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Structure Fires in Warehouse Properties

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Richard Campbell

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Abstract

During the five-year period of 2009-2013, U.S. fire departments responded to an estimated average of 1,210 fires in warehouse properties per year (excluding refrigerated or cold storage). These fires caused an annual average of $155 million in direct property damage, three civilian deaths, and 19 civilian injuries. Nearly one-fifth of these fires were set intentionally. Electrical distribution or lighting equipment was involved in 18% of fires. Electrical failure or malfunction was the leading factor contributing to the ignition of warehouse fires, as well as in contributing to direct property damage and to civilian injuries.

These estimates are based on data 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 fire department experience survey.

Keywords: fire statistics, warehouse fires, storage

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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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Copies of this analysis are available from:
National Fire Protection Association
One-Stop Data Shop
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org
E-mail: osds@nfpa.org
Phone: 617-984-7451

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Structure Fires in Warehouse Properties:

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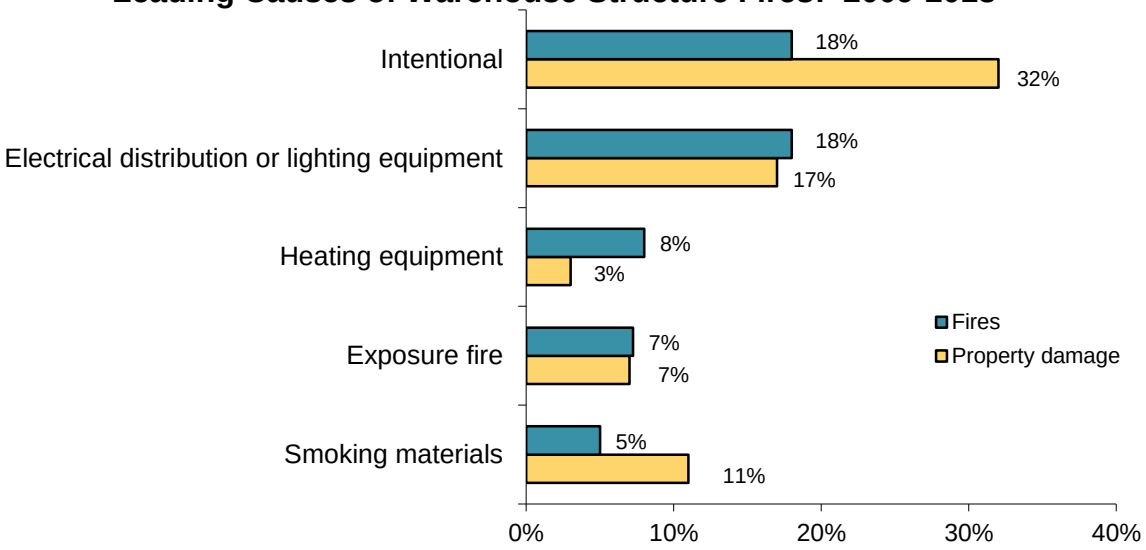
Structure Fires in U.S. Warehouses Fact Sheet

During 2009-2013, an estimated 1,210 warehouse structure fires were reported to U.S. fire departments each year. These fires caused an annual average of three civilian deaths, 19 civilian injuries, and $155 million in direct property damage.

- Nearly one-fifth (18%) of warehouse fires were intentionally set. These fires accounted for
- 32% of the direct property damage in warehouse properties.
- Electrical distribution or lighting equipment was the cause of 18% of warehouse fires and
- 17% of direct property damage.
- Arcing is the most common heat source (13% of fires) in warehouse fires.

Leading Causes of Warehouse Structure Fires: 2009-2013



Codes & Standards Related to Warehouse Properties

- NFPA 230: Standard for the Protection of Storage
- NFPA 101: Life Safety Code®
- NFPA 13: Standard for the Installation of Sprinkler Systems

Source: Structure Fires in Warehouse Properties, Richard Campbell, January 2016
NFPA, 1 Batterymarch Park, Quincy, MA 02169 www.nfpa.org
Fire Analysis & Research Division, osds@nfpa.org

Structure Fires in Warehouse Properties

Warehouses are properties that are used for the storage of commodities. Despite their common purpose, warehouses vary on the basis of size, types of materials stored, design, storage configurations, construction and other factors. The National Fire Protection Association has long recognized that warehouses present special challenges for fire protection because their contents and layouts are conducive to fire spread and present obstacles to manual fire suppression efforts. An increase in the number of very large warehouses in recent years, with attendant increases in their potential fuel loads, is likely to have an impact on both the warehouse fire experience and warehouse fire protection systems.

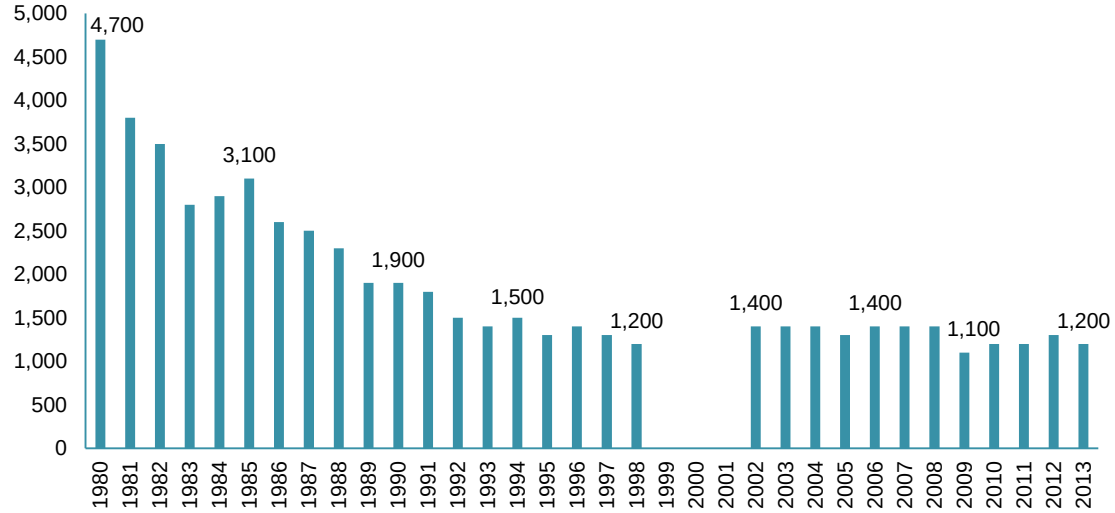
During the five-year period of 2009-2013, U.S. fire departments responded to an estimated average of 1,210 fires in warehouse properties per year (excluding refrigerated or cold storage). These fires caused an annual average of $155 million in direct property damage, three civilian deaths, and 19 civilian injuries. Due to low numbers, fatality data will not be analyzed in this report. Warehouse fires are associated with higher average property losses per fire than most other occupancies, but they also have lower than average rates of injury per 1,000 fires. It is worth noting that property damage figures do not include indirect costs, such as business interruption or environmental clean-up. Environmental impact is a particular concern when fires occur in warehouses storing hazardous chemicals.

