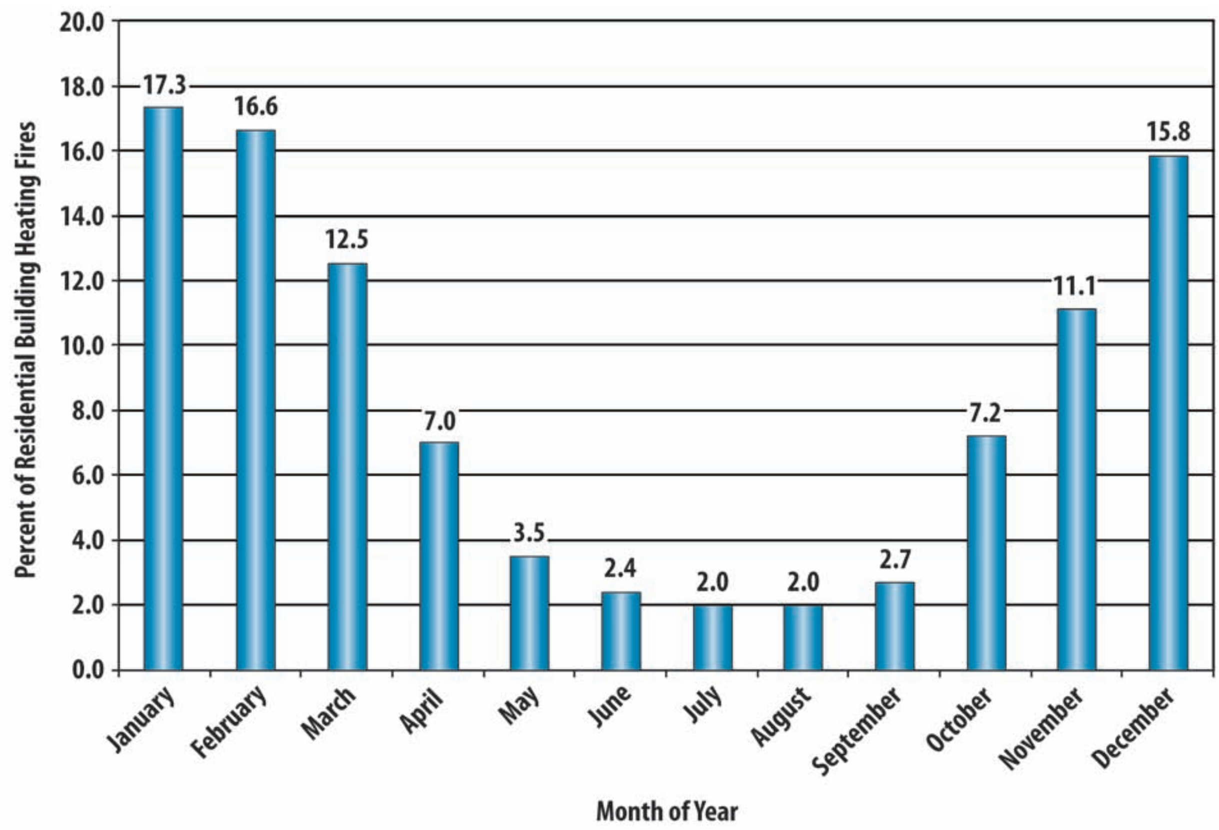
Figure 1. Residential Building Heating Fires by Time of Alarm (2005—2007)



Source: NFIRS 5.0.

As to be expected, residential heating fires are most prevalent during the winter months from December through February when the use of central heating systems, portable heaters, and fireplaces is most common (Figure 2). The incidence of heating fires peaks in January and February at 17 percent each. From March to August, fires decline from 13 percent to 2 percent. The percent of fires declines to the lowest point during the summer months from June to August, corresponding to reduced heating activities in residential buildings. Both confined and nonconfined residential heating fires follow this overall pattern of winter peaks and summer lows. Residential heating fires during the summer months tend to be confined fuel burner/boiler malfunction fires (64 percent) or involve water heaters (10 percent).

Figure 2. Residential Building Heating Fires by Month (2005–2007)



Source: NFIRS 5.0.

