

# **FIREWORKS**

**John R. Hall, Jr.**

**June 2009**



**National Fire Protection Association  
Fire Analysis and Research Division**

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## **Abstract**

In 2007, 9,800 fireworks-related injuries were treated in U.S. hospital emergency rooms. The trend in fireworks-related injuries has been mostly up since 1996, with spikes in 2000-2001, primarily due to celebrations around the advent of a new millennium, and in 2005. The highest injury rates were for children aged 5 to 9 and 10 to 14. In 2006, an estimated 32,600 reported fires were started by fireworks. These fires resulted in 6 civilian deaths, 70 civilian injuries and \$34 million in direct property damage. In 2007, more than nine out of ten (92%) emergency room fireworks injuries involved fireworks that Federal regulations permit consumers to use. The risk of fire death relative to exposure shows fireworks to be the riskiest consumer product.

Keywords: Fireworks, fire statistics, NFIRS, NEISS

## **Acknowledgements**

The National Fire Protection Association thanks all the fire departments and state fire authorities who participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS. And we appreciate the important work done by the U.S. Consumer Product Safety Commission to develop, maintain, and support analysis of the National Electronic Injury Surveillance System (NEISS) and the National Center for Health Statistics and the National Safety Council for maintenance and analysis of the U.S. death certificate data base.

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## Executive Summary

In 2007, 9,800 fireworks-related injuries were treated in U.S. hospital emergency rooms. The trend in fireworks-related injuries has been mostly up since 1996, with spikes in 2000-2001, primarily due to celebrations around the advent of a new millennium, and in 2005. Injuries were higher in 1984-1995 than in recent years but lower in the mid-1970s and earlier.

In 2006, an estimated 32,600 reported fires were started by fireworks. These fires resulted in 6 civilian deaths, 70 civilian injuries and \$34 million in direct property damage.

The largest numbers of fires associated with fireworks were grass fires (10,800 per year), brush fires (7,600), dumpster fires (2,900), unknown-type natural vegetation fires (2,300), and outside trash, rubbish, or waste fires (2,100).

In 2002-2006, 3 people per year were killed in fires started by fireworks, while 7 people per year were killed directly by fireworks. These estimates may overlap, because fireworks can directly kill someone while also starting a fatal fire.

Two of five victims of fireworks injuries in 2007 were under age 15. The highest rates of injuries per million population were for children ages 5 to 9 and 10 to 14. Males accounted for three-fourths (70%) of fireworks injuries.

In 2007, nine out of ten (92%) emergency room fireworks injuries involved fireworks that Federal regulations permit consumers to use.

The risk of fire death relative to exposure shows fireworks to be the riskiest consumer product for death due to fire.



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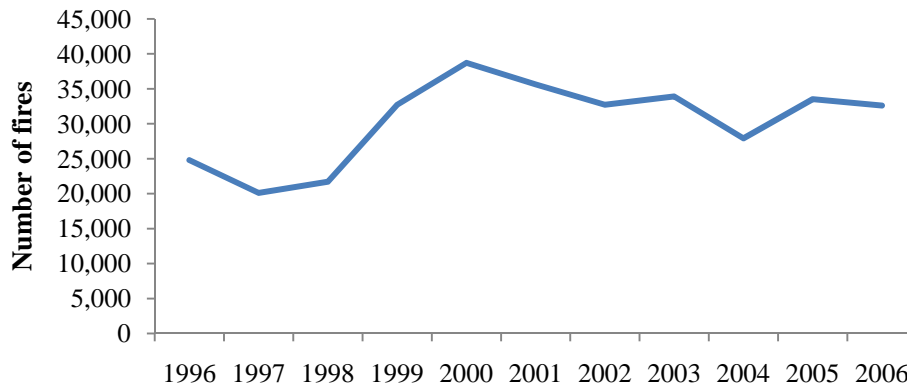
# Fireworks

## Size of the Fireworks Problem

On Independence Day in a typical year, more U.S. fires are reported than on any other day, and fireworks account for half of those fires, more than any other cause of fires.

- In 2006, fireworks caused an estimated **32,600** reported fires, including **1,700** total structure fires, **600** vehicle fires, and **30,300** outside and other fires.
- These fires resulted in an estimated **6** civilian deaths, **70** civilian injuries and **\$34 million** in direct property damage.