The statistics about fires and associated losses in this analysis are national estimates of fires reported to U.S. municipal fire departments. Fires reported only to federal or state agencies or industrial fire brigades are not captured here. These national estimates are projections based on the detailed information collected by the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS 5.0) and the annual fire department experience survey conducted by the National Fire Protection Association (NFPA). NFIRS 5.0 includes a category of structure fires referred to as "confined fires," which by definition are limited to the object of origin and are generally associated with minimal losses.

Fires in warehouse properties have declined substantially over the past 30 years. The number of structure fires in U.S. warehouses has been reduced by 74% since 1980, falling from 4,700 fires per year in 1980 to 1,200 in 2013. However, the value of direct property damage caused by warehouse fires has not shown a similar decrease when adjustments are made for inflation.

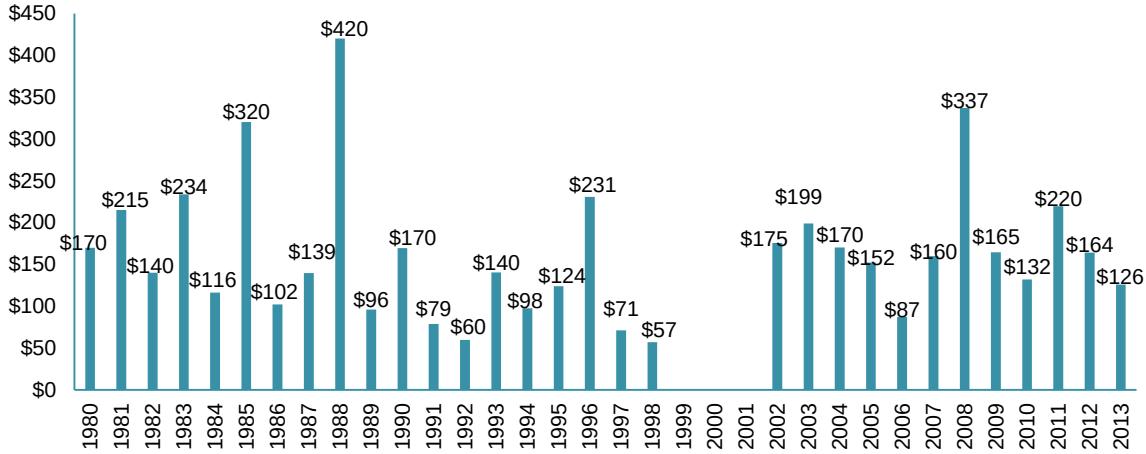
As shown in the figure on the following page, the decline in warehouse fires was sharpest during the 1980s, when the number of estimated warehouse fires fell by 60% between 1980 and 1989, from 4,700 to 1,900. The number of warehouse fires fell an additional 37% between 1990 (1,900 fires) and 1998 (1,200 fires). However, fires in warehouse properties in more recent years have experienced a plateau, with 1,200 to 1,400 fires a year between 2002 and 2013, with the exception of a historic low of 1,100 fires in 2009.

Figure 1. Reported Structure Fires in U.S. Warehouses, 1980-2013



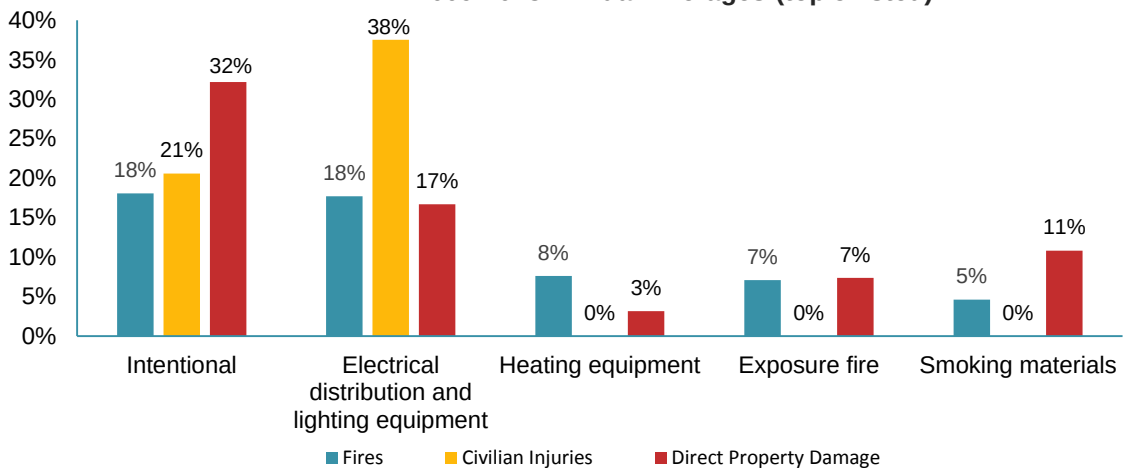
As illustrated in the figure below, there has not been a corresponding decrease in the levels of direct property damage caused by warehouse fires between 1980 and 2013. There have been substantial fluctuations in direct property losses from year to year, with decreases in financial losses regularly followed by increases, some of which have been very sharp.

Figure 2. Inflation-Adjusted Direct Property Damage, 1980-2013 in Warehouse Structure Fires



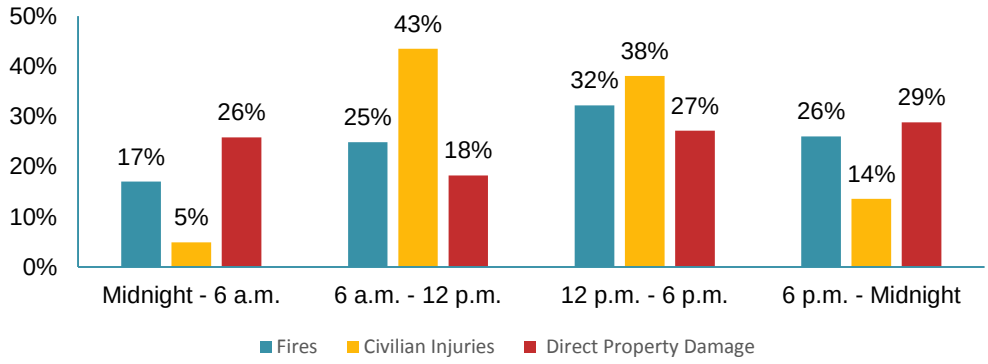
Fires that were intentionally set and fires caused by electrical distribution and lighting equipment were the leading causes of warehouse fires, each with 18% of the total. As shown in Figure 3, intentionally set fires caused 21% of civilian injuries and 32% of direct property damage, while electrical distribution and lighting equipment accounted for nearly two of five civilian injuries (38%) and 17% of direct property damage.