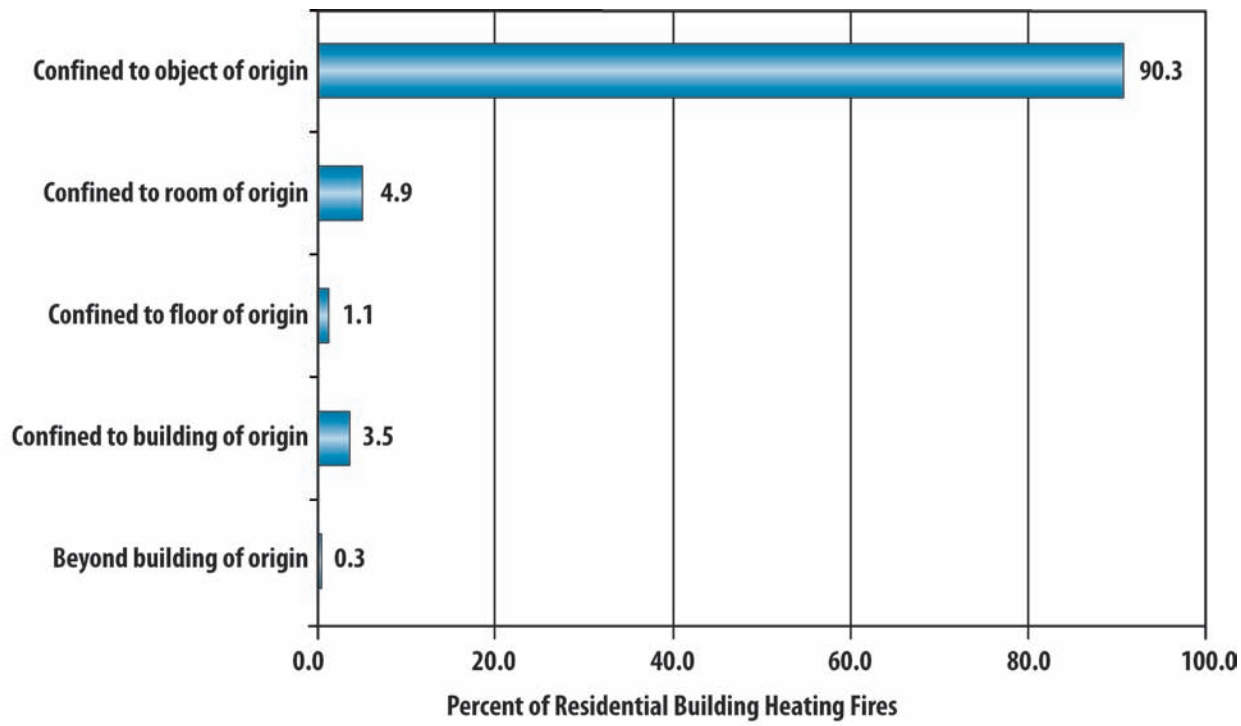
Fire Spread in Residential Building Heating Fires

Ninety percent of residential heating fires are confined to the object of origin (Figure 3). These fires are primarily coded as confined fires in NFIRS—96 percent of residential heating fires confined to the object of origin are coded as confined fires.[9] Few fires, 5 percent, extend beyond the room of origin.

Confined Fires

NFIRS allows abbreviated reporting for confined fires and many reporting details of these fires are not required nor reported. Confined residential heating fires account for the majority of residential heating fire incidents and dominate the time of alarm profile. The numbers of confined fires are greatest during the hours of 5 p.m. to 9 p.m. when they account for 91 percent of fires that occur during this period. Confined residential heating fires peak in January and February, decline through May, and are lowest during the months of June through August.

Figure 3. Extent of Fire Spread in Residential Building Heating Fires (2005–2007)



Source: NFIRS 5.0.

Nonconfined Fires

The next sections of this topical report will address nonconfined residential heating fires, where detailed fire data are available.

Where Nonconfined Residential Building Heating Fires Start

One- and two-family residences are disproportionately represented in residential heating fires. Heating fires in one- and two-family residences account for 81 percent of residential heating fires—yet one- and two-family residences represent only 66 percent of residential fires. Multifamily dwellings account for an additional 15 percent of these heating fires. Multifamily dwellings (apartments, condominiums, and the like) often have professionally maintained heating systems which may account for these differences in fire incidence.

