HIGH-RISE BUILDING FIRES

John R. Hall, Jr.

June 2009

National Fire Protection Association
Fire Analysis and Research Division

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Abstract

In 2003-2006, there were an average of 13,400 reported structure fires in high-rise buildings per year and associated losses of 62 civilian deaths, 490 civilian injuries, and $179 million in direct property damage per year. Four property classes account for the majority of high-rise fires: office buildings, hotels, apartment buildings, and facilities that care for the sick. Automatic fire protection equipment and fire-resistive construction are more common in high-rise buildings that have fires than in other buildings of the same property use that have fires. The risks of fire, fire death, and direct property damage due to fire tend to be lower in high-rise buildings than in other buildings of the same property use.

Keywords: fire statistics, high-rise, apartments, care of sick, office, hotel, fire protection, hospital, clinic, doctor's office

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

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Executive Summary

In 2003-2006, an estimated 13,400 reported high-rise structure fires per year resulted in associated losses of 62 civilian deaths, 490 civilian injuries, and $179 million in direct property damage per year. An estimated 2.7% of all 2003-2006 reported structure fires were in high-rise buildings.

The trends in high-rise fires and associated losses (inflation-adjusted for property damage) are clearly down, but the sharp post-1998 reduction appears to be mostly due to the change to NFIRS Version 5.0, which is shifting estimates to lower levels that also appear to be more accurate.

Four property classes account for the majority of high-rise fires: apartments, hotels, facilities that care for the sick, and offices. In 2003-2006, in these four property classes combined, there were 9,600 reported high-rise structure fires per year and associated losses of 29 civilian deaths, 320 civilian injuries, and $44 million in direct property damage per year.

This report emphasizes these four property classes. Some other property uses – such as stores and restaurants – may represent only a single floor in a tall building primarily devoted to other uses. Some property uses – such as grain elevators and factories – can be as tall as a high-rise building but without a large number of separate floors or stories. For these reasons, the four property use groups listed above define most of the buildings we think of as high-rise buildings, and their fires come closest to defining what we think of as the high-rise building fire problem.

By most measures of loss, the risks of fire and of associated fire loss are lower in high-rise buildings than in other buildings of the same property loss. This statement applies to risk of fire, civilian fire deaths, civilian fire injuries, and direct property damage due to fire, relative to housing units, for apartments, hotels, offices, and facilities that care for the sick.

The usage of wet pipe sprinklers and fire detection equipment is higher in high-rise buildings than in other buildings, for each property use group. Even so, considering the extensive requirements in NFPA 101®, *Life Safety Code*®, for fire and life safety features in both new and existing high-rise buildings, it seems clear that there are still major gaps, particularly in adoption and enforcement of the provisions requiring retrofit of automatic sprinkler systems and other life safety systems in existing high-rise buildings. NFPA 1®, *Fire Code*,® has sprinkler retrofit requirements.

This has implications for public officials and ordinary citizens in any city. Public officials should make sure that the latest editions of NFPA®, *Fire Code*®, and NFPA 101®, *Life Safety Code*®, are in place and that the codes they have are supported by effective code enforcement provisions, including plan review and inspection processes, both for new construction and for continued supervision of code compliance in existing buildings. The public can take responsibility for their own safety by insisting that their

public officials take these steps. As in so many areas of fire safety, we know what to do, but we still need to do it.

The trend had been toward a smaller share of fires being reported each year as occurring in buildings with fire-resistive construction, both for high-rise and other buildings, with the decline being most dramatic in facilities that care for the sick. This statistical decline could reflect any or all of the following: (a) a shift in construction between the two types permitted by codes, from Type I (442 or 332) construction, which is coded as fire-resistive, to Type II (222) construction, which is coded as protected non-combustible; (b) a shift to acceptable alternative designs using more sprinklers and less fire-resistive construction; or (c) enough success in containing fires that a rising fraction never are reported to fire departments, because the fires are caught and controlled so early by occupants.

Most high-rise building fires begin on floors no higher than the 6th story. The fraction of 2003-2006 high-rise fires that began on the 7th floor or higher was 27% for apartments, 22% for hotels and motels, 13% for facilities that care for the sick, and 30% for office buildings.

Means of egress include the following areas of origin:

- Hallway or corridor
- Interior stairway
- Exterior stairway
- Entrance way or lobby
- Escalator
- Unclassified means of egress

High-rise apartments have a slightly larger share of their fires originating in means of egress than do their shorter counterparts (4% vs. 3%). The same is true of hotels (5% vs. 4%). In offices (3% vs. 5%) and facilities that care for the sick (2% vs. 6%), the differences in percentages are larger and in the opposite direction; high-rise buildings in those properties have a smaller share of their fires originating in means of egress.

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What is a High-Rise?

Paragraph 3.3.28.7 of NFPA 101®, *Life Safety Code*®, 2009 edition, defines a high-rise building as a building more than 75 feet (23 meters) in height, measured from the lowest level of fire department vehicle access to the floor of the highest occupiable story. A height of 75 feet translates into roughly seven stories.

The number of stories was first captured in U.S. national fire incident coding in Version 4.0 of the National Fire Incident Reporting System (NFIRS). This version was in widespread use by 1985. Version 5.0, introduced in 1999, provides separate coding for the total number of stories and the number of stories above and below ground. In keeping with the definition in NFPA 101®, *Life Safety Code*®, a height above ground of seven or more stories is used to define high-rise from 1999 on.

Prior to 1999, the National Fire Incident Reporting System (NFIRS) coded building height in ranges, including four that may be considered high-rise: 7-12 stories, 13-24 stories, 25-49 stories, and 50 stories or more.

NFPA and other analysts have long used lists of particularly memorable incidents to study the high-rise fire problem, but these and other available special data bases are heavily weighted toward larger and more severe incidents. They should be viewed as illustrative but not representative.

The Council on Tall Buildings and Urban Habitat was created in 1969 in part to disseminate information on tall building technology. Visit their website at www.ctbuh.org for more information on their resources.

High-Rise Building Fires

In 2003-2006, an estimated 13,400 reported high-rise structure fires per year resulted in associated losses of 62 civilian deaths, 490 civilian injuries, and $179 million in direct property damage per year.

Four property classes account for the majority of high-rise fires:

- Apartments (Property Use codes 420-429),
- Hotels (Property Use codes 440-449),
- Facilities that care for the sick – hospitals, clinics, and doctor's offices (Property Use codes 330-339; also includes code 593 (medical or research office) prior to 1999 and NFIRS Version 5.0; also includes codes 340-349 in and after 1999 under NFIRS Version 5.0),
- Offices, excluding doctor's offices (Property Use codes 590-599, excluding 593).

In 2003-2006, in these four property classes combined, there were 9,600 reported high-rise structure fires per year and associated losses of 29 civilian deaths, 320 civilian injuries, and $44 million in direct property damage per year. See Table 1 for statistics for each year of 1985 to 1998 and for the average for 2003-2006, for each of these four property use classes and for the four property uses combined.

This report emphasizes these four property classes. Some other property uses – such as stores and restaurants – may represent only a single floor in a tall building primarily devoted to other uses. Some property uses – such as grain elevators and factories – can be as tall as a high-rise building but without a large number of separate floor or stories. For these reasons, the four property use groups listed above define most of the buildings we think of as high-rise buildings, and their fires come closest to defining what we think of as the high-rise building fire problem.

The calculations for Table 1 were done so as to proportionally allocate fires with height of structure unreported, with the allocation done separately for the four property classes and the four measures of loss – incidents, deaths, injuries, and property damage. Fires with number of stories above ground reported as zero nearly always also report stories below ground as unknown or zero. This suggests a zero value nearly always means unknown height, and so zeros are treated as unknowns. See Appendix A for more details on statistical methods.

These statistics generally show a declining fire problem from 1985 to 1998. After 1998, fires and losses declined more rapidly for apartments, hotels, and facilities that care for the sick. For various technical reasons (discussed more in Appendix B) it is likely that the new numbers are more accurate than the old numbers, and the more rapid decline is not real.

It is worth noting, in Table 1, that most high-rise building fires and associated losses occur in apartment buildings. This may seem surprising, but it shouldn't. Homes dominate the U.S. fire problem so completely that it is always a good bet that any newly

examined fire problem, unless it is one that cannot occur in homes, will have its largest share in homes.