**Reported Fires Associated with Fireworks, 1996-2006**



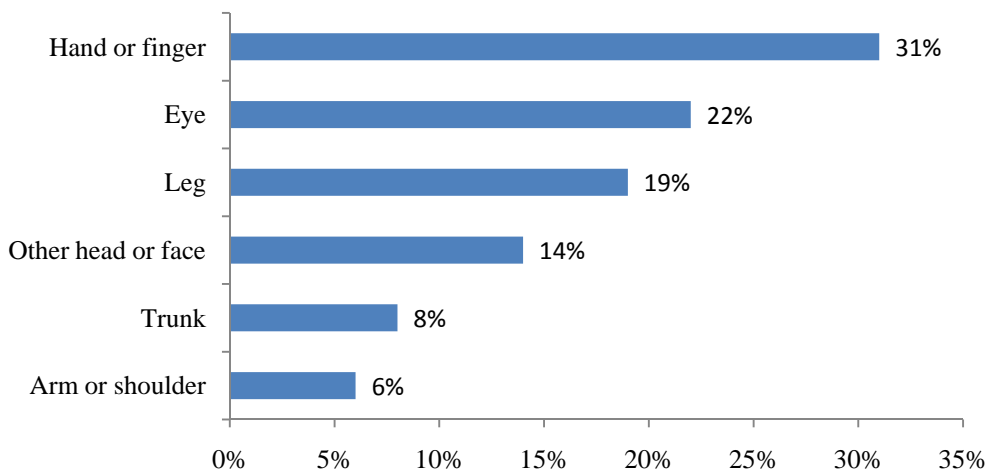
**FACT: 900** home structure fires were caused by fireworks in 2006.

## Characteristics of Fireworks Injuries

In 2007, U.S. hospital emergency rooms treated an estimated **9,800** people for fireworks related injuries.

- **56%** of 2007 emergency room fireworks-related injuries were to the extremities and **36%** were to the head.

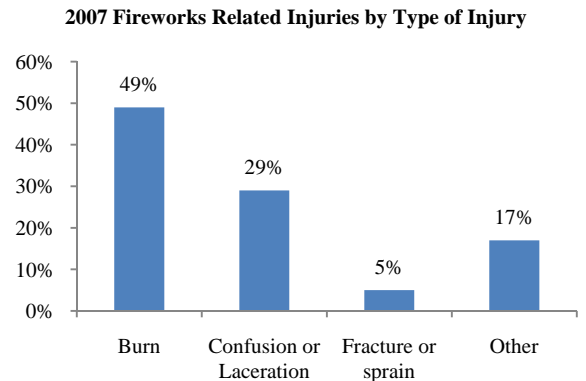
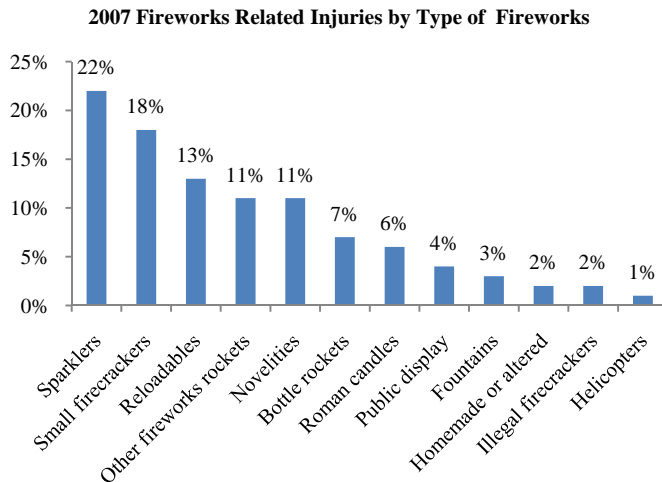
**2007 Fireworks-Related Injuries, by Part of Body**



**FACT: Males** accounted for **70%** of fireworks injuries in 2007.

## Characteristics of Fireworks Injuries Continued

- **49%** of the 2007 fireworks injuries were burns, while **29%** were contusions and lacerations.
- **Two of five (42%)** people injured by fireworks were under the age of 15.
- The risk of fireworks injury was **two-and-a-half** times as high for children ages 5-9 or 10-14 as for the general population.
- Sparklers, fountains, and novelties alone accounted for **36%** of the emergency room fireworks injuries in 2007.



**FACT: 92%** of the fireworks injuries treated in hospital emergency rooms involved fireworks that Federal regulations permit consumers to use.

## Risk of Private Fireworks Use

The risk of fire death relative to time used shows fireworks as the riskiest consumer product.

- The risk that someone will die from fire when fireworks are being used is higher relative to exposure time than the risk of fire death when a cigarette is being smoked.
- The risks with fireworks are **not** limited to displays, public or private. Risks also exist wherever fireworks are **manufactured, transported, or stored**.
- **“Safe and sane”** fireworks are neither. Fireworks and sparklers are designed to explode or throw off showers of hot sparks. Temperatures may exceed 1200°F.