Five areas in the home—heating rooms/areas or water heater areas (16 percent); cooking areas and kitchens (11 percent); common rooms or lounge areas (10 percent); bedrooms (9 percent), and walls or concealed wall spaces (7 percent)—account for over half of nonconfined residential heating fires (Table 3).

Table 3. Leading Areas of Fire Origin in Nonconfined Residential Building Heating Fires (2005–2007)

Area of Origin	Percent (Unknowns Apportioned)
Heating room or area, water heater area	16.1
Cooking area, kitchen	10.7
Common room, den, family room, living room, lounge	10.4
Bedrooms	8.8
Wall assembly, concealed wall space	6.7

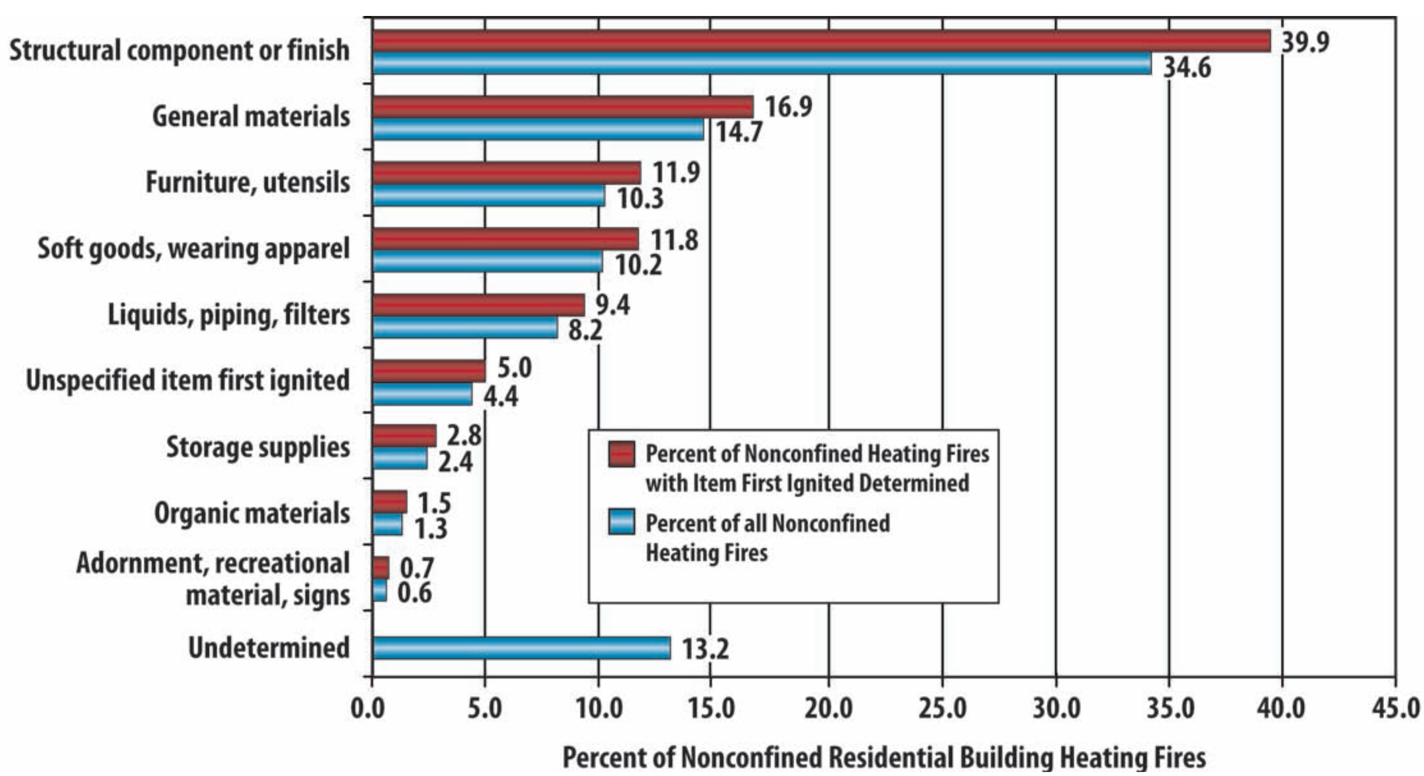
Source: NFIRS 5.0.