Table 2 provides more detail, indicating 2003-2006 structure fires by number of stories, for each of the four property classes.

Overall, 2.7% of 2003-2006 structure fires occurred in high-rise properties. Table 3 shows how the percentage varies for a range of mixed-use properties, from a high of 14.6% in medical use properties to a low of 1.0% in farm use properties.

Buildings under construction or major renovation accounted for 4% of high-rise office fires in 2003-2006 (as well as 16% of associated direct property damage), 2% of high-rise hotel fires, and 1% of high-rise apartment fires (as well as 3% of associated direct property damage).

Table 1. High-Rise Building Fires in Selected Property Classes, by Year

A. Apartments

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions) As Reported	Direct Property Damage (in Millions) 2006 Dollars	What Percentage of All Apartment Fires Were High-Rise?
1985	11,700	54	470	$15	$29	10%
1986	10,300	32	380	$21	$40	9%
1987	8,900	46	520	$22	$38	8%
1988	10,300	83	640	$48	$82	9%
1989	11,000	97	610	$30	$49	10%
1990	9,400	76	460	$22	$35	9%
1991	9,900	23	590	$129*	$191*	9%
1992	10,300	31	640	$19	$28	9%
1993	9,600	43	600	$41	$57	9%
1994	8,900	51	830	$36	$49	9%
1995	7,700	53	530	$31	$41	8%
1996	9,600	56	650	$33	$43	10%
1997	9,200	27	480	$30	$37	10%
1998	8,100	35	570	$23	$28	9%
2003-2006 average	8,300 (2,500)	26 (26)	280 (220)	$33 ($32)	$34 ($33)	7%

*Property damage figures for apartments in 1991 are inflated by problems in handling the Oakland wildfire in the estimates.

Note: Figures in parentheses exclude fires reported as confined fires – confined to fuel burner or boiler, cooking vessel, chimney or flue, trash, incinerator, or commercial compactor. These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional share of fires with unknown building height (until 1998) or number of stories above ground coded as unknown, blank or zero (from 1999 on). Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Property damage has been adjusted for inflation, using the Consumer Price Index, to 2006 dollars.

Source: NFIRS and NFPA survey.

Table 1. High-Rise Building Fires in Selected Property Classes, by Year (Continued)

B. Hotels

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions) As Reported	Direct Property Damage (in Millions) 2006 Dollars	What Percentage of All Hotel and Motel Fires Were High-Rise?
1985	1,800	0	70	$2	$3	21%
1986	1,600	0	50	$2	$4	20%
1987	1,500	5	40	$6	$11	20%
1988	1,800	8	60	$20	$34	24%
1989	1,600	5	60	$4	$7	22%
1990	1,600	7	120	$6	$9	24%
1991	1,300	0	90	$6	$9	21%
1992	1,300	0	80	$4	$6	21%
1993	1,000	0	60	$6	$9	17%
1994	900	0	70	$4	$6	17%
1995	1,000	0	70	$5	$7	20%
1996	1,100	8	100	$17	$22	21%
1997	800	6	40	$9	$11	18%
1998	800	0	20	$11	$13	19%
2003-2006 average	500 (300)	2 (2)	30 (30)	$7 ($7)	$7 ($7)	12%

Note: Figures in parentheses exclude fires reported as confined fires – confined to fuel burner or boiler, cooking vessel, chimney or flue, trash, incinerator, or commercial compactor. These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional share of fires with unknown building height (until 1998) or number of stories above ground coded as unknown, blank or zero (from 1999 on). Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Property damage has been adjusted for inflation, using the Consumer Price Index, to 2006 dollars.

Source: NFIRS and NFPA survey.

Table 1. High-Rise Building Fires in Selected Property Classes, by Year (Continued)

C. Facilities That Care for the Sick

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions) As Reported	Direct Property Damage (in Millions) 2006 Dollars	What Percentage of All Apartment Fires Were High-Rise?
1985	2,500	11	120	$2	$4	34%
1986	2,000	4	30	$1	$1	32%
1987	1,700	0	70	$2	$3	28%
1988	1,500	2	70	$1	$2	30%
1989	1,400	9	110	$5	$8	30%
1990	1,400	0	40	$3	$5	33%
1991	1,200	0	50	$3	$5	31%
1992	1,100	2	20	$3	$4	27%
1993	1,000	0	30	$3	$4	28%
1994	900	6	40	$4	$5	26%
1995	800	2*	40	$3	$3	26%
1996	900	0*	20	$4	$6	28%
1997	800	0	30	$1	$1	25%
1998	600	2	80	$6	$8	24%
2003-2006	400 (200)	0 (0)	0 (0)	$1 ($1)	$1 ($1)	17%

*Based on high-rise share of fires in 1995 and 1996, because all deaths were in buildings with unknown height.

Note: Figures in parentheses exclude fires reported as confined fires – confined to fuel burner or boiler, cooking vessel, chimney or flue, trash, incinerator, or commercial compactor. These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional share of fires with unknown building height (until 1998) or number of stories above ground coded as unknown, blank or zero (from 1999 on). Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Property damage has been adjusted for inflation, using the Consumer Price Index, to 2006 dollars. Facilities that care for the sick include hospitals, clinics, and doctor's offices.

Source: NFIRS and NFPA survey.

Table 1. High-Rise Building Fires in Selected Property Classes, by Year (Continued)

D. Offices

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions) As Reported	Direct Property Damage (in Millions) 2006 Dollars	What Percentage of All Office Fires Were High-Rise?
1985	1,200	1	10	$6	$11	14%
1986	1,100	1	80	$17	$32	13%
1987	900	2	10	$7	$12	11%
1988	1,000	0	20	$34	$59	14%
1989	900	0	20	$18	$30	13%
1990	900	0	10	$15	$24	14%
1991	800	0	10	$12	$18	12%
1992	1,000	1	90	$57	$81	13%
1993	800	0	20	$10	$14	13%
1994	600	0	16	$16	$21	11%
1995	500	0	50	$6	$7	10%
1996	500	0	20	$14	$18	9%
1997	600	0	10	$3	$4	11%
1998	500	0	10	$3	$4	10%
2003-2006 average	400 (200)	0 (0)	0 (0)	$4 ($4)	$4 ($4)	10%

Note: Figures in parentheses exclude fires reported as confined fires – confined to fuel burner or boiler, cooking vessel, chimney or flue, trash, incinerator, or commercial compactor. These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional share of fires with unknown building height (until 1998) or number of stories above ground coded as unknown, blank or zero (from 1999 on). Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Property damage has been adjusted for inflation, using the Consumer Price Index, to 2006 dollars. Offices include general business offices, bank buildings, and post offices, but exclude doctor's offices, which are included in facilities that care for the sick.

In 1985, 1986, 1989, 1991, and 1992, all office fire deaths, were in buildings with unreported height. An estimated three deaths were allocated. Property damage figures for office buildings are underestimated in several years due to problems in handling some large-loss fires, such as the $325 million One Meridian Plaza fire in Pennsylvania in 1991 and the $230 million World Trade Center incident in 1993, whose more than 1,000 injuries also are not properly reflected in national estimates.

Source: NFIRS and NFPA survey.

Table 1. High-Rise Building Fires in Selected Property Classes, by Year (Continued)

E. Four Property Use Groups Combined

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions) As Reported	2006 Dollars
1985	17,200	66	670	$25	$48
1986	15,100	38	550	$41	$76
1987	13,000	52	640	$36	$64
1988	14,600	94	780	$104	$177
1989	14,800	111	800	$58	$94
1990	13,300	84	620	$47	$73
1991	13,100	23	750	$150	$222
1992	13,600	35	830	$83	$119
1993	12,400	43	700	$60	$84
1994	11,400	57	950	$60	$82
1995	10,000	55	690	$44	$59
1996	12,100	64	790	$69	$88
1997	11,400	33	560	$43	$54
1998	10,000	37	680	$42	$52
2003-2006 average	9,600 (3,200)	29 (29)	320 (250)	$44 ($44)	$46 ($45)

Note: Figures in parentheses exclude fires reported as confined fires – confined to fuel burner or boiler, cooking vessel, chimney or flue, trash, incinerator, or commercial compactor. These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional share of fires with unknown building height (until 1998) or number of stories above ground coded as unknown, blank or zero (from 1999 on). Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Property damage has been adjusted for inflation, using the Consumer Price Index, to 2006 dollars.