**FACT:** The following five states have banned access by the public to all fireworks: **Delaware, Massachusetts, New Jersey, New York, and Rhode Island.**

***NFPA encourages people to enjoy public displays of fireworks that comply with NFPA 1123. NFPA is strongly opposed to any consumer use of fireworks.***

## Size of the Fireworks Problem

### **In 2007, 9,800 fireworks-related injuries were treated in U.S. hospital emergency rooms.**

The trend in fireworks-related injuries has been mostly up since 1996, except for spikes in 2000-2001, primarily due to celebrations around the advent of a new millennium, and in 2005. Injuries were higher in 1984-1995 than in recent years but lower in the mid-1970s and earlier. (See Figure 1.) These statistics are estimates based on the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS) sample of hospital emergency rooms.

### **In 2006, an estimated 32,600 reported fires were ignited by fireworks.**

These fires resulted in 6 civilian deaths, 70 civilian injuries and \$34 million in direct property damage. Most fires were outside fires, while most associated deaths and property damage were in structures and specifically homes. (See Table 1.)

These estimates do not include any proportional allocation of fires involving explosives of unknown type. A side analysis indicates such an allocation would add 10-15% to the estimates of structure fires started by fireworks in a typical year. These estimates also do not include estimates of fireworks explosions with no after-fire.

### **In 2002-2006, an estimated 3 people per year were killed in reported fires started by fireworks, while 7 people per year were killed directly by fireworks.**

Deaths involving fireworks are identified from two data sources, which may partially or largely overlap, because fireworks can directly kill someone while also starting a fatal fire. (See Table 2.) The period of 2002-2006 is the latest 5-year period for which there are estimates of deaths in fires started by fireworks and directly from fireworks according to death certificates. In both data bases, the death toll varies substantially from year to year.

In 2003, 100 people were killed in a Rhode Island nightclub fire ignited by the indoor use of pyrotechnics in a small, crowded room with interior finish that promoted rapid flame spread. The facility had no sprinkler protection. These deaths were not reported to NFIRS and are not reflected in the national estimates.

As a comparison of Figure 1 and Table 1 demonstrates, most non-fatal injuries due to fireworks do not occur in the context of a reported fire. For both fatal and non-fatal injuries, it is clear that fireworks can injure directly via a traumatic injury or indirectly via a fire injury from a fire initiated by the fireworks. As for non-fatal injuries, the available statistics also omit injuries that are treated in doctor's offices or are left untreated.

### **Grass and brush fires account for most fireworks-related outside or other fires.**

Grass and brush fires account for 62% of all fireworks-related outside or other fires plus some, probably most, of the 8% attributed to unknown-type natural vegetation. (See Table A.) Dumpster fires and other rubbish or trash fires account for about 20% of all fireworks-related outside or other fires.

Each year, most fireworks-related fires begin outside, but most of the loss occurs in fires with structures involved. Structure fires can start with outside use of fireworks, as when a bottle rocket, launched outside, lands on a roof. Because cause information is no longer required for outside refuse fires, only a small fraction of reported outside refuse fires have known heat source. This fact means that single-year estimates for outside and other fireworks fires can be highly variable; a multi-year average is more stable.