Figure 3. Structure Fires in Warehouses by Leading Cause, 2009-2013 Annual Averages (top 5 listed)



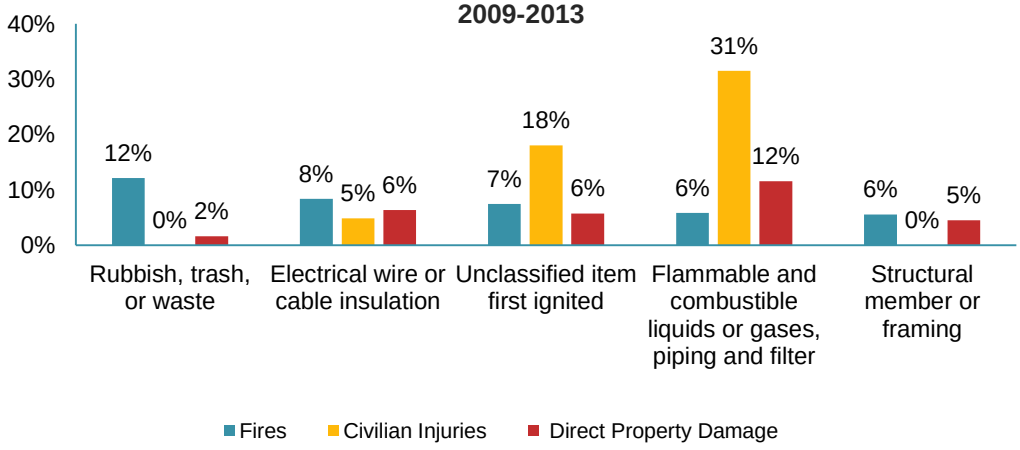
Timing of warehouse fires. Warehouse fires were less likely to take place on a Saturday (12% of fires) or Sunday (11% of fires), as is generally the case with business properties, with all the other days of the week accounting for 15% or 16% of fires. In general there was little seasonal variation in the distribution of fires by month, with all months having between 8% and 9% of the total. As the figure below shows, warehouse fires were less common during evening or overnight hours, but these fires were associated with higher property loss. Fires between midnight and 6 a.m. accounted for 17% of fires, but 26% of direct property damage, while fires between 6 p.m. and midnight accounted for 26% of fires, but 29% of direct property damage. More than two of five injuries (43%) were associated with fires taking place between 6 a.m. and 12 p.m.

Figure 4. Structure Fires in Warehouses, by Time of Day, 2009-2013



Rubbish, trash, or waste was the item first ignited in 12% of warehouse fires, but there were no injuries associated with these fires, and they caused just 2% of direct property damage. Flammable and combustible liquids and gases, piping and filter were the item first ignited in 6% of fires, but these fires caused 31% of civilian injuries and 12% of direct property damage. (See Figure 5).

Figure 5. Structure Fires in Warehouses by Item First Ignited, 2009-2013



Approximately one-quarter of fires in warehouses were identified as confined or contained incidents (23%), while 14% were confined to the object of origin. Another one-fifth of the incidents (21%) were confined to the room of origin, with 6% to the floor of origin. Fires that extended beyond the room of origin represented 41% of the total, but caused 91% of direct property damage, as well as 49% of civilian injuries.

Concluding observations

Warehouses pose substantial challenges for fire protection due to their building layouts, storage configurations and technologies, ceiling heights, and types of commodities stored, with the specific challenges influenced by the characteristics of a given warehouse. Properly designed sprinkler systems are an essential element of warehouse fire protection. In the most recent NFPA report on the U.S. experience with sprinklers, John Hall calculated that some type of sprinkler was present in 32% of warehouse structure fires from 2007 to 2011, and that sprinklers operated 86% of the time when properties were protected by wet pipe sprinklers and fires were large enough to activate the equipment.[1] Wet pipe sprinklers were effective in 84% of the fires in which they were present and contributed to a 61% reduction in dollar loss in those fires. Other protective measures generally applicable to warehouse properties include automatic alarms to the fire department and building security systems. Pre-fire inspections and planning are recommended in order to identify appropriate protection measures for specific warehouse environments.

Guidance for fire protection systems is available from NFPA 13, *Standard for the Installation of Sprinkler Systems* and NFPA 230, *Standard for the Fire Protection of Storage*.

[1] John R. Hall, Jr., *U.S. Experience with Sprinklers*, Division of Fire Analysis and Research, June 2013.

Table 1. Structure Fires in Warehouse Properties, 2009-2013

Year	Fires	Direct Property Damage in Millions (as reported)	Direct Property Damage in Millions (in 2013 Dollars)
1980	4,700	$60	$170
1981	3,800	$84	$215
1982	3,500	$58	$140
1983	2,800	$100	$234
1984	2,900	$52	$116
1985	3,100	$148	$320
1986	2,600	$48	$102
1987	2,500	$68	$139
1988	2,300	$213	$420
1989	1,900	$51	$96
1990	1,900	$95	$170
1991	1,800	$46	$79
1992	1,500	$36	$60
1993	1,400	$87	$140
1994	1,500	$62	$98
1995	1,300	$81	$124
1996	1,400	$155	$231
1997	1,300	$49	$71
1998	1,200	$40	$57
1999	1,400	$433	$605
2000	1,500	$165	$223
2001	1,500	$140	$185
2002	1,400	$135	$175
2003	1,400	$157	$199
2004	1,400	$138	$170
2005	1,300	$128	$152
2006	1,400	$76	$87
2007	1,400	$142	$160
2008	1,400	$311	$337
2009	1,100	$152	$165
2010	1,200	$123	$132
2011	1,200	$212	$220
2012	1,300	$162	$164
2013	1,200	$126	$126

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires are rounded to the nearest ten, and direct property damage is rounded to the nearest million dollars. Inflation adjustments were based on the Consumer Price Index Purchasing Power of the Dollar.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 2. Structure Fires in Warehouses, by Month
2009-2013 Annual Averages

Month	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
January	110	(9%)	1	(7%)	$8	(5%)
February	100	(9%)	2	(8%)	$22	(14%)
March	100	(8%)	4	(18%)	$18	(11%)
April	90	(8%)	2	(8%)	$10	(6%)
May	110	(9%)	2	(9%)	$11	(7%)
June	110	(9%)	0	(2%)	$11	(7%)
July	100	(8%)	4	(21%)	$10	(7%)
August	110	(9%)	2	(9%)	$17	(11%)
September	100	(8%)	1	(4%)	$14	(9%)
October	90	(8%)	0	(0%)	$12	(8%)
November	90	(8%)	0	(2%)	$12	(8%)
December	100	(8%)	3	(13%)	$10	(6%)
Total	1,210	(100%)	20	(100%)	$155	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 3. Structure Fires in Warehouses, by Day of Week
2009-2013 Annual Averages

Day of Week	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Sunday	140	(11%)	1	(4%)	$25	(16%)
Monday	180	(15%)	3	(14%)	$22	(14%)
Tuesday	190	(16%)	3	(14%)	$25	(16%)
Wednesday	190	(16%)	5	(27%)	$27	(17%)
Thursday	180	(15%)	3	(17%)	$17	(11%)
Friday	180	(15%)	3	(13%)	$16	(11%)
Saturday	150	(12%)	2	(11%)	$22	(14%)
Total	1,210	(100%)	20	(100%)	$155	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 4. Structure Fires in Warehouses, by Time of Day
2009-2013 Annual Averages