Items First Ignited in Nonconfined Residential Building Heating Fires

Forty percent of the items first ignited in nonconfined residential heating fires fall under the "structural component or finish" category (Figure 4). This category includes structural members or framing, exterior trim and finishes, interior wall coverings, insulation within the walls, partitions, and floor/ceiling surfaces. The second leading category is "general materials," a catch-all category that includes items such as electrical wire insulation, trash/rubbish, and residues (such as chimney residue). The general materials category accounts for 17 percent of nonconfined residential heating fires. At 12 percent, "furniture" is the third leading category of items first ignited.

Structural members or framing (18 percent) and electrical wire and cable insulation (11 percent) are the specific items most often first ignited in nonconfined residential heating fires.

Figure 4. Item First Ignited in Nonconfined Residential Building Heating Fires by Major Category (2005–2007)

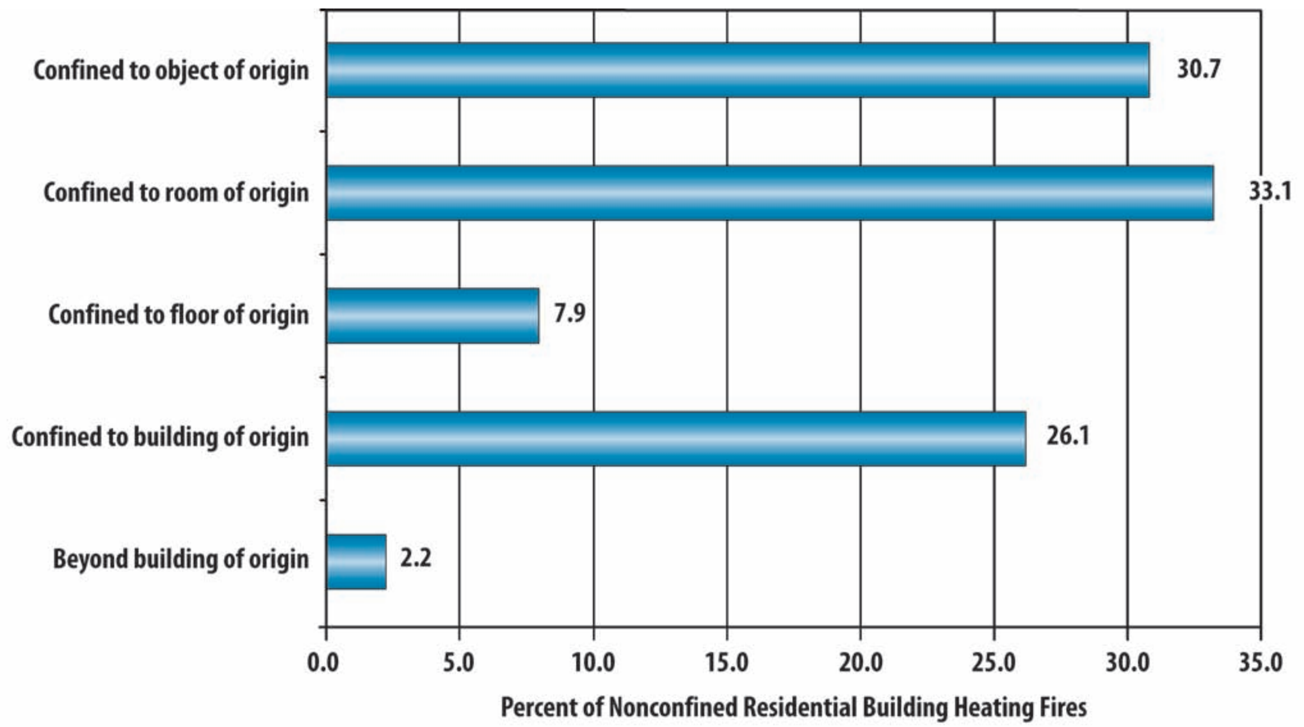


Source: NFIRS 5.0.