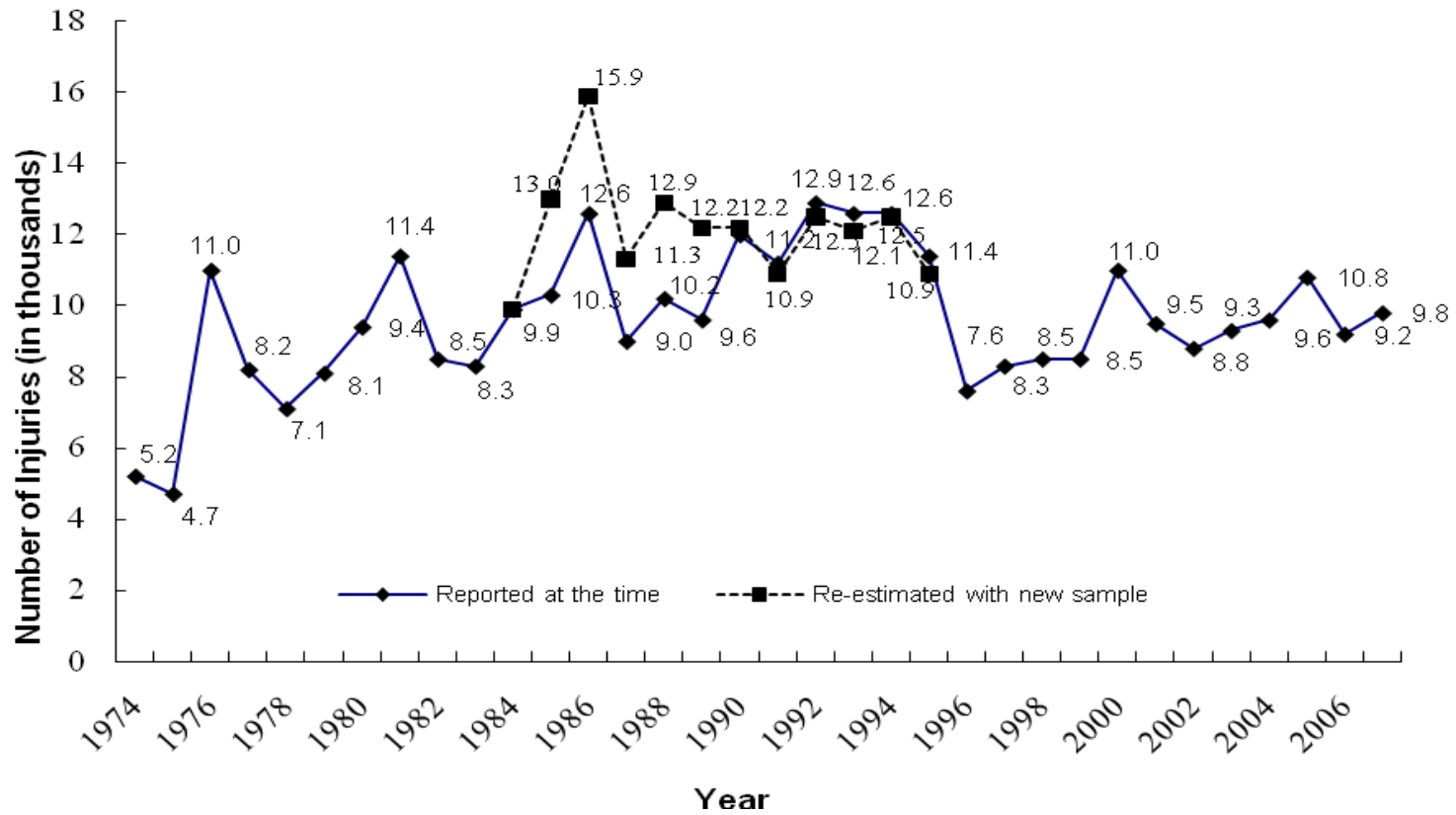
**Table A. Estimated Outside and Other Fires Associated With Fireworks  
Annual Average of 2003-2006 Fires Reported to U.S. Fire Departments**

<b>Incident Type</b>	<b>Fires</b>	
Grass	10,800	(36%)
Brush or brush/grass mixture	7,600	(26%)
Dumpster or other outside trash receptacle	2,900	(10%)
Unknown-type natural vegetation	2,300	(8%)
Outside trash, rubbish, or waste	2,100	(7%)
Forest, woods, or wildland	1,000	(3%)
Unknown-type outside rubbish	800	(3%)
Unknown-type special outside	700	(2%)
Outside mailbox	300	(1%)
Unknown-type outside or other	300	(1%)
Unknown-type cultivated vegetation or crop	300	(1%)
Cultivated trees or nursery stock	200	(1%)
Cultivated grain or crop	100	(0%)
Outside storage	100	(0%)
Outside equipment	100	(0%)
Other	100	(0%)
<b>Total</b>	<b>29,600</b>	<b>(100%)</b>

Source: NFIRS and NFPA survey.

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Fires are rounded to the nearest hundred. Figures reflect a proportional share of fires with heat source unknown. Totals may not equal sums because of rounding error.

**Figure 1.**  
**Fireworks-Related Injuries Reported to Hospital Emergency Rooms**  
**1974-2007**



Source: CPSC's NEISS

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006**  
**Fires Reported to U.S. Fire Departments**

**A. Fires**

<b>Year</b>	<b>Home Structures</b>		<b>Other Residential Structures</b>		<b>Nonresidential Structures</b>		<b>Total Structures</b>		<b>Vehicles</b>	<b>Outside and Other</b>	<b>Total</b>
1980	2,900		100		1,100		4,000	500	21,800	26,400	
1981	2,800		100		1,300		4,200	500	27,100	31,800	
1982	1,700		100		1,000		2,700	500	24,600	27,800	
1983	1,400		100		800		2,300	500	25,300	28,000	
1984	2,400		100		1,200		3,700	1,000	34,700	39,400	
1985	2,600		100		1,500		4,100	900	46,600	51,600	
1986	2,300		100		1,200		3,600	1,000	30,500	35,100	
1987	1,900		100		1,100		3,100	800	33,200	37,100	
1988	2,300		100		1,400		3,700	900	47,400	52,100	
1989	1,700		100		900		2,700	800	29,900	33,400	
1990	1,600		100		800		2,500	800	30,000	33,300	
1991	1,600		100		900		2,600	900	24,900	28,400	
1992	1,400		0		900		2,300	700	22,500	25,500	
1993	1,300		0		800		2,100	800	27,300	30,200	
1994	1,300		0		900		2,200	700	35,100	38,000	
1995	1,100		0		700		1,900	700	24,900	27,500	
1996	1,100		0		600		1,700	600	22,500	24,800	
1997	1,000		0		700		1,700	500	17,900	20,100	
1998	800		0		500		1,400	500	19,800	21,700	
1999	1,700	(1,600)	0	(0)	1,200	(600)	2,800	(2,200)	900	29,000	32,700
2000	1,500	(1,400)	100	(100)	1,200	(700)	2,800	(2,200)	900	35,000	38,700
2001	1,200	(1,100)	100	(0)	1,000	(700)	2,200	(1,900)	900	32,600	35,600