Time of Day	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Midnight-12:59 a.m.	30	(3%)	0	(0%)	$5	(3%)
1:00-1:59 a.m.	40	(3%)	0	(2%)	$12	(8%)
2:00-2:59 a.m.	40	(3%)	0	(0%)	$5	(3%)
3:00-3:59 a.m.	30	(2%)	0	(0%)	$4	(3%)
4:00-4:59 a.m.	30	(2%)	0	(0%)	$9	(6%)
5:00-5:59 a.m.	40	(3%)	1	(3%)	$5	(3%)
6:00-6:59 a.m.	40	(3%)	0	(2%)	$3	(2%)
7:00-7:59 a.m.	40	(4%)	1	(3%)	$4	(3%)
8:00-8:59 a.m.	50	(4%)	2	(11%)	$3	(2%)
9:00-9:59 a.m.	50	(4%)	1	(7%)	$4	(3%)
10:00-10:59 a.m.	60	(5%)	3	(14%)	$8	(5%)
11:00-11:59 a.m.	60	(5%)	1	(6%)	$5	(3%)
12:00-12:59 p.m.	60	(5%)	2	(9%)	$7	(4%)
1:00-1:59 p.m.	70	(6%)	1	(5%)	$11	(7%)
2:00-2:59 p.m.	70	(5%)	2	(9%)	$6	(4%)
3:00-3:59 p.m.	60	(5%)	1	(7%)	$8	(5%)
4:00-4:59 p.m.	70	(6%)	1	(7%)	$5	(3%)
5:00-5:59 p.m.	60	(5%)	0	(2%)	$5	(3%)
6:00-6:59 p.m.	60	(5%)	1	(5%)	$3	(2%)
7:00-7:59 p.m.	70	(5%)	1	(3%)	$19	(12%)
8:00-8:59 p.m.	60	(5%)	0	(2%)	$4	(2%)
9:00-9:59 p.m.	50	(4%)	0	(0%)	$3	(2%)
10:00-10:59 p.m.	50	(4%)	1	(4%)	$11	(7%)
11:00-11:59 p.m.	40	(3%)	0	(0%)	$6	(4%)
Total	1,210	(100%)	20	(100%)	$155	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 5. Structure Fires in Warehouse Properties, by Leading Cause
2009-2013 Annual Averages

Cause	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Intentional	220	(18%)	4	(21%)	$50	(32%)
Electrical distribution and lighting equipment	220	(18%)	8	(38%)	$26	(17%)
Heating equipment	90	(8%)	0	(0%)	$5	(3%)
Exposure fire	90	(7%)	0	(0%)	$11	(7%)
Smoking materials	60	(5%)	0	(0%)	$17	(11%)
Cooking equipment	50	(4%)	0	(0%)	$0	(0%)
Lightning	20	(2%)	0	(0%)	$6	(4%)

Note: This table summarizes findings from multiple fields, meaning that the same fire may be listed under multiple causes. Property damage has not been adjusted for inflation. The methodology used is described in Appendix B. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 6. Structure Fires in Warehouse Properties, by Equipment Involved
2009-2013 Annual Averages

Equipment Involved	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
No equipment involved in ignition	**340**	**(28%)**	**4**	**(21%)**	**$81**	**(52%)**
Electrical distribution and lighting equipment	**220**	**(18%)**	**8**	**(38%)**	**$26**	**(17%)**
Wiring and related equipment	110	(9%)	3	(12%)	$12	(8%)
Lamp, bulb or lighting	50	(5%)	3	(17%)	$11	(7%)
Transformers and power supplies	30	(2%)	2	(8%)	$1	(1%)
Cord or plug	20	(2%)	0	(0%)	$2	(1%)
Contained trash or rubbish fire	**170**	**(14%)**	**0**	**(2%)**	**$0**	**(0%)**
Heating equipment	**90**	**(8%)**	**0**	**(0%)**	**$5**	**(3%)**
Fixed or portable space heater	40	(3%)	0	(0%)	$4	(3%)
Confined fuel burner or boiler fire	20	(2%)	0	(0%)	$0	(0%)
Central heat	10	(1%)	0	(0%)	$0	(0%)
Confined chimney or flue fire	10	(1%)	0	(0%)	$0	(0%)
Other known heating equipment	10	(1%)	0	(0%)	$0	(0%)
Torch, burner or soldering iron	**70**	**(5%)**	**0**	**(0%)**	**$20**	**(13%)**
Cooking equipment	**50**	**(4%)**	**0**	**(0%)**	**$0**	**(0%)**
Confined cooking fire	40	(3%)	0	(0%)	$0	(0%)
Other known cooking equipment	10	(1%)	0	(0%)	$0	(0%)
Confined commercial compactor fire	**30**	**(3%)**	**1**	**(5%)**	**$0**	**(0%)**
Fan	**30**	**(3%)**	**0**	**(0%)**	**$3**	**(2%)**
Unclassified equipment involved in ignition	**30**	**(2%)**	**0**	**(0%)**	**$3**	**(2%)**
Hoist or lift	**20**	**(1%)**	**3**	**(14%)**	**$4**	**(3%)**
Air conditioner	**10**	**(1%)**	**0**	**(0%)**	**$0**	**(0%)**
Air compressor	**10**	**(1%)**	**2**	**(10%)**	**$3**	**(2%)**
Power sander, grinder, buffer, or polisher	**10**	**(1%)**	**0**	**(0%)**	**$0**	**(0%)**
Power saw	**10**	**(1%)**	**0**	**(0%)**	**$1**	**(1%)**
Heat treating equipment	**10**	**(1%)**	**0**	**(0%)**	**$0**	**(0%)**
Lawn mower	**10**	**(1%)**	**0**	**(0%)**	**$0**	**(0%)**
Other known Equipment involved in ignition	**110**	**(9%)**	**4**	**(20%)**	**$9**	**(6%)**
Total	**1,210**	**(100%)**	**20**	**(100%)**	**$155**	**(100%)**

Table 6. Structure Fires in Warehouse Properties, by Equipment Involved
2009-2013 Annual Averages (Continued)

Note: NFPA treats fires in which EII=NNN and heat source is not in the range of 40-99 as an additional unknown. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 7. Structure Fires in Warehouse Properties, by Cause of Ignition
2009-2013 Annual Averages

Cause of Ignition	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Unintentional	650	(54%)	12	(58%)	$70	(45%)
Non-Confined	500	(41%)	12	(58%)	$70	(45%)
Confined	160	(13%)	0	(0%)	$0	(0%)
Failure of equipment or heat source	230	(19%)	2	(12%)	$15	(10%)
Non-Confined	190	(15%)	2	(12%)	$15	(10%)
Confined	40	(3%)	0	(0%)	$0	(0%)
Intentional	220	(18%)	4	(21%)	$50	(32%)
Non-Confined	150	(12%)	4	(21%)	$50	(32%)
Confined	70	(6%)	0	(0%)	$0	(0%)
Unclassified cause	70	(0%)	0	(0%)	$0	(0%)
Non-Confined	70	(0%)	0	(0%)	$0	(0%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Act of nature	30	(3%)	0	(0%)	$12	(8%)
Non-Confined	30	(2%)	0	(0%)	$12	(8%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Other Known Cause	10	(7%)	0	(2%)	$8	(5%)
Non-Confined	0	(6%)	0	(2%)	$8	(5%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Total	1,210	(100%)	20	(100%)	$155	(100%)
Non-Confined	930	(77%)	19	(93%)	$154	(100%)
Confined	280	(23%)	1	(0%)	$1	(0%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 8. Structure Fires in Warehouse Properties, Factors Contributing to Ignition
2009-2013 Annual Averages