Property damage figures for apartments in 1991 are inflated by problems in handling the Oakland wildfire in the estimates. Property damage figures for office buildings are underestimated in several years due to problems in handling some large-loss fires, such as the $325 million One Meridian Plaza fire in Pennsylvania in 1991 and the $230 million World Trade Center incident in 1993, whose more than 1,000 injuries also are not properly reflected in national estimates. The events of September 11, 2001, are not reflected in these figures.

Source: NFIRS and NFPA survey.

Table 2. Fires in Selected Properties, by Number of Stories Above Ground
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

A. Apartments

	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
1 story	16,420	(14%)	83	(18%)	405	(11%)	$98	(9%)
2 stories	53,770	(47%)	218	(49%)	1,987	(52%)	$546	(48%)
3 stories	25,890	(23%)	94	(21%)	926	(24%)	$361	(32%)
4 stories	5,420	(5%)	18	(4%)	130	(3%)	$64	(6%)
5 stories	1,940	(2%)	4	(1%)	68	(2%)	$13	(1%)
6 stories	1,560	(1%)	5	(1%)	45	(1%)	$16	(1%)
Total not high-rise (1-6 stories)	**104,990**	**(93%)**	**423**	**(94%)**	**3,561**	**(93%)**	**$1,098**	**(97%)**
7 stories	930	(1%)	4	(1%)	45	(1%)	$3	(0%)
8 stories	600	(1%)	4	(1%)	31	(1%)	$3	(0%)
9 stories	570	(1%)	1	(0%)	18	(0%)	$1	(0%)
10 stories	880	(1%)	3	(1%)	22	(1%)	$2	(0%)
11 stories	360	(0%)	2	(0%)	14	(0%)	$1	(0%)
12 stories	690	(1%)	2	(0%)	15	(0%)	$2	(0%)
13 or more stories	4,250	(4%)	12	(3%)	138	(3%)	$20	(2%)
Total high-rise (7 or more stories)	**8,280**	**(7%)**	**26**	**(6%)**	**282**	**(7%)**	**$33**	**(3%)**

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional shares of fire with number of stories above ground coded as unknown, blank or zero. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars without adjustment for inflation.

Source: NFIRS and NFPA survey.

Table 2. Fires in Selected Properties, by Number of Stories Above Ground (Continued)
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

B. Hotels

	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
1 story	660	(17%)	6	(46%)	17	(11%)	$9	(14%)
2 stories	1,270	(32%)	3	(28%)	53	(36%)	$23	(38%)
3 stories	910	(23%)	1	(10%)	32	(22%)	$18	(29%)
4 stories	310	(8%)	0	(0%)	12	(8%)	$2	(3%)
5 stories	180	(4%)	0	(0%)	4	(2%)	$1	(1%)
6 stories	130	(3%)	0	(0%)	5	(4%)	$2	(3%)
Total not high-rise (1-6 stories)	**3,460**	**(88%)**	**10**	**(85%)**	**123**	**(83%)**	**$55**	**(89%)**
7 stories	40	(1%)	1	(4%)	10	(6%)	$3	(6%)
8 stories	60	(2%)	0	(0%)	6	(4%)	$1	(1%)
9 stories	40	(1%)	0	(0%)	0	(0%)	$1	(1%)
10 stories	40	(1%)	0	(0%)	1	(0%)	$0	(0%)
11 stories	30	(1%)	0	(0%)	0	(0%)	$0	(0%)
12 stories	50	(1%)	0	(0%)	2	(1%)	$0	(0%)
13 or more stories	250	(6%)	1	(11%)	7	(5%)	$1	(2%)
Total high-rise (7 or more stories)	**490**	**(12%)**	**2**	**(15%)**	**26**	**(17%)**	**$7**	**(11%)**

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional shares of fire with number of stories above ground coded as unknown, blank or zero. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars without adjustment for inflation.

Source: NFIRS and NFPA survey.

Table 2. Fires in Selected Properties, by Number of Stories Above Ground (Continued)
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

C. Facilities That Care for the Sick

	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
1 story	700	(31%)	0	(0%)	4	(14%)	$11	(44%)
2 stories	350	(15%)	0	(0%)	4	(12%)	$5	(22%)
3 stories	340	(15%)	0	(0%)	6	(20%)	$4	(15%)
4 stories	200	(9%)	0	(0%)	5	(15%)	$3	(12%)
5 stories	170	(8%)	0	(38%)	4	(12%)	$0	(2%)
6 stories	140	(6%)	0	(0%)	4	(13%)	$0	(2%)
Total not high-rise (1-6 stories)	**1,900**	**(83%)**	**0**	**(38%)**	**27**	**(85%)**	**$5**	**(96%)**
7 stories	70	(3%)	0	(0%)	0	(0%)	$0	(1%)
8 stories	110	(5%)	0	(0%)	0	(1%)	$0	(1%)
9 stories	80	(3%)	0	(0%)	0	(2%)	$0	(2%)
10 stories	40	(2%)	0	(0%)	2	(6%)	$0	(0%)
11 stories	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
12 stories	30	(1%)	0	(0%)	1	(5%)	$0	(0%)
13 or more stories	40	(2%)	0	(62%)	0	(1%)	$0	(1%)
Total high-rise (7 or more stories)	**400**	**(17%)**	**0**	**(62%)**	**5**	**(15%)**	**$1**	**(4%)**

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional shares of fire with number of stories above ground coded as unknown, blank or zero. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars without adjustment for inflation. Facilities that care for the sick include hospitals, clinics, and doctor's offices.

Source: NFIRS and NFPA survey.

Table 2. Fires in Selected Properties, by Number of Stories Above Ground (Continued)
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

D. Offices

	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
1 story	1,840	(47%)	0	(20%)	11	(35%)	$44	(43%)
2 stories	1,010	(26%)	1	(80%)	10	(30%)	$39	(38%)
3 stories	410	(10%)	0	(0%)	5	(16%)	$9	(9%)
4 stories	150	(4%)	0	(0%)	2	(6%)	$3	(3%)
5 stories	90	(2%)	0	(0%)	0	(1%)	$1	(1%)
6 stories	60	(1%)	0	(0%)	1	(2%)	$3	(3%)
Total not high-rise (1-6 stories)	**3,550**	**(90%)**	**1**	**(100%)**	**29**	**(90%)**	**$98**	**(96%)**
7 stories	60	(2%)	0	(0%)	1	(2%)	$1	(1%)
8 stories	10	(0%)	0	(0%)	0	(0%)	$1	(1%)
9 stories	50	(1%)	0	(0%)	0	(0%)	$0	(0%)
10 stories	30	(1%)	0	(0%)	2	(5%)	$0	(0%)
11 stories	50	(1%)	0	(0%)	1	(2%)	$0	(0%)
12 stories	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
13 or more stories	180	(5%)	0	(0%)	0	(1%)	$1	(1%)
Total high-rise (7 or more stories)	**400**	**(10%)**	**0**	**(0%)**	**3**	**(10%)**	**$4**	**(4%)**

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional shares of fire with number of stories above ground coded as unknown, blank or zero. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one, and direct property damage to the nearest million dollars without adjustment for inflation. Offices include general business offices, bank buildings, and post offices, but exclude doctor's offices, which are included in facilities that care for the sick.

Source: NFIRS and NFPA survey.

Table 3. High-Rise Percentage of Structure Fires in Mixed-Use Properties
Percentage of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

Mixed-Use Status	Percentage of Fires in High-Rise Properties
Medical use	14.6%
Unclassified mixed-use status	5.3%
Military use	4.5%
Office use	4.5%
Industrial use	3.4%
Business and residential	3.1%
Not mixed use	2.9%
Residential use	2.6%
Educational use	2.0%
Assembly use	1.8%
Enclosed mall	1.3%
Row of stores	1.2%
Farm use	1.0%
Unknown mixed-use status	2.6%
All structures	2.7%

Note: "Mixed use" refers to buildings with more than one property use, such as a building with stores and restaurants on some floors, apartment units on other floors, and hotel rooms on still other floors. These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Estimates include proportional shares of fire with number of stories above ground coded as unknown, blank or zero.

Source: NFIRS and NFPA survey.

Is There More or Less Fire-Related Risk in a High-Rise Building?

Statistics on the U.S. building inventory by height of building are scarce and not ideally suited to calculations of relative fire risk, but some analysis is possible.