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006  
Fires Reported to U.S. Fire Departments (Continued)**

**A. Fires (Continued)**

<b>Year</b>	<b>Home Structures</b>		<b>Other Residential Structures</b>		<b>Nonresidential Structures</b>		<b>Total Structures</b>		<b>Vehicles</b>	<b>Outside and Other</b>	<b>Total</b>
2002	1,100	(1,000)	100	(100)	700	(600)	1,900	(1,600)	900	29,900	32,700
2003	1,000	(900)	100	(100)	700	(600)	1,800	(1,600)	800	31,300	33,900
2004	900	(800)	0	(0)	600	(400)	1,500	(1,300)	600	25,800	27,900
2005	1,000	(900)	0	(0)	700	(500)	1,800	(1,400)	700	31,000	33,500
2006	900	(800)	100	(0)	700	(500)	1,700	(1,300)	600	30,300	32,600

Note: Numbers in parentheses exclude fires reported as confined fires. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred. Figures reflect a proportional share of fires with heat source unknown. *Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution.* Totals may not equal sums because of rounding error.  
Source: Data from NFIRS Version 4.1 (1980-1998) and Version 5.0 (1999-2006) and NFPA survey.

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006  
Fires Reported to U.S. Fire Departments (Continued)**

**B. Civilian Deaths**

<b>Year</b>	<b><u>Home Structures</u></b>		<b><u>Other Residential Structures</u></b>		<b><u>Nonresidential Structures</u></b>		<b><u>Total Structures</u></b>		<b><u>Vehicles</u></b>	<b><u>Outside and Other</u></b>	<b><u>Total</u></b>
1980	0		0		0		0		0	0	0
1981	0		0		0		0		0	0	0
1982	0		0		0		0		0	0	0
1983	0		0		0		0		0	0	0
1984	3		0		0		3		0	0	3
1985	8		0		0		8	3	4		15
1986	4		0		0		4	0	0		4
1987	4		0		3		7	0	0		7
1988	20		0		0		20	0	0		20
1989	4		0		0		4	0	0		4
1990	3		0		0		3	0	0		3
1991	0		0		0		0	2	0		2
1992	0		0		0		0	0	1		1
1993	0		0		0		0	0	3		3
1994	12		0		0		12	0	0		12
1995	0		0		0		0	0	2		2
1996	9		0		18*		27	0	0		27
1997	0		0		0		0	0	3		3
1998	0		0		0		0	0	0		0
1999	44	(44)	0	(0)	0	(0)	44	(44)	0	0	44
2000	30	(30)	0	(0)	0	(0)	30	(30)	0	0	30
2001	0	(0)	0	(0)	0	(0)	0	(0)	0	0	0

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006  
Fires Reported to U.S. Fire Departments (Continued)**

**B. Civilian Deaths (Continued)**

<b>Year</b>	<b><u>Home Structures</u></b>		<b><u>Other Residential Structures</u></b>		<b><u>Nonresidential Structures</u></b>		<b><u>Total Structures</u></b>		<b><u>Vehicles</u></b>	<b><u>Outside and Other</u></b>	<b><u>Total</u></b>
2002	0	(0)	0	(0)	0	(0)	0	(0)	0	0	0
2003	7	(7)	0	(0)	0**	(0)	7**	(7)	0	0	7
2004	0	(0)	0	(0)	0	(0)	0	(0)	0	0	0
2005	0	(0)	0	(0)	0	(0)	0	(0)	0	0	0
2006	4	(4)	0	(0)	0	(0)	4	(4)	0	2	6

\* 1996 total is inflated by statistical projection of one Ohio fire with nine deaths.

\*\* Does not include 100 deaths in the Station night club fire.

Note: Numbers in parentheses exclude fires reported as confined fires. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Civilian deaths are expressed to the nearest one. Figures reflect a proportional share of fires with heat source unknown. *Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution.* Totals may not equal sums because of rounding error.