Factors Contributing to Ignition	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	230	(19%)	3	(14%)	$28	(18%)
Non-Confined	220	(18%)	3	(14%)	$28	(18%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Equipment not being operated properly	130	(11%)	0	(2%)	$1	(0%)
Non-Confined	0	(0%)	0	(0%)	$1	(0%)
Confined	120	(10%)	0	(2%)	$0	(0%)
Mechanical failure or malfunction	130	(11%)	2	(12%)	$14	(9%)
Non-Confined	80	(7%)	2	(12%)	$13	(9%)
Confined	40	(4%)	0	(0%)	$0	(0%)
Abandoned or discarded material or product	120	(10%)	1	(4%)	$7	(5%)
Non-Confined	80	(6%)	1	(4%)	$7	(5%)
Confined	50	(4%)	0	(0%)	$0	(0%)
Heat source too close to combustibles	110	(9%)	1	(4%)	$16	(10%)
Non-Confined	90	(8%)	1	(4%)	$16	(10%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Cutting or welding too close to combustibles	100	(8%)	0	(0%)	$10	(7%)
Non-Confined	80	(7%)	0	(0%)	$10	(7%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Unclassified factor contributed to ignition	100	(8%)	6	(30%)	$26	(17%)
Non-Confined	80	(6%)	6	(30%)	$26	(17%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Improper startup	90	(7%)	0	(2%)	$0	(0%)
Non-Confined	0	(0%)	0	(0%)	$0	(0%)
Confined	90	(7%)	0	(2%)	$0	(0%)
Exposure fire	90	(7%)	0	(0%)	$11	(7%)
Non-Confined	80	(7%)	0	(0%)	$11	(7%)
Confined	10	(1%)	0	(0%)	$0	(0%)

Table 8. Structure Fires in Warehouse Properties, Factors Contributing to Ignition 2009-2013 Annual Averages (Continued)

Factors Contributing to Ignition	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified misuse of material or product	80	(6%)	0	(0%)	$14	(9%)
Non-Confined	50	(4%)	0	(0%)	$14	(9%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Rekindle	60	(5%)	1	(4%)	$0	(0%)
Non-Confined	60	(5%)	1	(4%)	$0	(0%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Improper container or storage	30	(3%)	1	(3%)	$11	(7%)
Non-Confined	20	(1%)	1	(3%)	$11	(7%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Outside/open fire for warming or cooking	30	(2%)	0	(0%)	$0	(0%)
Non-Confined	0	(0%)	0	(0%)	$0	(0%)
Confined	30	(2%)	0	(0%)	$0	(0%)
Failure to clean	30	(2%)	0	(0%)	$0	(0%)
Non-Confined	10	(1%)	0	(0%)	$0	(0%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Equipment unattended	30	(2%)	0	(0%)	$3	(2%)
Non-Confined	10	(1%)	0	(0%)	$3	(2%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Equipment used for not intended purpose	20	(2%)	0	(0%)	$0	(0%)
Non-Confined	0	(0%)	0	(0%)	$0	(0%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Outside/open fire for debris or waste disposal	20	(2%)	0	(0%)	$0	(0%)
Non-Confined	10	(1%)	0	(0%)	$0	(0%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Other known factor contributing to ignition	160	(13%)	0	(24%)	$27	(17%)
Non-Confined	110	(9%)	0	(24%)	$27	(17%)
Confined	50	(4%)	0	(0%)	$0	(0%)

Table 8. Structure Fires in Warehouse Properties, Factors Contributing to Ignition 2009-2013 Annual Averages (Continued)

Factors Contributing to Ignition	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Total Fires	1,210	(100%)	20	(100%)	$155	(100%)
Non-Confined	930	(77%)	19	(93%)	$154	(100%)
Confined	280	(23%)	1	(7%)	$1	(0%)
Total Factors	1,550	(128%)	20	(99%)	$170	(110%)
Non-Confined	980	(81%)	19	(95%)	$169	(109%)
Confined	580	(47%)	1	(3%)	$1	(1%)

* Multiple entries allowed in this field, so total factors add up to more than total fires.

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 9. Structure Fires in Warehouse Properties, by Heat Source
2009-2013 Annual Averages

Heat Source	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Arcing	160	(13%)	2	(8%)	$17	(11%)
Non-Confined	150	(13%)	2	(8%)	$17	(11%)
Confined	10	(0%)	0	(0%)	$0	(0%)
Unclassified heat from powered equipment	150	(12%)	5	(22%)	$10	(7%)
Non-Confined	100	(9%)	5	(22%)	$10	(6%)
Confined	50	(4%)	0	(0%)	$0	(0%)
Spark, ember or flame from operating equipment	120	(10%)	2	(11%)	$21	(14%)
Non-Confined	90	(8%)	2	(11%)	$21	(14%)
Confined	30	(2%)	0	(0%)	$0	(0%)
Unclassified hot or smoldering object	90	(8%)	1	(3%)	$3	(2%)
Non-Confined	70	(6%)	1	(3%)	$3	(2%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Radiated or conducted heat from operating equipment	80	(7%)	2	(8%)	$12	(8%)
Non-Confined	60	(5%)	2	(8%)	$11	(7%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Unclassified heat source	70	(6%)	2	(12%)	$10	(7%)
Non-Confined	50	(4%)	2	(12%)	$10	(7%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Hot ember or ash	60	(5%)	0	(0%)	$4	(3%)
Non-Confined	50	(4%)	0	(0%)	$4	(3%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Smoking Materials	60	(5%)	0	(0%)	$17	(11%)
Non-Confined	40	(3%)	0	(0%)	$17	(11%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Lighter	50	(4%)	1	(4%)	$11	(7%)
Non-Confined	30	(3%)	1	(4%)	$11	(7%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Spontaneous combustion or chemical reaction	50	(4%)	0	(0%)	$11	(7%)
Non-Confined	30	(3%)	0	(0%)	$11	(7%)
Confined	20	(1%)	0	(0%)	$0	(0%)

Table 9. Structure Fires in Warehouse Properties, by Heat Source
2009-2013 Annual Averages (Continued)

Heat Source	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Match	50	(4%)	0	(0%)	$0	(0%)
Non-Confined	20	(1%)	0	(0%)	$0	(0%)
Confined	30	(3%)	0	(0%)	$0	(0%)
Heat from direct flame or convection currents	50	(4%)	1	(3%)	$4	(2%)
Non-Confined	40	(3%)	1	(3%)	$4	(2%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Flame or torch used for lighting	40	(3%)	0	(0%)	$1	(1%)
Non-Confined	30	(3%)	0	(0%)	$1	(1%)
Confined	10	(0%)	0	(0%)	$0	(0%)
Heat or spark from friction	40	(3%)	1	(3%)	$4	(2%)
Non-Confined	20	(2%)	1	(3%)	$4	(2%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Molten or hot material	30	(3%)	0	(0%)	$1	(1%)
Non-Confined	30	(2%)	0	(0%)	$1	(1%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Lightning	20	(2%)	0	(0%)	$6	(4%)
Non-Confined	20	(2%)	0	(0%)	$6	(4%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Other known heat source	100	(8%)	4	(19%)	$23	(15%)
Non-Confined	100	(8%)	4	(19%)	$23	(15%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Total	1,210	(100%)	20	(100%)	$155	(100%)
Non-Confined	930	(77%)	19	(93%)	$154	(100%)
Confined	280	(23%)	1	(0%)	$1	(0%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors. Estimates of matches, lighters, smoking materials, and candles included a proportional share of fires in which the heat source was heat from an unclassified open flame or smoking material.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 10. Structure Fires in Warehouse Properties, by Area of Origin
2009-2013 Annual Averages