The best data is on apartment buildings. Statistics are published on U.S. housing units in every odd-numbered year. In 2003-2006, an average of 8-11% of occupied year-round housing units were in apartment buildings defined as buildings with 3 or more housing units.[1] The percentage range is necessary because the data on housing combines housing units in 2-unit buildings with housing units in buildings having 3-4 housing units. If most buildings with 2-4 housing units are in 2-unit buildings, then the high-rise share of apartments is close to 11%. If most buildings with 2-4 housing units are not in 2-unit buildings, then the high-rise share of apartments is close to 8%.

Risk can be calculated as fires (or fire loss) per million housing units (or per million buildings per billion square feet). Risk is therefore a ratio of a measure of fire loss to a measure of exposure, where "exposure" refers to people, space, or value exposed to potential harm if fire occurs.

Suppose high-rise and low-rise risks are both expressed as [(high-rise or low-rise percentage of fire loss) times (total fire loss)] divided by [(high-rise or low-rise percentage of units of exposure) times (total units of exposure)]. Then both risk measures include total loss divided by total exposure in their formulas, and you can compare risk quickly by comparing the ratios of percentages.

Now suppose that for high-rise buildings the percentage of fire loss is less than the percentage of exposure. If the high-rise percentage of fire loss is less than the high-rise percentage of exposure, then the high-rise risk is lower than the low-rise risk.[2]

In 2003-2006, 7% of apartment fires were in high-rise buildings. (See Table 2A.) Because 7% falls below the 8-11% range, the risk of fire in a high-rise apartment building is lower than in an apartment building that is not a high-rise.

Also in 2003-2006, high-rise buildings accounted for 6% of civilian deaths in apartment fires, 7% of civilian injuries in apartment fires, and 3% of direct property damage in apartment fires. (See Table 2A.) For all these loss measures, the risk is lower in a high-rise apartment than in other apartments.

For the other three property classes, other data must be used, and it is necessary to measure exposure by square feet rather than number of buildings or housing units. The Energy Information Administration publishes figures (latest from 2003) on floor space

[1] *See Statistical Abstract of the United States*, Washington, DC: U.S. Bureau of Census, 2004-2008.

[2] In that case the risk-related ratio will be less than one (e.g., if the high-rise percentage of fire loss were 7% and the high-rise percentage of exposure were 8%, a higher number, then 7%/8% is less than one). Moreover, the corresponding percentages for low-rise buildings will be 100% minus the high-rise percentages (because every building has to be high-rise or low-rise and cannot be both). The low-rise ratio will be greater than one if the high-rise ratio is less than one (e.g., 93%/92% is more than one).

for properties with defined ranges of square feet of floor space.[3] Breakdowns are available by defined ranges of number of stories or by principal economic activity in the building, but not by both simultaneously.

An estimate can be made of the percent of exposure (floor space) occurring in high-rise buildings for a particular property use by taking the sum over the various floor-space ranges of: (fraction of that property use's total floor space occurring in buildings with floor space in the defined range) times (combining all types of property uses, fraction of total floor space in buildings with a defined range of floor space occurring in high-rise buildings). Because the defined ranges of number of stories do not include a break at seven stories (the minimum for a high-rise), three estimates are useful. The lower bound is for buildings with ten or more stories, and the upper bound is for buildings with four or more stories. The middle estimate is based on assuming that buildings of various heights have comparable footprints, so that their total floor space is proportional to their number of stories. If that is true, then the 7-9 story share of floor space in buildings with 4-9 stories will be (7+8+9)/(4+5+6+7+8+9) or 62%.

These crude formulas produce the following estimates for the high-rise share of exposure (floor space): For lodging properties, the estimate is 18%, with a middle estimate of 41%. (These numbers may be depressed by the inclusion of lodging properties other than hotels and motels. The former tend to be smaller.) For office buildings, the estimate is 25-46%, with a middle estimate of 38%. For health care properties, the estimate is 18-55%, with a middle estimate of 41%. These compare to high-rise shares of 2003-2006 reported structure fires of 12% for hotels and motels, 10% for office buildings and 17% for facilities that care for the sick. (See Tables 2B to 2D.)

The combination of all these statistics is sufficient to indicate that the high-rise share of fires is lower, indicating lower risk, than the high-rise share of square footage in use, for hotels, offices, and facilities that care for the sick.

For direct property damage, the high-rise share was 11% for hotels, 4% for facilities that care for the sick, and 4% for offices. (See Tables 2B to 2D.) These are all well below the corresponding ranges for high-rise share of square footage, indicating a clearly lower risk of property damage in high-rise buildings compared to other buildings, for all three of these property uses.

[3] See the 2003 Commercial Buildings Energy Consumption Survey, Energy Information Administration website, http://www.eia.doe.gov/emeu/consumption.

Fire Protection in High-Rise Buildings

NFPA 101®, *Life Safety Code*® has for decades had provisions for existing as well as new high-rise buildings. Where NFPA 101®, *Life Safety Code*®, is adopted into law or otherwise followed in practice, these required practices should be in place.

In NFPA 101®, *Life Safety Code*®, 2009 edition, section 11.8 contains requirements potentially applicable to a high-rise building. The chapter for a particular occupancy determines whether all or some of the section 11.8 requirements are required for that occupancy. Among the section 11.8 requirements are an approved supervised automatic sprinkler system; a Class I standpipe system; a fire alarm system with an approved emergency voice/alarm communication system; two-way telephone service for fire department use; emergency lighting; standby power; and a central control station.

Existing high-rise hotels must be protected throughout by an approved supervised automatic sprinkler system. Existing high-rise health care occupancies must be Type I (442 or 332) or Type II (222) construction (as must existing health care occupancies 4-6 stories in height). This corresponds to the "fire resistive" construction type category previously used in NFIRS as well as a subpart of the "protected noncombustible" category. Existing high-rise apartment buildings are required to have an approved supervised automatic sprinkler system, installed throughout, with two exceptions. One is if every living unit has exterior exit access in accordance with section 7.5.3; the other is if the building has an "approved, engineered life safety system" in accordance with section 31.3.5.12.3. The latter exception for an engineered life safety system, (see section 39.4.2.1(2)) is also the only exception to the requirement for a complete, approved, supervised automatic sprinkler system in existing high-rise office buildings. NFPA 1®, *Fire Code*®, requires sprinkler retrofitting in all high-rise buildings.

Changes in fire incident coding, effective in 1999, have affected the comparability of statistics from before and after this year.

Table 4 provides statistics on percentage of fires with fire protection present for three types of fire protection for three groups of years (1986-1989, 1994-1998, and 2003-2006):

- Automatic extinguishing equipment. In 2003-2006, partial systems and equipment other than wet-pipe sprinklers can be identified and have been excluded. This refinement of the statistics is partly to mostly responsible for the drops in fires reported with equipment present.
- Fire detection equipment.
- Fire resistive construction. Type of construction is no longer collected and is not available for 2003-2006.

The defined construction types can be briefly summarized by these major characteristics:

- Fire resistive – Concrete or fire-resistant-covered steel construction rated for 2 hours;

- Heavy timber – Construction where any exposed wood load-bearing members has no dimension less than 2 inches;
- Protected non-combustible – Concrete or fire-resistant-covered steel construction rated for 1 hours;
- Unprotected non-combustible – Exposed steel construction without fire-resistant covering;
- Protected ordinary – Masonry load-bearing walls with columns, wood floors, and roof decks all protected by fire-resistive coating rated for 1 hour;
- Unprotected ordinary – Masonry load-bearing walls with exposed columns, wood floors, and roof decks without fire-resistive coating;
- Protected wood frame – Wood frame construction with wall and ceiling surfaces protected by fire-resistive covering, such as gypsum board; and
- Unprotected wood frame – Wood frame construction without fire-resistive covering.

From 1999 on, there is an option to report fires as confined fires, in which case very little detail is required. This change encourages the reporting of very small fires, but introduces a high degree of uncertainty in the analysis of detailed characteristics of those fires.

Some conclusions can be seen in Table 4.

- The usage of wet pipe sprinklers is much higher in high-rise buildings than in other buildings, for each property use group. This is also true for facilities that care for the sick, where the gap in automatic extinguishing equipment had been much smaller before 1999.

- The usage of fire detection equipment is higher in high-rise buildings than in other buildings, for each property use group.