Fire Spread in Nonconfined Residential Building Heating Fires

The majority of nonconfined fires, 64 percent, are limited to the object or room of fire origin (Figure 5). The fire spread profile for nonconfined residential heating fires is similar to the fire spread profile for all nonconfined residential fires with slightly more nonconfined heating fires being confined to the room or object of origin.

Figure 5. Extent of Fire Spread in Nonconfined Residential Building Heating Fires (2005–2007)



Source: NFIRS 5.0.

Factors Contributing to Ignition

Table 4 shows the categories of factors contributing to ignition for nonconfined residential heating fires. The "misuse of material or product" is the leading category contributing (39 percent) to the ignition of nonconfined residential heating fires. "Mechanical failure or malfunction" is the second leading category in 23 percent of residential heating fires and "operational deficiency" is the third leading category in 18 percent of the fires. These 3 categories play a role in 79 percent of nonconfined residential heating fires.

Heat source too close to combustibles (31 percent) is, by far, the leading specific factor contributing to ignition. Heat source too close to combustibles is more than twice the second leading factor contributing to ignition, miscellaneous mechanical failure/malfunction (13 percent).

Table 4. Factors Contributing to Ignition for Nonconfined Residential Building Heating Fires by Major Category (Where Factor Contributing Specified, 2005–2007)

Factor Contributing to Ignition Category	**Percent of Nonconfined Residential Building Heating Fires** (Unknowns Apportioned)
Misuse of material or product	38.7
Mechanical failure, malfunction	22.7
Operational deficiency	17.6
Electrical failure, malfunction	17.2
Design, manufacture, installation deficiency	10.5
Other factors contributing to ignition	3.4
Natural condition	0.9
Fire spread or control	0.8

Source: NFIRS 5.0.
Notes: 1) Includes only incidents where factors that contributed to the ignition of the fire were specified.
2) Multiple factors contributing to fire ignition may be noted for each incident; total will exceed 100 percent.

Suppression/Alerting Systems in Residential Building Heating Fires

Smoke alarm data are available for both confined and nonconfined fires although for confined fires, the data are very limited in scope.

Smoke alarms were present in 54 percent of nonconfined residential heating fires (Table 5). Smoke alarms are known to have operated in 30 percent of nonconfined heating fires. Smoke alarms were not present in 23 percent of the nonconfined residential heating fires. Firefighters were unable to determine if a smoke alarm was present in another 23 percent of these nonconfined fires. Of the nonconfined residential heating fires where a smoke alarm was present, the alarms failed to operate in 18 percent of the incidents.

Smoke alarms operated and alerted occupants in 20 percent of confined fires (Table 6). Occupants were not alerted by the smoke alarm in 25 percent of confined residential heating fires.[10] Smoke alarm effectiveness was unknown in 55 percent of confined residential heating fires. Note that the data presented in Table 5 and Table 6 are the raw counts from the NFIRS data set and not scaled to national estimates of smoke alarms in residential heating fires.

Table 5. NFIRS Smoke Alarm Data for Nonconfined Residential Building Heating Fires (NFIRS, 2005–2007)

Presence of Smoke Alarms	Smoke Alarm Operational Status	Smoke Alarm Effectiveness	Count	Percent
Present	Fire too small to activate smoke alarm		842	8.0
	Smoke alarm operated	Smoke alarm alerted occupants, occupants responded	2,336	22.2
		Smoke alarm alerted occupants, occupants failed to respond	109	1.0
		No occupants	353	3.3
		Smoke alarm failed to alert occupants	86	0.8
		Undetermined	240	2.3
	Smoke alarm failed to operate		1,005	9.5
	Undetermined		733	7.0
None present			2,371	22.5
Undetermined			2,468	23.4
Total Incidents			10,543	100.0

Source: NFIRS 5.0.
Notes: The data presented in this table are raw data counts from the NFIRS data set. They do not represent national estimates of smoke alarms in nonconfined residential building heating fires. They are presented for informational purposes. Total may not add to 100 percent due to rounding.