Area of Origin	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified storage area	140	(11%)	4	(19%)	$52	(33%)
Non-Confined	120	(10%)	4	(19%)	$52	(33%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Shipping receiving or loading area	120	(10%)	2	(10%)	$23	(15%)
Non-Confined	90	(7%)	2	(10%)	$23	(15%)
Confined	30	(2%)	0	(0%)	$0	(0%)
Storage room, area, tank, or bin	80	(7%)	1	(4%)	$9	(6%)
Non-Confined	60	(5%)	1	(4%)	$9	(6%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Vacant structural area	60	(5%)	0	(0%)	$3	(2%)
Non-Confined	40	(3%)	0	(0%)	$3	(2%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Unclassified outside area	50	(4%)	1	(3%)	$2	(1%)
Non-Confined	30	(2%)	1	(3%)	$2	(1%)
Confined	30	(2%)	0	(0%)	$0	(0%)
Storage of supplies or tools or dead storage	50	(4%)	0	(0%)	$6	(4%)
Non-Confined	50	(4%)	0	(0%)	$6	(4%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Exterior roof surface	50	(4%)	0	(0%)	$2	(1%)
Non-Confined	50	(4%)	0	(0%)	$2	(1%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Trash or rubbish chute, area or container	40	(4%)	0	(0%)	$0	(0%)
Non-Confined	10	(1%)	0	(0%)	$0	(0%)
Confined	40	(3%)	0	(0%)	$0	(0%)
Unclassified equipment or service area	40	(4%)	0	(2%)	$3	(2%)
Non-Confined	30	(2%)	0	(2%)	$3	(2%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Processing or manufacturing area, or workroom	40	(3%)	1	(5%)	$7	(4%)
Non-Confined	30	(3%)	1	(5%)	$7	(4%)
Confined	10	(1%)	0	(0%)	$0	(0%)

Table 10. Structure Fires in Warehouse Properties, Area of Origin
2009-2013 Annual Averages (Continued)

Area of Origin	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified area of origin	40	(3%)	1	(5%)	$1	(1%)
Non-Confined	20	(2%)	1	(5%)	$1	(1%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Office	40	(3%)	1	(7%)	$5	(3%)
Non-Confined	40	(3%)	1	(7%)	$5	(3%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Exterior wall surface	40	(3%)	0	(0%)	$2	(1%)
Non-Confined	40	(3%)	0	(0%)	$2	(1%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Maintenance or paint shop area	30	(3%)	1	(5%)	$5	(4%)
Non-Confined	30	(2%)	1	(5%)	$5	(4%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Unclassified structural area	30	(2%)	0	(0%)	$3	(2%)
Non-Confined	30	(2%)	0	(0%)	$3	(2%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Garage or vehicle storage area	30	(2%)	1	(6%)	$4	(2%)
Non-Confined	20	(2%)	1	(6%)	$4	(2%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Kitchen or cooking area	20	(2%)	0	(0%)	$0	(0%)
Non-Confined	10	(0%)	0	(0%)	$0	(0%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Wall assembly or concealed space	20	(2%)	0	(0%)	$0	(0%)
Non-Confined	20	(2%)	0	(0%)	$0	(0%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Machinery room or area or elevator machinery room	20	(2%)	0	(0%)	$1	(0%)
Non-Confined	20	(1%)	0	(0%)	$1	(0%)
Confined	0	(0%)	0	(0%)	$0	(0%)

Table 10. Structure Fires in Warehouse Properties, by Area of Origin
2009-2013 Annual Averages (Continued)

Area of Origin	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Other known area of origin	280	(23%)	6	(27%)	$27	(17%)
Non-Confined	220	(18%)	6	(27%)	$27	(17%)
Confined	70	(6%)	0	(0%)	$0	(0%)
Total	1,210	(100%)	20	(100%)	$155	(100%)
Non-Confined	930	(77%)	19	(93%)	$154	(100%)
Confined	280	(23%)	1	(0%)	$1	(0%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors. Non-confined and non-contained structure fires in which the area of origin was unknown or not reported have been allocated proportionally among fires with known area of origin.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 11. Structure Fires in Warehouses, by Item First Ignited
2009-2013 Annual Averages

Item First Ignited	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Rubbish, trash, or waste	150	(12%)	0	(0%)	$3	(2%)
Non-Confined	70	(5%)	0	(0%)	$2	(2%)
Confined	80	(7%)	0	(0%)	$0	(0%)
Electrical wire or cable insulation	100	(8%)	1	(5%)	$10	(6%)
Non-Confined	90	(8%)	1	(5%)	$10	(6%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Unclassified item first ignited	90	(7%)	4	(18%)	$9	(6%)
Non-Confined	70	(6%)	4	(18%)	$9	(6%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Flammable or combustible liquids or gases, piping or filter	70	(6%)	6	(31%)	$18	(12%)
Non-Confined	50	(4%)	6	(31%)	$18	(11%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Structural member or framing	70	(5%)	0	(0%)	$7	(5%)
Non-Confined	70	(5%)	0	(0%)	$7	(5%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Box, carton, bag, basket, or barrel	60	(5%)	2	(10%)	$16	(10%)
Non-Confined	40	(3%)	2	(10%)	$16	(10%)
Confined	20	(1%)	0	(0%)	$0	(0%)
Exterior roof covering or finish	60	(5%)	0	(0%)	$5	(3%)
Non-Confined	60	(5%)	0	(0%)	$5	(3%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Multiple items first ignited	50	(5%)	0	(0%)	$16	(11%)
Non-Confined	50	(4%)	0	(0%)	$16	(11%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Exterior wall covering or finish	50	(4%)	0	(0%)	$4	(3%)
Non-Confined	50	(4%)	0	(0%)	$4	(3%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Dust, fiber, lint, including sawdust or excelsior	40	(3%)	1	(3%)	$3	(2%)
Non-Confined	30	(2%)	1	(3%)	$3	(2%)
Confined	10	(1%)	0	(0%)	$0	(0%)

Table 11. Structure Fires in Warehouses, by Item First Ignited
2009-2013 Annual Averages (Continued)

Item First Ignited	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Magazine, newspaper, or writing paper	30	(3%)	0	(0%)	$0	(0%)
Non-Confined	10	(1%)	0	(0%)	$0	(0%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Cooking materials, including food	30	(2%)	0	(0%)	$0	(0%)
Non-Confined	0	(0%)	0	(0%)	$0	(0%)
Confined	20	(2%)	0	(0%)	$0	(0%)
Insulation within structural area	30	(2%)	0	(0%)	$0	(0%)
Non-Confined	30	(2%)	0	(0%)	$0	(0%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Unclassified structural component or finish	20	(2%)	1	(3%)	$1	(0%)
Non-Confined	20	(2%)	1	(3%)	$1	(0%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Palletized material, material stored on pallets	20	(2%)	1	(4%)	$17	(11%)
Non-Confined	20	(1%)	1	(4%)	$17	(11%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Packing or wrapping material	20	(2%)	0	(0%)	$1	(1%)
Non-Confined	10	(1%)	0	(0%)	$1	(1%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Bulk storage	20	(2%)	1	(3%)	$4	(2%)
Non-Confined	20	(1%)	1	(3%)	$4	(2%)
Confined	0	(0%)	0	(0%)	$0	(0%)
Oily rags	20	(2%)	0	(0%)	$0	(0%)
Non-Confined	10	(1%)	0	(0%)	$0	(0%)
Confined	10	(0%)	0	(0%)	$0	(0%)
Interior ceiling cover or finish	20	(2%)	0	(0%)	$1	(0%)
Non-Confined	20	(2%)	0	(0%)	$1	(0%)
Confined	0	(0%)	0	(0%)	$0	(0%)