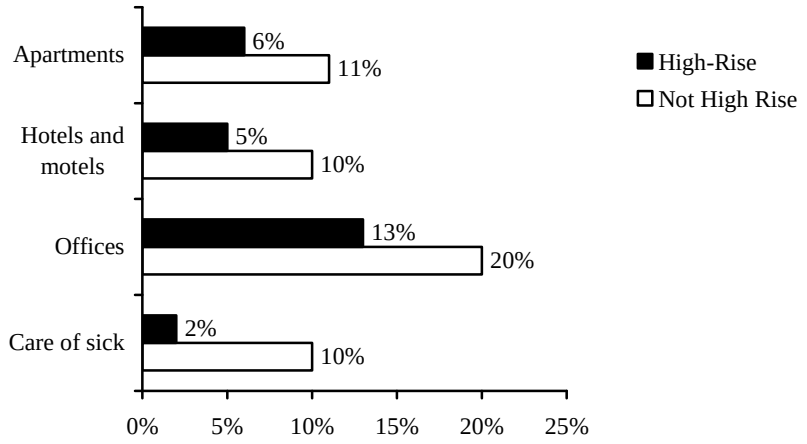
- For fire-resistive construction, the trend had been toward a smaller share of fires being reported each year as occurring in buildings with fire-resistive construction, both for high-rise and other buildings, with the decline being most dramatic in facilities that care for the sick. This statistical decline could reflect any or all of the following: (a) a shift in construction between the two types permitted by codes, from Type I (442 or 332) construction, which is coded as fire-resistive, to Type II (222) construction, which is coded as protected non-combustible; (b) a shift to acceptable alternative designs using more sprinklers and less fire-resistive construction; or (c) enough success in containing fires that a rising fraction never are reported to fire departments, because the fires are caught and controlled so early by occupants.

- The greater usage of fire protection systems and features is the most likely explanation of the lower statistical risk of property damage in high-rise buildings compared to other buildings, as noted in the previous section.

- The greater usage of fire protection systems and features also is the most likely explanation of the lower statistical risk of fire death in high-rise apartments compared to other apartments, as noted in the previous section. In the other property uses, there are not enough deaths per year for a stable analysis of differences between high-rise and other buildings.

- The value of these fire protection systems and features can also be seen in the differences in final extent of flame damage. See Figure 1.

Figure 1. Flame Damage Beyond Room of Origin, by Property Use and High-Rise versus Not High-Rise Percentage of 2003-2006 Structure Fires Reported to U.S. Fire Departments (Including Fires Reported as Confined Fires)



Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height.

Source: NFIRS and NFPA survey.

Table 4. Fire Protection in High-Rise vs. Other Buildings, by Major Property Use

A. Apartments

1. Automatic Extinguishing Equipment

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Equipment present	23%	3%	5%
1994-1998: Equipment present	32%	5%	7%
2003-2006: Wet-pipe sprinklers present, excluding buildings under construction	35%	7%	7%

2. Fire Detection Equipment

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Equipment present	69%	58%	59%
1994-1998: Equipment present	85%	76%	77%
2003-2006: Equipment present	90%	86%	86%

3. Fire Resistive Construction

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Construction is fire-resistive	57%	7%	12%
1994-1998: Construction is fire-resistive	50%	6%	10%

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Prior to 1999, fires with unknown building height are not allocated before calculating property and statistics for "all buildings" are based only on buildings of known height. These statistics may differ from statistics based on calculations that include buildings of unknown height.

Source: NFIRS and NFPA survey.

Table 4. Fire Protection in High-Rise vs. Other Buildings, by Major Property Use (Continued)

B. Hotels

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1. Automatic Extinguishing Equipment			
1986-1989: Equipment present	62%	18%	28%
1994-1998: Equipment present	72%	26%	35%
2003-2006: Wet-pipe sprinklers present, excluding buildings under construction	71%	36%	40%

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
2. Fire Detection Equipment			
1986-1989: Equipment present	84%	65%	69%
1994-1998: Equipment present	89%	76%	79%
2003-2006: Equipment present	93%	89%	89%

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
3. Fire Resistive Construction			
1986-1989: Construction is fire-resistive	57%	14%	23%
1994-1998: Construction is fire-resistive	48%	12%	19%

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Prior to 1999, fires with unknown building height are not allocated before calculating property and statistics for "all buildings" are based only on buildings of known height. These statistics may differ from statistics based on calculations that include buildings of unknown height.

Source: NFIRS and NFPA survey.

Table 4. Fire Protection in High-Rise vs. Other Buildings, by Major Property Use (Continued)

C. Facilities That Care for the Sick

1. Automatic Extinguishing Equipment

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Equipment present	62%	51%	54%
1994-1998: Equipment present	76%	57%	62%
2003-2006: Wet-pipe sprinklers present, excluding buildings under construction	79%	39%	45%

2. Fire Detection Equipment

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Equipment present	89%	76%	80%
1994-1998: Equipment present	94%	82%	85%
2003-2006: Equipment present	96%	83%	85%

3. Fire Resistive Construction

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Construction is fire-resistive	39%	30%	33%
1994-1998: Construction is fire-resistive	33%	22%	26%

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Prior to 1999, fires with unknown building height are not allocated before calculating property and statistics for "all buildings" are based only on buildings of known height. These statistics may differ from statistics based on calculations that include buildings of unknown height. Facilities that care for the sick include hospitals, clinics, and doctor's offices.

Source: NFIRS and NFPA survey.

Table 4. Fire Protection in High-Rise vs. Other Buildings, by Major Property Use (Continued)

D. Offices

1. Automatic Extinguishing Equipment

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Equipment present	47%	17%	21%
1994-1998: Equipment present	61%	21%	25%
2003-2006: Wet-pipe sprinkler present, excluding buildings under construction	54%	18%	21%

2. Fire Detection Equipment

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Equipment present	69%	33%	37%
1994-1998: Equipment present	79%	48%	51%
2003-2006: Equipment present	89%	62%	65%

3. Fire Resistive Construction

Year of Fire	High-Rise Buildings	Buildings That Are Not High-Rise	All Buildings
1986-1989: Construction is fire-resistive	36%	14%	18%
1994-1998: Construction is fire-resistive	32%	10%	13%

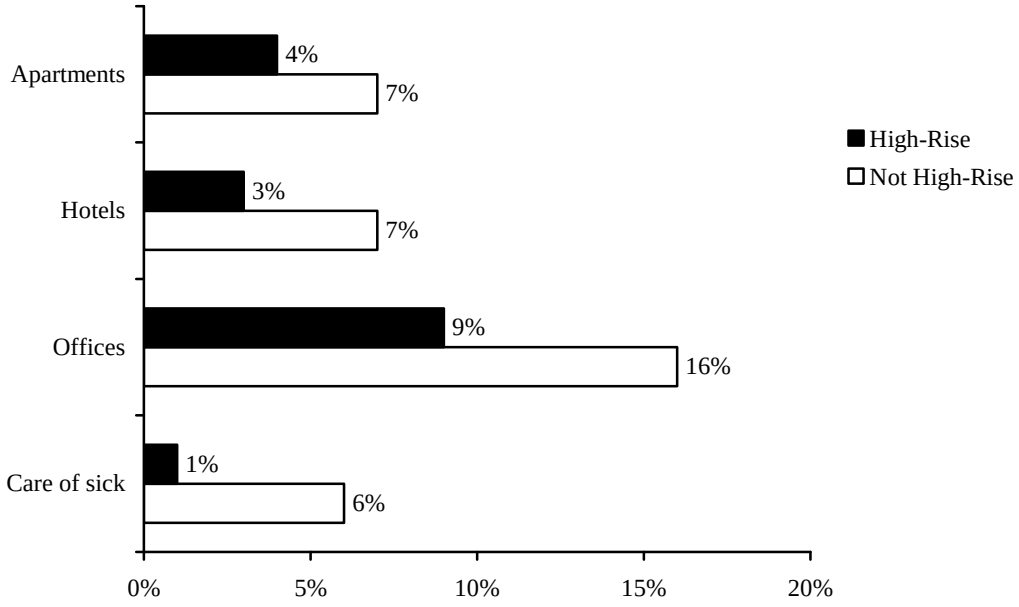
Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Prior to 1999, fires with unknown building height are not allocated before calculating property and statistics for "all buildings" are based only on buildings of known height. These statistics may differ from statistics based on calculations that include buildings of unknown height. Offices include general business offices, bank buildings, and post offices, but exclude doctor's offices, which are included in facilities that care for the sick.