Table 6. NFIRS Smoke Alarm Data for Confined Residential Building Heating Fires (NFIRS, 2005–2007)

Smoke Alarm Effectiveness	Count	Percent
Smoke alarm alerted occupants	14,356	20.4
Smoke alarm did not alert occupants	17,432	24.8
Unknown	38,501	54.8
Null/Blank	1	0.0
Total Incidents	70,290	100.0

Source: NFIRS 5.0.
Notes: The data presented in this table are raw data counts from the NFIRS data set. They do not represent national estimates of smoke alarms in confined residential building heating fires. They are presented for informational purposes. Total may not add to 100 percent due to rounding.

Automatic Extinguishing System (AES) data are only available for nonconfined fires. Full or partial AESs were present in only 2 percent of nonconfined residential heating fires (Table 7). The lack of AES is not unexpected as only 3 percent of all nonconfined residential building fires have AES present.

Table 7. NFIRS Automatic Extinguishing System Data for Nonconfined Residential Building Heating Fires (2005–2007)

AES Presence	Count	Percent
AES present	256	2.4
Partial system present	5	0.0
AES not present	9,908	94.0
Undetermined	374	3.5
Total Incidents	10,543	100.0

Source: NFIRS 5.0.
Notes: The data presented in this table are raw data counts from the NFIRS data set. They do not represent national estimates of AESs in nonconfined residential building heating fires. They are presented for informational purposes. Totals may not add to 100 percent due to rounding.

Examples

The following are some recent examples of residential heating fires. These fires were reported by the media.

- June 2009: Hillsboro, OR, fire officials reported that a fire was caused in a home when the homeowner was replacing his water heater. The homeowner was using a propane torch to connect the water pipes when the flames erupted. The damage was contained to the crawl spaces of the home.[11]
- June 2009: A furnace that was overdue for repairs and that may have been modified is likely to blame for a fire in the Newman Building in Durango, CO, which displaced several tenants. The fire caused severe structural damage. Damaged insulation around electrical wiring and misplacement of an air filter in the furnace were under investigation as causes of the furnace fire.[12]
- October 2009: Firefighters responded to a multifamily building fire started by a boiler in the basement. Residents were evacuated and the fire was extinguished. This fire marked one of several boiler fires that the Providence, RI, firefighters had responded to over the past few weeks. The fire chief recommended that people call a heating professional each year to check their heating systems.[13]
- October 2009: Two people were displaced from their home in Lancaster, OH, when a baseboard heating fire destroyed their house. No one was injured and firefighters were able to control the blaze within minutes of arriving on the scene.[14]

Conclusion

Safer heating equipment and public awareness of heating fire prevention have substantially decreased the incidence of residential heating fires. Chimney maintenance is now more often the norm rather than the exception. Although the numbers of these fires have decreased, residential building heating fires still affect neighborhoods and communities, and therefore, continue to receive attention within local fire departments and State agencies. This attention is largely because residential building heating fires account for and cause injuries and deaths as well as property damage. Many of these fires can be prevented through proper maintenance and proper use of heating equipment.

Despite the decrease in residential building heating fires, they remain worrisome. The ebb and flow of energy pricing and availability affects the choices people make to heat their homes. As conventional energy sources—oil, electricity, natural gas, etc. — rise and fall in price and availability, alternative heating becomes more attractive, and with it, the potential for the reemergence of residential heating fires.

NFIRS Data Specifications for Residential Building Heating Fires

Data for this report were extracted from the NFIRS annual Public Data Release files for 2005, 2006, and 2007. Only version 5.0 data were extracted.

Residential building heating fires were defined as:

- Incident Types 111, 112, 114, 116, 120 to 123:[15]

continued on next page

Incident Type	Description
111	Building fire
112	Fires in structure other than in a building
114	Chimney or flue fire, confined to chimney or flue
116	Fuel burner/boiler malfunction, fire confined
120	Fire in mobile property used as a fixed structure, other
121	Fire in mobile home used as fixed residence
122	Fire in motor home, camper, recreational vehicle
123	Fire in portable building, fixed location

Note that Incident Types 114 and 116 do not specify if the structure is a building.

Incident Type 112 is included as previous analyses have shown that Incident Types 111 and 112 are used interchangeably.