Table 11. Structure Fires in Warehouses, by Item First Ignited
2009-2013 Annual Averages (Continued)

Item First Ignited	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Empty pallet or skid	20	(2%)	0	(0%)	$1	(1%)
Non-Confined	10	(1%)	0	(0%)	$1	(1%)
Confined	10	(1%)	0	(0%)	$0	(0%)
Other known item first ignited	260	(21%)	3	(15%)	$38	(24%)
Non-Confined	210	(18%)	3	(15%)	$38	(24%)
Confined	40	(3%)	0	(0%)	$0	(0%)
Total	1,210	(100%)	20	(100%)	$155	(100%)
Non-Confined	930	(77%)	19	(93%)	$154	(100%)
Confined	280	(23%)	1	(0%)	$1	(0%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

Table 12. Structure Fires in Warehouses, by Extent of Flame Damage
2009-2013 Annual Averages

Extent of Flame Damage	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Confined fire identified by incident type	280	23%	0	0%	$1	0%
Confined to object of origin	170	14%	6	32%	$5	3%
Confined to room of origin	260	21%	4	19%	$8	5%
Confined to floor of origin	70	6%	1	6%	$8	5%
Confined to building of origin	370	31%	7	38%	$99	64%
Beyond building of origin	60	5%	1	5%	$34	22%
Total	1,210	100%	20	100%	$155	100%

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These national estimates are projections based on the detailed information collected in Version 5.0 of NFIRS. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. Totals may not equal sums due to rounding errors.

Source: NFIRS and NFPA Fire Experience Survey, 2009-2013.

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 from 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.

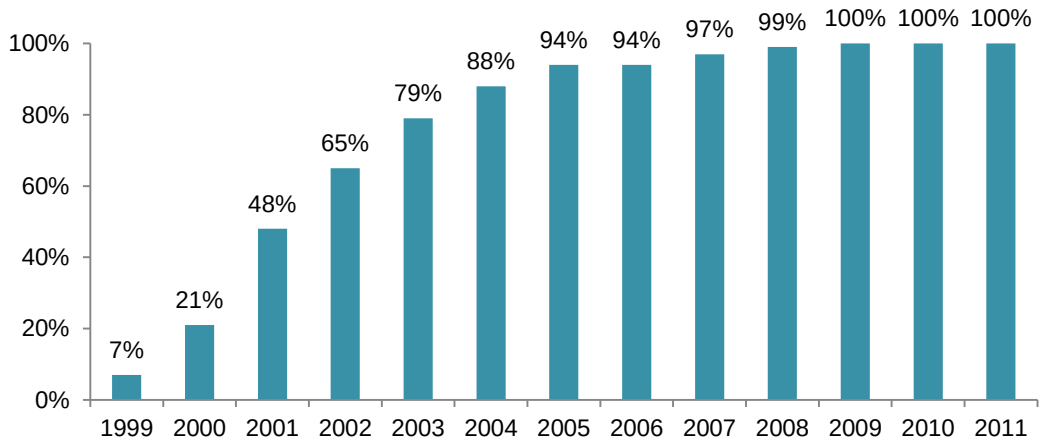
Figure A.1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

From 1999 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.

Figure A.1. Fires Originally Collected in NFIRS 5.0 by Year



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.

Because this analysis focused on fatalities only, no distinction was made between confined and non-confined fires.

For most fields other than Property Use and Incident Type, 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. The percentages of fires with known or unknown data are provided for non-confined fires and associated losses, and for confined fires only.

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.

In the formulas that follow, the term "all fires" refers to all fires in NFIRS on the dimension studied. The percentages of fires with known or unknown data are provided for non-confined fires and associated losses, and for confined fires only.

Cause of Ignition: This field is used chiefly to identify intentional fires. "Unintentional" in this field is a specific entry and does not include other fires that were not intentionally set: failure of equipment or heat source, act of nature, or "other" (unclassified)." The last should be used for exposures but has been used for other situations as well. Fires that were coded as under investigation and those that were coded as undetermined after investigation were treated as unknown.

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 mechanical failure, malfunction (factor contributing to ignition 20-29) are combined and shown as one entry, "mechanical failure or malfunction." This category includes:

21. Automatic control failure;
22. Manual control failure;
23. Leak or break. Includes leaks or breaks from containers or pipes. Excludes operational deficiencies and spill mishaps;
25. Worn out;
26. Backfire. Excludes fires originating as a result of hot catalytic converters;
27. Improper fuel used; Includes the use of gasoline in a kerosene heater and the like; and
20. Mechanical failure or malfunction, other.

Entries in "electrical failure, malfunction" (factor contributing to ignition 30-39) may also be combined into one entry, "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.

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

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

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

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

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

Equipment Involved in Ignition (EII). NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment malfunctioned or was used improperly. In 2006, the definition was modified to "the piece of equipment that provided the principal heat source to cause ignition." However, much of the data

predates the change. Individuals who have already been trained with the older definition may not change their practices. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

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

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

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

In some analyses, various types of equipment are grouped together.

Code Grouping	EII Code	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	120	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
Fixed wiring and related equipment	210	Unclassified electrical wiring
	211	Electrical power or utility line
	212	Electrical service supply wires from utility
	213	Electric meter or meter box
	214	Wiring from meter box to circuit breaker
	215	Panel board, switch board or circuit breaker board
	216	Electrical branch circuit
	217	Outlet or receptacle
	218	Wall switch
	219	Ground fault interrupter
Transformers and power supplies	221	Distribution-type transformer
	222	Overcurrent, disconnect equipment
	223	Low-voltage transformer
	224	Generator
	225	Inverter
	226	Uninterrupted power supply (UPS)
	227	Surge protector
	228	Battery charger or rectifier
	229	Battery (all types)

Code Grouping	EII Code	NFIRS definitions
Lamp, bulb or lighting	230	Unclassified lamp or lighting
	231	Lamp-tabletop, floor or desk
	232	Lantern or flashlight
	233	Incandescent lighting fixture
	234	Fluorescent light fixture or ballast
	235	Halogen light fixture or lamp
	236	Sodium or mercury vapor light fixture or lamp
	237	Work or trouble light
	238	Light bulb
	241	Nightlight
	242	Decorative lights – line voltage
	243	Decorative or landscape lighting – low voltage
	244	Sign
Cord or plug	260	Unclassified cord or plug
	261	Power cord or plug, detachable from appliance
	262	Power cord or plug- permanently attached
	263	Extension cord
Torch, burner or soldering iron	331	Welding torch
	332	Cutting torch
	333	Burner, including Bunsen burners
	334	Soldering equipment
Portable cooking or warming equipment	631	Coffee maker or teapot
	632	Food warmer or hot plate
	633	Kettle
	634	Popcorn popper
	635	Pressure cooker or canner
	636	Slow cooker
	637	Toaster, toaster oven, counter-top broiler
	638	Waffle iron, griddle
	639	Wok, frying pan, skillet
	641	Breadmaking machine

Equipment was not analyzed separately for confined fires. Instead, each confined fire incident type was listed with the equipment or as other known equipment.