Source: NFIRS and NFPA survey.

Other Patterns of High-Rise Building Fires

Figure 2 shows that flame damage beyond the floor of origin is very rare in high-rise buildings. These are the fires that are most likely to extend into the stairways. For offices, two-thirds of the estimated fires with extent of flame beyond floor of origin began outside the building or involved projection from a single fire reported as a confined fire. The former are unlikely to threaten stairwells and the latter is clearly a miscoding. After adjusting for these fires, flame damage beyond floor of origin for a fire that began indoors is reported for at most 3-4% of reported high-rise fires.

Figure 2. Flame Damage Beyond Floor of Origin, by Property Use and High-Rise versus Not High-Rise
Percentage of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)



When a high-rise fire fatally injures people who were not on the floor of origin when fire began, there is usually some type of failure to maintain protection of stairways or elevators. Here are some examples:

- *Elevator travels to fire-involved floor and opens*. This problem has been largely eliminated by redesign of elevator and prominent display of warnings against elevator use during a fire. An older example of a fire where five people died under these conditions is documented in Laurence D. Watrous, "Fatal hotel fire: New Orleans," *Fire Journal*, January 1972, pp. 5-8.

- *Door to exit stairs is blocked open and allows smoke or fire to enter*. An example with multiple fatalities is documented in Mike Isner, "Smoking fire kills four in New York high-rise," *Fire Journal*, September/October 1988, pp. 72-77.

- *Substandard or other inadequate or non-compliant enclosure of stairs allows smoke into stairways*. This problem is particularly well illustrated in Richard and David P. Demers, "Fire at the MGM Grand," *Fire Journal*, January 1982, pp. 19-37.

When high-rise building fires do involve fire spread beyond the floor of fire origin, it is not unusual for the fire to be investigated by NFPA's Fire Investigations Department. To view a list of NFPA investigations of high-rise building fires, visit www.nfpa.org/investigations. They provide case-study evidence of the potential hazard in high-rise buildings that do not provide adequate fire protection.

Just because a fire occurs in a high-rise building, that does not mean the fire began at or above the 7th floor. Figure 3 shows that most high-rise building fires begin on floors no higher than the 6th story. The fraction of 2003-2006 high-rise fires that began on the 7th floor or higher was 27% for apartments, 22% for hotels and motels, 13% for facilities that care for the sick, and 30% for office buildings.

One special concern with high-rise building fires could be fires originating in a means of egress. Means of egress include the following areas of origin:

- Hallway or corridor
- Interior stairway
- Exterior stairway
- Entrance way or lobby
- Escalator
- Unclassified means of egress

Table 5 shows that high-rise apartments have a slightly larger share of their fires originating in means of egress than do their shorter counterparts (4% vs. 3%). The same is true of hotels (5% vs. 4%). In offices (3% vs. 5%) and facilities that care for the sick (2% vs. 6%), the differences in percentages are larger and in the opposite direction; high-rise buildings in these properties have a smaller share of their fires originating in means of egress.

Table 6 shows differences between the cause profiles of high-rise and other buildings, by property use. Some differences probably reflect differences in activity that are correlated with building height. For example, shorter hotels and motels might be more likely to have in-room cooking, either approved (in-room ranges and microwave ovens) or unapproved (guests' hot plates). Many shorter facilities that care for the sick are medical office buildings that are less likely to have patients checked in for overnight stays and so may have less cooking activity. Cooking equipment accounts for a larger share of fires in shorter hotels and motels and in taller facilities that care for the sick, in both cases paralleling what may be differences in degree of cooking activity.

Another element in surviving a high-rise building fire is the ability of occupants to escape effectively. A 2007 survey study by NuStats for the Fire Protection Research Foundation found that levels of knowledge and preparedness related to escape readiness were quite different for residents of commercial high-rise buildings (presumably offices) compared

to residential high-rise buildings (presumably apartments).[4] The following are two examples:

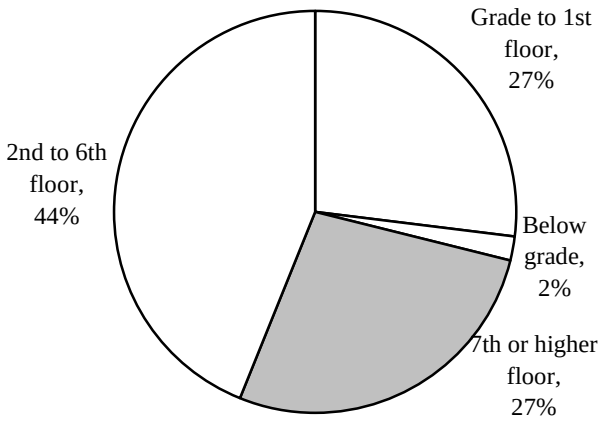
- Fire drills are much more common among residents of high-rise commercial buildings (83% had participated in a drill within the last year) than in residential buildings (19%).

- Flashlights are much more commonly in the possession of residents of high-rise residential buildings (76%) than in commercial buildings (30%).

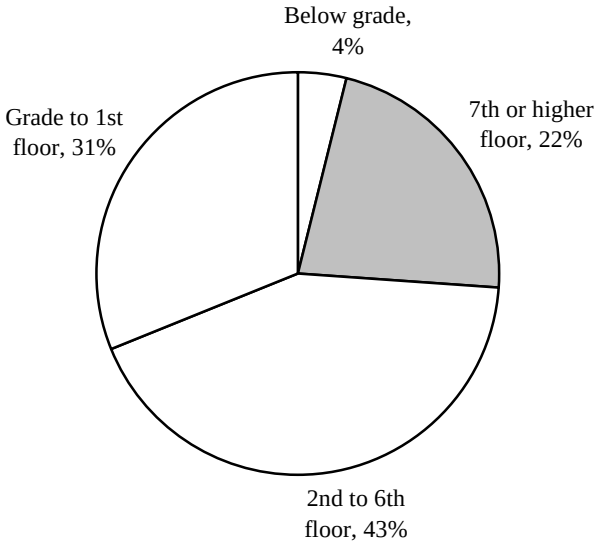
[4] Mia Zmud, *Public Perceptions of High-Rise Building Safety and Emergency Evacuation Procedures Research Project – Final Report,* Fire Protection Research Foundation, July 2007.

Figure 3. High-Rise Building Fires, by Level of Fire Origin
Percentage of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

A. Apartments



B. Hotels

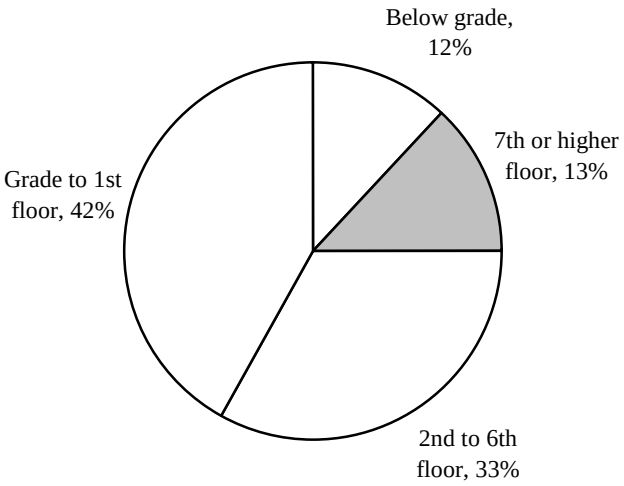


Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Includes proportional share of fires with level of fire origin or height of building unknown. There are six types of confined fires – confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator or commercial compactor. Fires coded as confined do not require reporting of most details, including building height.

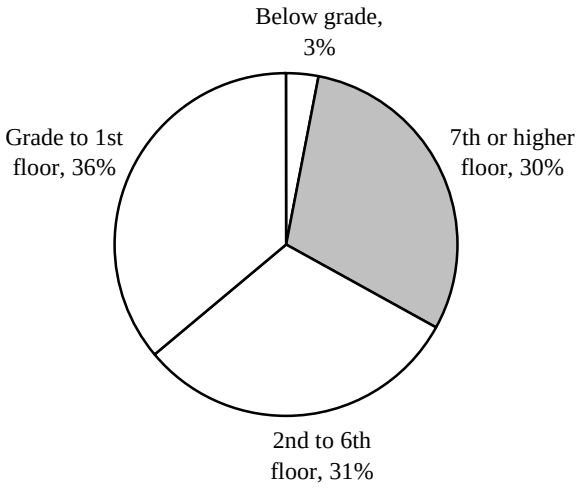
Source: NFIRS and NFPA survey.