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

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006  
Fires Reported to U.S. Fire Departments (Continued)**

**C. Civilian Injuries**

<b>Year</b>	<b><u>Home Structures</u></b>		<b><u>Other Residential Structures</u></b>		<b><u>Nonresidential Structures</u></b>		<b><u>Total Structures</u></b>		<b><u>Vehicles</u></b>	<b><u>Outside and Other</u></b>	<b><u>Total</u></b>
1980	30		10		0		30		0	20	50
1981	30		0		20		50		0	20	70
1982	10		0		20		30		0	60	100
1983	50		0		0		50		0	30	80
1984	40		0		10		50	10		30	90
1985	70		10		10		80	30		30	140
1986	50		10		50		100	0		20	130
1987	50		10		10		70	0		30	90
1988	40		0		20		50	20		30	100
1989	50		0		0		50	20		30	110
1990	30		10		10		50	0		60	110
1991	50		10		10		70	10		30	110
1992	40		0		10		50	10		40	100
1993	20		0		20		40	0		20	70
1994	90		0		10		100	10		50	150
1995	50		0		0		50	0		40	90
1996	20		0		20		40	0		20	70
1997	20		0		10		30	20		20	70
1998	10		0		0		10	10		30	40
1999	0	(0)	0	(0)	0	(0)	0	(0)	0	80	80
2000	30	(30)	0	(0)	0	(0)	30	(30)	0	40	70
2001	40	(40)	0	(0)	10	(10)	50	(50)	10	20	80

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006  
Fires Reported to U.S. Fire Departments (Continued)**

**C. Civilian Injuries (Continued)**

<b>Year</b>	<b><u>Home Structures</u></b>		<b><u>Other Residential Structures</u></b>		<b><u>Nonresidential Structures</u></b>		<b><u>Total Structures</u></b>		<b><u>Vehicles</u></b>	<b><u>Outside and Other</u></b>	<b><u>Total</u></b>
2002	20	(20)	10	(10)	0	(0)	30	(30)	20	10	60
2003	40	(40)	0	(0)	10*	(10)	50*	(50)	0	30	80
2004	10	(10)	0	(0)	0	(0)	10	(10)	0	30	50
2005	50	(50)	0	(0)	0	(0)	50	(50)	10	40	90
2006	20	(20)	10	(0)	0	(0)	30	(20)	10	30	70

\*Does not include injuries in the Station night club fire.

Note: Numbers in parentheses exclude fires reported as confined fires. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Civilian injuries are expressed to the nearest ten. Figures reflect a proportional share of fires with heat source unknown. *Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution.* Totals may not equal sums because of rounding error.

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

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006**  
**Fires Reported to U.S. Fire Departments (Continued)**

**D. Direct Property Damage (in Millions)**

<b>Year</b>	<b><u>Home Structures</u></b>		<b><u>Other Residential Structures</u></b>		<b><u>Nonresidential Structures</u></b>		<b><u>Total Structures</u></b>		<b><u>Vehicles</u></b>	<b><u>Outside and Total</u></b>	<b><u>Total</u></b>	<b><u>Total in 2006 Dollars</u></b>
1980	\$12		\$0		\$3		\$15		\$0	\$0	\$16	\$38
1981	\$12		\$0		\$6		\$18		\$0	\$1	\$19	\$41
1982	\$9		\$0		\$2		\$11		\$0	\$0	\$11	\$24
1983	\$7		\$0		\$5		\$12		\$0	\$0	\$13	\$26
1984	\$19		\$0		\$6		\$25		\$2	\$1	\$27	\$52
1985	\$22		\$1		\$7		\$30		\$1	\$5	\$36	\$68
1986	\$24		\$0		\$29		\$53		\$2	\$1	\$55	\$102
1987	\$17		\$0		\$7		\$24		\$1	\$0	\$25	\$45
1988	\$22		\$0		\$14		\$37		\$1	\$1	\$39	\$66
1989	\$56		\$0		\$3		\$59		\$1	\$2	\$62	\$101
1990	\$22		\$1		\$4		\$26		\$2	\$1	\$28	\$43
1991	\$17		\$0		\$5		\$21		\$2	\$0	\$23	\$34
1992	\$13		\$0		\$16		\$29		\$1	\$3	\$33	\$48
1993	\$12		\$0		\$6		\$19		\$1	\$1	\$21	\$30
1994	\$10		\$0		\$8		\$18		\$2	\$2	\$22	\$30
1995	\$21		\$1		\$9		\$30		\$2	\$1	\$32	\$43
1996	\$12		\$0		\$7		\$19		\$1	\$6	\$27	\$34
1997	\$13		\$0		\$8		\$21		\$1	\$0	\$23	\$29
1998	\$9		\$0		\$3		\$12		\$1	\$2	\$16	\$19
1999	\$17	(\$17)	\$0	(\$0)	\$1	(\$1)	\$19	(\$19)	\$3	\$1	\$23	\$27
2000	\$36	(\$36)	\$0	(\$0)	\$6	(\$6)	\$42	(\$42)	\$3	\$3	\$48	\$56
2001	\$33	(\$33)	\$1	(\$1)	\$17	(\$17)	\$50	(\$50)	\$5	\$4	\$59	\$67