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." Chimney is no longer a valid area of origin code for non-confined fires.

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.

Appendix B.
Methodology and Definitions Used in "Leading Cause" Tables

The cause table reflects relevant causal factors that accounted for at least 2% of the fires in a given occupancy. Only those causes that seemed to describe a scenario are included. Because the causal factors are taken from different fields, some double counting is possible. Percentages are calculated against the total number of structure fires, including both confined and non-confined fires. Bear in mind that every fire has at least three "causes" in the sense that it could have been prevented by changing behavior, heat source, or ignitability of first fuel, the last an aspect not reflected in any of the major cause categories. For example, several of the cause categories in this system refer to types of equipment (cooking, heating, electrical distribution and lighting, clothes dryers and washers, torches). However, the problem may be not with the equipment but with the way it is used. The details in national estimates are derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS). This methodology is based on the coding system used in Version 5.0 of NFIRS. The *NFIRS 5.0 Reference Guide*, containing all of the codes, can be downloaded from http://www.nfirs.fema.gov/documentation/reference/.

Cooking equipment and heating equipment are calculated by summing fires identified by equipment involved in ignition and relevant confined fires. Confined fires will be shown if they account for at least 2% of the incidents. **Confined cooking fires** (cooking fires involving the contents of a cooking vessel without fire extension beyond the vessel) are identified by NFIRS incident type 113.

Confined heating equipment fires include **confined chimney or flue fires (**incident type 114) and **confined fuel burner or boiler** fires (incident type 116). The latter includes delayed ignitions and incidents where flames caused no damage outside the fire box. The two types of confined heating fires may be combined or listed separately, depending on the numbers involved.

Intentional fires are identified by fires with a "1" (intentional) in the field "cause." The estimate includes a proportional share of fires in which the cause was undetermined after investigation, under investigation, or not reported. All fires with intentional causes are included in this category regardless of the age of the person involved. Earlier versions of NFIRS included codes for incendiary and suspicious. Intentional fires were deliberately set; they may or may not be incendiary in a legal sense. No age restriction is applied.

Fires caused by **playing with heat source** (typically matches or lighters) are identified by code 19 in the field "factor contributing to ignition." Fires in which the factor contribution to ignition was undetermined (UU), entered as none (NN) or left blank are considered unknown and allocated proportionally. Because factor contributing to ignition is not required for intentional fires, the share unknown, by these definitions, is somewhat larger than it should be.

The heat source field is used to identify fires started by: **smoking materials** (cigarette, code 61; pipe or cigar, code 62; and heat from undetermined smoking material, code 63); **candles** (code 66), **lightning** (code 73); and **spontaneous combustion or chemical reaction** (code 72). Fires started by heat from unclassified open flame or smoking materials (code 60) are allocated

proportionally among the "other open flame or smoking material" codes (codes 61-69) in an allocation of partial unknown data. This includes smoking materials and candles. This approach results in any true unclassified smoking or open flame heat sources such as incense being inappropriately allocated. However, in many fires, this code was used as an unknown.

The equipment involved in ignition field is used to find several cause categories. This category includes equipment that functioned properly and equipment that malfunctioned.

Cooking equipment Non-confined fire refers to equipment used to cook, heat or warm food (codes 620-649 and 654). Fire in which ranges, ovens or microwave ovens, food warming appliances, fixed or portable cooking appliances, deep fat fryers, open fired charcoal or gas grills, grease hoods or ducts, or other cooking appliances) were involved in the ignition are said to be caused by cooking equipment. Food preparation devices that do not involve heating, such as can openers or food processors, are not included here. As noted in Appendix A, a proportional share of unclassified kitchen and cooking equipment (code 600) is included here.

Heating equipment Non-confined fire (codes 120-199) includes central heat, portable and fixed heaters (including wood stoves), fireplaces, chimneys, hot water heaters, and heat transfer equipment such as hot air ducts or hot water pipes. Heat pumps are not included. As noted in Appendix A, a proportional share of unclassified heating, ventilation and air condition equipment (code 100) is included here.

Confined fires are excluded from the tallies of the remaining categories of fires involving equipment.

Electrical distribution and lighting equipment (codes 200-299) include: fixed wiring; transformers; associated overcurrent or disconnect equipment such as fuses or circuit breakers; meters; meter boxes; power switch gear; switches, receptacles and outlets; light fixtures, lamps, bulbs or lighting; signs; cords and plugs; generators, transformers, inverters, batteries and battery charges.

Torch, burner or soldering iron (codes 331-334) includes welding torches, cutting torches, Bunsen burners, plumber furnaces, blowtorches, and soldering equipment. As noted in Appendix A, a proportional share of shop tools and industrial equipment (code 300) is included here.

Clothes dryer or washer (codes 811, 813 and 814) includes clothes dryers alone, washer and dryer combinations within one frame, and washing machines for clothes. As noted in Appendix A, a proportional share of unclassified personal and household equipment (code 800) is included here.

Electronic, office or entertainment equipment (codes 700-799) includes: computers and related equipment; calculators and adding machines; telephones or answering machines; copiers; fax machines; paper shredders; typewriters; postage meters; other office equipment; musical instruments; stereo systems and/or components; televisions and cable TV converter

boxes,, cameras, excluding professional television studio cameras, video equipment and other electronic equipment. Older versions of NFIRS had a code for electronic equipment that included radar, X-rays, computers, telephones, and transmitter equipment.

Shop tools and industrial equipment excluding torches, burners or soldering irons (codes 300-330, 335-399) includes power tools; painting equipment; compressors; atomizing equipment; pumps; wet/dry vacuums; hoists, lifts or cranes; powered jacking equipment; water or gas drilling equipment; unclassified hydraulic equipment; heat-treating equipment; incinerators, industrial furnaces, ovens or kilns; pumps; compressors; internal combustion engines; conveyors; printing presses; casting, molding; or forging equipment; heat treating equipment; tar kettles; working or shaping machines; coating machines; chemical process equipment; waste recovery equipment; power transfer equipment; power takeoff; powered valves; bearings or brakes; picking, carding or weaving machines; testing equipment; gas regulators; separate motors; non-vehicular internal combustion engines; and unclassified shop tools and industrial equipment. . As noted in Appendix A, a proportional share of shop tools and industrial equipment (code 300) is included here.

Medical equipment (codes 410-419) includes: dental, medical or other powered bed, chair or wheelchair; dental equipment; dialysis equipment; medical monitoring and imaging equipment; oxygen administration equipment; radiological equipment; medical sterilizers, therapeutic equipment and unclassified medical equipment. As noted in Appendix A, a proportional share of commercial and medical equipment (code 400) is included here.

Exposures are fires that are caused by the spread of or from another fire. These were identified by factor contributing to ignition code 71. This code is automatically applied when the exposure number is greater than zero.