- Structure type:
  - 1 - Enclosed building
  - 2 - Fixed portable or mobile structure
  - Structure type not specified (null entry)
- Aid types 3 (mutual aid given) and 4 (automatic aid given) were excluded to avoid double counting of incidents.
- Property use 400 to 464:

Property Use	Description
400	Residential, other
419	One- and two-family dwelling
429	Multifamily dwelling
439	Boarding/Rooming house, residential hotels
449	Hotel/Motel, commercial
459	Residential board and care
460	Dormitory-type residence, other
462	Sorority house, fraternity house
464	Barracks, dormitory

- The USFA cause hierarchy was used to determine residential building heating fire incidents:[16]
- Heating fire incidents involving heating stoves and food were believed to be cooking fires. As a result, fires with equipment involved in ignition code 124 (stove, heating) and item first ignited code 76 (cooking materials; includes edible materials for man or animal; excludes cooking utensils) were removed from the query.

To request additional information or to comment on this report, visit http://www.usfa.dhs.gov/applications/feedback/index.jsp

Notes:

[1] National estimates are based on 2005 to 2007 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 surveys of fire loss. Fires are rounded to the nearest 100, deaths to the nearest 5, injuries to the nearest 25, and loss to the nearest $million.

[2] In NFIRS, version 5.0, a structure is a constructed item of which a building is one type. In previous versions of NFIRS, the term "residential structure" commonly referred to buildings where people live. To coincide with this concept, the definition of a residential structure fire for NFIRS 5.0 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.

[3] Residential buildings include, but are not limited to, one- or two-family dwellings, multifamily dwellings, boarding houses or residential hotels, commercial hotels, college dormitories, and sorority/fraternity houses.

[4] For 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.

[5] Fire in the United States 1983–1990, Eighth Edition, U.S. Fire Administration, Federal Emergency Management Agency, October 1993.

continued on next page

[6] NFIRS distinguishes between “content” and “property” loss. Content loss includes loss to the contents of a structure due to damage by fire, smoke, water, and overhaul. Property loss includes losses to the structure itself or to the property itself. Total loss is the sum of the content loss and the property loss. For confined fires, the expectation is that the fire did not spread beyond the container (or rubbish for incident type 118) and hence, there was no property damage (damage to the structure itself) from the flames. There could be, however, property damage as a result of smoke, water, and overhaul.

[7] The average fire death and fire injury loss rates computed from the national estimates above will not agree with average fire death and fire injury loss rates computed from NFIRS data alone. The fire death rate computed from national estimates would be (1,000*(190/54,500)) = 3.5 deaths per 1,000 residential building heating fires and the fire injury rate would be (1,000*(625/54,500)) =11.5 injuries per 1,000 residential building heating fires.

[8] For the purposes of this report, the time of the fire alarm is used as an approximation for the general time the fire started. However, in NFIRS, it is the time the fire was reported to the fire department.

[9] In NFIRS, confined fires are defined by Incident Type codes 113 to 118.

[10] In confined fires, the entry “smoke alarm did not alert occupants” can mean: no smoke alarm was present, the smoke alarm was present but did not operate, or the smoke alarm was present and operated but the occupant was already aware of the fire.

[11] “Soldering Torch Sparks Residential Fire in Hillsboro,” Salem-News.com, June 24, 2009. http://www.salem-news.com/articles/june242009/hillsboro_fire_6-24-09.php (accessed July 7, 2009).

[12] Garrett Andrews, “Furnace likely cause of April fire,” durangoherald.com, June 27, 2009. http://durangoherald.com/sections/News/2009/06/27/Furnace_likely_cause_of_April_fire/ (accessed July 10, 2009).

[13] Kate Bramson, “Weather keys rash of boiler fire calls,” www.projo.com, October 17, 2009. http://www.projo.com/news/content/BOILER_FIRES_10-17-09_CAG499L_v6.353f3d9.html (accessed October 28, 2009).

[14] Morgan Day, “Residents say baseboard heating caused fire in home,” www.lancastereaglegazette.com, October 27, 2009. http://www.lancastereaglegazette.com/article/20091027/NEWS01/910270305.

[15] Heating is defined by the equipment used to heat a residential building. Incident Types 113, 115, 117, and 118 were excluded because by definition these Incident Types were not heating fires.

[16] The USFA cause hierarchy is designed for structure fires. Buildings are a subset of structures. The cause hierarchy can be found at: http://www.usfa.dhs.gov/fireservice/nfirs/tools/fire_cause_category_matrix.shtm.