**Table 1. Fires and Losses Associated With Fireworks, 1980-2006  
Fires Reported to U.S. Fire Departments (Continued)**

**D. Direct Property Damage (in Millions) (Continued)**

<b>Year</b>	<b><u>Home Structures</u></b>		<b><u>Other Residential Structures</u></b>		<b><u>Nonresidential Structures</u></b>		<b><u>Total Structures</u></b>		<b><u>Vehicles</u></b>	<b><u>Outside and Total</u></b>	<b><u>Total</u></b>	<b><u>Total in 2006 Dollars</u></b>
2002	\$25	(\$25)	\$1	(\$1)	\$5	(\$5)	\$31	(\$31)	\$4	\$1	\$35	\$40
2003	\$47	(\$47)	\$1	(\$1)	\$13*	(\$13)	\$60*	(\$60)	\$4	\$1	\$65	\$72
2004	\$15	(\$15)	\$0	(\$0)	\$5	(\$5)	\$20	(\$20)	\$2	\$1	\$22	\$24
2005	\$26	(\$26)	\$0	(\$0)	\$10	(\$10)	\$37	(\$37)	\$2	\$1	\$41	\$42
2006	\$28	(\$28)	\$0	(\$0)	\$3	(\$3)	\$31	(\$31)	\$1	\$1	\$34	\$34

\*Does not include damages in the Station night club fire.

Note: Numbers in parentheses exclude fires reported as confined fires. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Direct property damage is rounded to the nearest million dollars. Figures reflect a proportional share of fires with heat source unknown. Inflation adjustment to 2006 dollars is done using the consumer price index. *Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution.* Totals may not equal sums because of rounding error.  
Source: Data from NFIRS Version 4.1 (1980-1998) and Version 5.0 (1999-2006) and NFPA survey.

**Table 2. Deaths Associated With Fireworks Incidents  
1980-2007**

<b>Year</b>	<b>Estimated Civilian Deaths in Fireworks-Related Fires Reported to U.S. Fire Departments</b>	<b>Recorded on U.S. Death Certificates</b>
1980	0	10
1981	0	4
1982	0	5
1983	0	13
1984	3	7
1985	15	11
1986	4	8
1987	7	5
1988	20	4
1989	4	5
1990	3	5
1991	2	4
1992	1	2
1993	3	10
1994	12	4
1995	2	2
1996	27*	9
1997	3	8
1998	0	9
1999	44*	7
2000	30*	5
2001	0	6
2002	0	5
2003	7**	11**
2004	0	2
2005	0	4
2006	6	11***
2007	****	11***

\* 1996 total is inflated by statistical projection of one Ohio fire with nine deaths. Estimates for 1999-2001 are subject to greater uncertainty because of limited participation in NFIRS Version 5.0 in those years.

\*\* Does not include 100 deaths in the Station night club fire.

\*\*\* Death certificate figures for 2006-2007 are preliminary based on reports to the U.S. Consumer Product Safety Commission and exclude fireworks-caused fires.

\*\*\*\* Not yet available.

Note: In any year, the figures in these two columns may partially overlap if fireworks that directly cause a fatality also ignite a reported fire.

Sources: For death certificate tallies, *Accident Facts* and *Injury Facts*, Chicago (1985-1992) and Itasca, IL (1993-2005): National Safety Council, 1985-2007, and [www.nchs.gov](http://www.nchs.gov) for 2004. For national estimates of fire deaths, data from NFIRS Version 4.1 (1980-1998) and Version 5.0 (1999-2005) and NFPA survey.

## Characteristics of Fireworks Injuries

### **More than half (56%) of 2007 emergency room fireworks injuries were to extremities and one-third (36%) were to the head.**

Injuries to extremities were primarily to hand or finger (31% of total emergency room fireworks injuries) or leg (19%). (See Figure 2.) One-fifth (22%) of injuries were to the eye, and 14% were to other parts of the head or face. The detailed U.S. statistics are based on injuries reported to hospital emergency rooms for CPSC's NEISS system during the month around July 4.

A 1998 study of all Canadian fireworks injuries ever reported to the Canadian Hospitals Injury Reporting and Prevention Program found a large share of injuries occurred while the victim was holding the fireworks device, and the U.S. injury patterns are at least consistent with that pattern.<sup>1</sup>

### **Half (49%) of 2007 fireworks injuries were burns.**

Contusions and lacerations were second (29%). (See Figure 3.) Contusions and lacerations were twice as numerous as burns when the injury was to any part of the head or face, including the eye.

### **Highest risks of fireworks injury are to school-age children.**

Two of five (42%) victims of fireworks injuries in 2007 were under age 15. (See Figure 4.) The highest relative risks of fireworks injury (see Figure 5) were for children aged 10 to 14 and children aged 5 to 9. The rates for every age group in the range of age 5 to 24 were at least 50% higher than the rate for any other age group. Males accounted for seven of ten (70%) fireworks injuries.