Figure 3. High-Rise Building Fires, by Level of Fire Origin (Continued)
Percentage of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires

C. Facilities That Care for the Sick



D. Offices



Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Includes proportional share of fires with level of fire origin or height of building unknown. There are six types of confined fires – confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator or commercial compactor. Fires coded as confined do not require reporting of most details, including building height.

Source: NFIRS and NFPA survey.

Table 5. High-Rise and Other Building Fires, by Leading Areas of Origin
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

A. Apartments

High-Rise			Not High-Rise		
Area of Origin	**Fires**		**Area of Origin**	**Fires**	
Kitchen	5,530	(67%)	Kitchen	70,330	(67%)
Trash room or area	440	(5%)	Bedroom	6,220	(6%)
Bedroom	420	(5%)	ALL MEANS OF EGRESS	2,770	(3%)
ALL MEANS OF EGRESS	340	(4%)	Living room, family room, or den	3,010	(3%)
Living room, family room, or den	280	(3%)			
ALL MEANS OF EGRESS			ALL MEANS OF EGRESS		
Interior stairway	160	(2%)	Interior stairway	730	(1%)
Hallway or corridor	120	(1%)	Hallway or corridor	650	(1%)
Entrance way or lobby	20	(0%)	Exterior stairway	620	(1%)
Unclassified means of egress	20	(0%)	Entrance way or lobby	390	(0%)
Exterior stairway	10	(0%)	Unclassified means of egress	380	(0%)

B. Hotels and Motels

High-Rise			Not High-Rise		
Area of Origin	**Fires**		**Area of Origin**	**Fires**	
Kitchen	145	(29%)	Kitchen	1,103	(32%)
Bedroom	58	(12%)	Bedroom	526	(15%)
Laundry room or area	53	(11%)	Laundry room or area	304	(9%)
Exterior roof surface	33	(7%)	Bathroom	163	(5%)
ALL MEANS OF EGRESS	22	(5%)	ALL MEANS OF EGRESS	146	(4%)
Heating equipment room or area	22	(4%)	Unclassified function room	100	(3%)
Bathroom	21	(4%)	Living room, family room, or den	97	(3%)
Machinery room or area	13	(3%)	Heating equipment room or area	95	(3%)
ALL MEANS OF EGRESS			ALL MEANS OF EGRESS		
Hallway or corridor	15	(3%)	Hallway or corridor	54	(2%)
Entrance way or lobby	5	(1%)	Unclassified means of egress	36	(1%)
Interior stairway	1	(0%)	Exterior stairway	30	(1%)
Unclassified means of egress	1	(0%)	Entrance way or lobby	15	(0%)
			Interior stairway	11	(0%)

Table 5. High-Rise and Other Building Fires, by Leading Areas of Origin (Continued)
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

C. Facilities That Care for the Sick

High-Rise			Not High-Rise		
Area of Origin	**Percent of Fires**		**Area of Origin**	**Percent of Fires**	
Kitchen	157	(39%)	Kitchen	575	(30%)
Large open room without fixed seats	26	(6%)	Heating equipment room or area	146	(8%)
Dining room	26	(6%)	ALL MEANS OF EGRESS	117	(6%)
Office	24	(6%)	Bedroom	98	(5%)
Heating equipment room or area	18	(5%)	Bathroom or locker room	96	(5%)
Process or manufacturing area	18	(4%)	Office	95	(5%)
Bedroom	15	(4%)	Laundry room or area	69	(4%)
Machinery room or area	14	(4%)			
Laundry room or area	13	(3%)			
ALL MEANS OF EGRESS	9	(2% of total)	ALL MEANS OF EGRESS		
			Hallway or corridor	63	(3%)
Hallway	3	(1%)	Exterior stairway	21	(1%)
Entrance way or lobby	2	(1%)	Entrance way or lobby	18	(1%)
Unclassified means of egress	2	(1%)	Unclassified means of egress	9	(0%)
Interior stairway	1	(0%)	Interior stairway	7	(0%)

D. Offices

High-Rise			Not High-Rise		
Area of Origin	**Percent of Fires**		**Area of Origin**	**Percent of Fires**	
Kitchen	83	(21%)	Office	688	(19%)
Office	82	(21%)	Kitchen	502	(14%)
Utility shaft	26	(7%)	ALL MEANS OF EGRESS	181	(5%)
Machinery room or area	24	(6%)	Bathroom	155	(4%)
Trash room or area	22	(6%)	Exterior roof surface	118	(3%)
Switchgear area or transformer vault	19	(5%)	Attic or ceiling/roof assembly or concealed space	116	(3%)
Product storage room or area	18	(5%)	Ceiling/floor assembly or concealed space	115	(3%)
Shipping, receiving, or loading area	17	(4%)	Unclassified service or equipment area	114	(3%)
Unclassified service or equipment area	16	(4%)	Exterior wall surface	108	(3%)
ALL MEANS OF EGRESS	12	(3%)	Heating equipment room or area	108	(3%)
ALL MEANS OF EGRESS			ALL MEANS OF EGRESS		
Entrance way or lobby	4	(1%)	Entrance way or lobby	78	(2%)
Interior stairway	3	(1%)	Unclassified means of egress	50	(1%)
Hallway or corridor	1	(0%)	Hallway or corridor	23	(1%)
Exterior stairway	1	(0%)	Exterior stairway	21	(1%)
Escalator	1	(0%)	Interior stairway	9	(0%)
Unclassified means of egress	1	(0%)			

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Includes proportional share of fires with level of fire origin or height of building unknown. There are six types of confined fires – confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator or commercial compactor. Fires coded as confined do not require reporting of most details, including building height. Fires are rounded to nearest ten for apartments and nearest one for all other tables. Fires with unknown area of origin are proportionally allocated.

Source: NFIRS and NFPA survey.

Table 6. High-Rise and Other Building Fires, by Leading Causes
Annual Average of 2003-2006 Structure Fires Reported to U.S. Fire Departments
(Including Fires Reported as Confined Fires)

A. Apartments

High-Rise		Not High-Rise	
Cause	**Fires**	**Cause**	**Fires**
Cooking equipment	5,350 (65%)	Cooking equipment	62,920 (60%)
Heating equipment	990 (12%)	Heating equipment	12,370 (12%)
Smoking materials	890 (11%)	Smoking materials	6,600 (6%)
International	390 (5%)	Intentional	5,040 (5%)

B. Hotels

High-Rise		Not High-Rise	
Cause	**Fires**	**Cause**	**Fires**
Cooking equipment	128 (26%)	Cooking equipment	1,344 (39%)
Clothes dryer or washer	61 (12%)	Heating equipment	426 (12%)
Smoking materials	40 (8%)	Smoking materials	363 (10%)
Electrical distribution or lighting equipment	38 (8%)	Clothes dryer or washer	320 (9%)
		Intentional	230 (7%)
Air conditioning or fan	30 (6%)	Electrical distribution or lighting equipment	196 (6%)
Intentional	23 (5%)		
		Air conditioning or fan	196 (6%)

C. Facilities That Care for the Sick

High-Rise		Not High-Rise	
Cause	**Fires**	**Cause**	**Fires**
Cooking equipment	228 (57%)	Cooking equipment	531 (28%)
Heating equipment	40 (10%)	Heating equipment	354 (19%)
Electrical distribution or lighting equipment	32 (8%)	Intentional	127 (7%)
		Electrical distribution or lighting equipment	126 (7%)
		Air conditioning or fan	105 (6%)
		Smoking materials	95 (5%)

D. Offices

Cause	**Fires**	**Cause**	**Fires**
Cooking equipment	209 (53%)	Cooking equipment	695 (20%)
Electrical distribution or lighting equipment	70 (18%)	Heating equipment	564 (16%)
		Electrical distribution or lighting equipment	463 (13%)
Smoking materials	18 (5%)		
		Smoking materials	382 (11%)
		Intentional	311 (9%)
		Air conditioning or fan	280 (8%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. "High-rise" means seven or more stories in height. Includes proportional share of fires with level of fire origin or height of building unknown. There are six types of confined fires – confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator or commercial compactor. Fires coded as confined do not require reporting of most details, including building height. Fires with unknown heat source, cause of ignition, or equipment involved in ignition have been proportionally allocated.

Source: NFIRS 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.

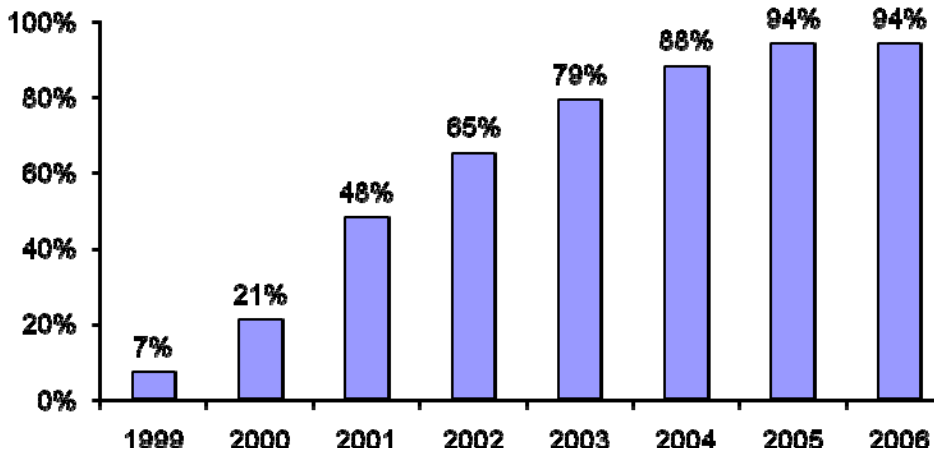
Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific 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:

NFPA survey projections
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 alls 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

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

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 as 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 equipm	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.

Appendix B
Reasons Why High-Rise Share of Building Fires Appears to Decline More Rapidly Under NFIRS 5.0

After 1998, fires and losses in high-rise buildings declined more rapidly than would have been expected from the historic trend, for apartments, hotels, and facilities that care for the sick. These accelerated declines may not be real but may be associated with changes associated with or occurring at the same time as the change to NFIRS Version 5.0

- In some recent years, fewer large cities participated in NFIRS. These communities account for a disproportionately large share of high-rises. This could be a significant factor in the observed decline in estimated high-rise fires.

- NFIRS Version 5.0 permitted high-rise to be defined, more appropriately, by floors above ground rather than total floors. Some of the changes in the percentage of buildings that are high-rise can be explained by this change in how high-rise buildings are identified. Specifically, a building with seven or more total stories but fewer than seven stories above ground would have been counted as high-rise before 1999 (because the old NFIRS coding did not distinguish stories above ground from stories below ground) but as not high-rise after 1999.

- Structure height is not required, and typically is not captured, for fires reported as confined fires, which are fires confined to fuel burner or boiler, cooking vessel, chimney or flue, trash, incinerator, or commercial compactor. This will increase the share of fires with unknown structure height but would not affect the high-rise estimates, which include allocation of unknowns, unless confined fires are unusually likely or unlikely in high-rise structures.

- Another change appears likely to account for much of the decline. In NFIRS Version 4.1, height of building is coded by ranges, with codes 4-7 corresponding to high-rise (7 or more stories) and codes 1-3 corresponding to shorter buildings. In such a system, if the height of the building is incorrectly entered as the code, then a 4- to 6-story building will be incorrectly recorded as high-rise. Such an error is not possible in NFIRS Version 5.0.

  As evidence that this may be a significant problem for 1998 and earlier data, consider the three years before 1999 that show unusual spikes in estimated direct property damage – 1991, 1995, and 1996. These spikes are driven by six individual large-loss incidents. One of the six had its loss amount entered incorrectly, one was a tall manufacturing plant (equivalent to 18 stories), three were 5-story buildings coded incorrectly, and the sixth also had questions about its height.

  The error potential in NFIRS Version 5.0 arises if the building's height is recorded in the left of the three-digit field. For example, a 1-story building could be recorded as 100 stories and a 25-story building could be recorded as 250 stories. Such errors would show up as 100, 200, 300, 400, 400, 500, or 600-story buildings. Very few such buildings are recorded.

Most of these factors mean that the new numbers are more accurate than the older numbers, and any apparent larger decline is not real. The exception is declining large-city participation, which would mean that the old numbers were more accurate. However, the factors other than declining large-city participation are enough to explain all the unusually large declines.

Appendix C
Deadliest and Costliest High-Rise Building Fires in History

Table C-1 lists the deadliest high-rise building fires in world history. Tables C-2 and C-3 list the costliest high-rise building fires in world history, after adjustment for inflation, either including or excluding buildings without conventional floors, respectively.

Table C-1. Deadliest High-Rise Building Fires (based on NFPA incident records)

	Incident	Civilian or Firefighter Deaths	Height in Stories	Floor of Origin
1.	Office complex (2 towers) New York, September 2001	2,791	110	94-98 (tower 1) 78-84 (tower 2)
2.	Office Brazil, February 1974	179	25	12
3.	Office Oklahoma, April 1995	168	9	Outside
4.	Hotel South Korea, December 1971	163	21	2
5.	Clothing manufacturer New York, March 1911	146	10	8
6.	Hotel Georgia, December 1946	119	15	3
7.	Department store Japan, May 1972	118	7	3
8.	Department store Japan, November 1973	104	9	Unknown
9.	Hotel Puerto Rico, December 1986	96	20	1
10.	Hotel Thailand, July 1977	90	17	1
11.	Hotel Nevada, November 1980	85	23	1
12.	Hotel Illinois, June 1946	61	22	1
13.	Office Hong Kong, November 1996	40	16	Basement
14.	Hotel South Korea, January 1984	38	10	4
15.	Hotel Japan, February 1982	32	10	9
16.	Hotel Arizona, December 1970	28	11	4
17A.	Office Brazil, February 1986	23	13	Unknown
17B.	Plastic manufacturing plant Texas, October 1989	23	20	Unknown
19.	Hotel Florida, December 1963	22	14	1
20.	Jail New Brunswick, Canada, June 1977	21	16	Sub-level

Table C-2. Costliest High-Rise Building Fires
Including Buildings Without Conventional Floor Spacing
(based on NFPA incident records)

	Incident	Loss in Millions in Year of Occurrence	Loss in Millions in 2007 Dollars	Height in Stories	Floor of Origin
1.	Office complex (2 towers) New York, September 2001	$33,340	$39,198	110	94-98 (tower 1) 78-84 (tower 2)
2.	Plastic manufacturing plant Texas, October 1989	$700	$1,172	20	Unknown
3.	Oil refinery Louisiana, May 1988	$330	$579	16	Unknown
4.	Office New York, February 1993	$230	$330	110	Sub-level
5.	Office Oklahoma, April 1995	$136	$185	9	Outside
6.	Hotel Nevada, November 1980	$50	$126	23	1
7.	Grain elevator Kansas, June 1998	$75	$95	12	Unknown
8.	Office California, May 1988	$50	$88	12	Basement
9.	Sugar manufacturing plant Nebraska, July 1996	$44	$58	18	Basement
10.	Office New York, August 1970	$10	$53	50	33

Table C-3. Costliest High-Rise Building Fires
Excluding Buildings Without Conventional Floor Spacing
(based on NFPA incident records)

	Incident	Loss in Millions in Year of Occurrence	Loss in Millions in 2007 Dollars	Height in Stories	Floor of Origin
1.	Office complex (2 towers) New York, September 2001	$33,340	$39,198	110	94-98 (tower 1) 78-84 (tower 2)
2.	Office New York, February 1993	$230	$330	110	Sub-level
3.	Office Oklahoma, April 1995	$136	$185	9	Outside
4.	Hotel Nevada, November 1980	$50	$126	23	1
5.	Office California, May 1988	$50	$88	12	Basement
6.	Office New York, August 1970	$10	$53	50	33
7.	Office New York, January 1912	$2.5	$52	10	Basement
8.	Department store New York, June 1979	$10	$29	20	5
9.	Hotel Nevada, February 1981	$13	$29	30	8
10.	Office California, March 1991	$12	$18	18	2