Similar patterns in fireworks injuries were found in the Health Canada study cited above. The highest rates in that study were for the 10 to 14 and 15 to 19 age groups, followed closely by the 5 to 9 age groups. A Greek study found that young female victims were usually bystanders, while young male victims were usually involved in igniting fireworks.<sup>2</sup>

### **In 2007, more than nine out of ten (92%) emergency room fireworks injuries involved fireworks that Federal regulations permit consumers to use.**

The other 8% were large/illegal firecrackers, homemade or altered devices, and public display fireworks. Federal law permits public use of what are now referred to as "consumer fireworks" (formerly known as "common" or Class C fireworks), which are defined as "any small fireworks device designed primarily to produce visible effects by combustion" that comply with specific construction, chemical composition, and labeling regulations. These include a 50-mg maximum limit of explosive composition for ground devices and a 130-mg maximum limit of explosive composition for aerial devices. (See Figure 6.)

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<sup>1</sup> Health Canada, "Injuries associated with fireworks," at <http://www.hc-sc.gc.ca>.

<sup>2</sup> K. Vassilis, P. Eleni, and T. Dimitrios, "Fireworks-related childhood injuries in Greece: A national problem," *Burns*, Vol. 30, No. 2, 2004, pp. 151-153.

Some states further restrict the public's access to fireworks. The following five states have banned access by the public to all fireworks except for attendance at public displays by licensed operators – Delaware, Massachusetts, New Jersey, New York, and Rhode Island.

**“Safe and sane” fireworks caused more injuries than illegal fireworks, especially to preschool children.**

Six states – Arizona, Illinois, Iowa, Maine, Ohio, and Vermont – permit sale of sparklers and some other devices of comparable strength such as fountains, snakes, party poppers, and ground spinners. As a promotional technique, the fireworks allowed under rules of this type have been labeled “safe and sane” fireworks by their advocates. Laws based on this approach allow considerable private use of fireworks, but exclude any explosive type devices that lift off the ground that are allowed under Federal law.

In 2007, sparklers, fountains, and novelties alone accounted for one-third (36%) of emergency-room fireworks injuries, including half of all fireworks injuries to pre-school children (ages 4 and under) where the type of fireworks device was specified. At least two of the sparkler injuries required amputations when multiple sparklers were tied together and exploded.

Here is a sample of NEISS incident narratives involving pre-school children and fireworks injuries in 2007:

A 3-year-old boy ran into a tree while holding a Roman candle, which was pushed into his eye and burned his eyelid.

A 2-year-old boy suffered a second-degree burn to his hand while holding a sparkler.

A 2-year-old boy and a 2-year-old girl were burned on their foot when they stepped on sparklers.

A 3-year-old boy suffered an eye contusion from a popper type firework device.

A 3-year-old boy suffered a burn to his arm from a bottle rocket.

A 5-year-old boy threw an unknown-type fireworks device into a pit where it exploded, causing first- and second-degree burns to the face of a 16-year-old boy.

A man handed a lit Roman candle to a “small boy,” who reacted to its discharge by spinning around and unintentionally shooting fireballs into the mouth of a 13-year-old boy, who suffered second-degree burns to his lips, tongue, and the roof of his mouth.

Sparklers can also start very large fires, e.g.:

A fire started in the bedroom of a first-floor apartment when a lit sparkler ignited a combustible bed skirt. The apartment's resident had placed the sparkler on a cupcake for her 10-year-old daughter's birthday. After sparks ignited the bed skirt, flames spread to bedding and other combustibles. The occupants detected the fire before smoke alarms could operate and escaped.

Flames heavily damaged the bedroom of origin and other rooms in the apartment, while the structural steel elements sustained significant heat damage. Smoke extensively damaged the first floor and spread to the upper floors through a construction deficiency around a vertical ventilation shaft. Water damaged the lower floors. Damages were estimated at \$1.6 million.<sup>3</sup>

“Safe and sane” fireworks are neither. When things go wrong with fireworks, they typically go very wrong very fast, far faster than any fire protection can reliably respond. And fireworks are a classic attractive nuisance for children. If children are present to watch, they may be tempted to touch. Children can move too fast and be badly hurt too quickly if they are close to fireworks, as they inevitably are at home fireworks displays.

**State laws to restrict fireworks use by the public are very difficult to enforce.**

While five states ban all consumer use of fireworks and another six states permit sparklers and like devices just discussed, the other 39 states and the District of Columbia impose no restrictions beyond the Federal requirements. This patchwork approach means that people living in a state that prohibits fireworks can often cross a state border to buy fireworks, thereby violating a state law that is difficult to enforce. Every year, for example, people from Massachusetts drive into neighboring New Hampshire – a trip of at most a couple of hours – and buy fireworks from rows of retail stands set up near the border for the convenience of the scofflaw trade.

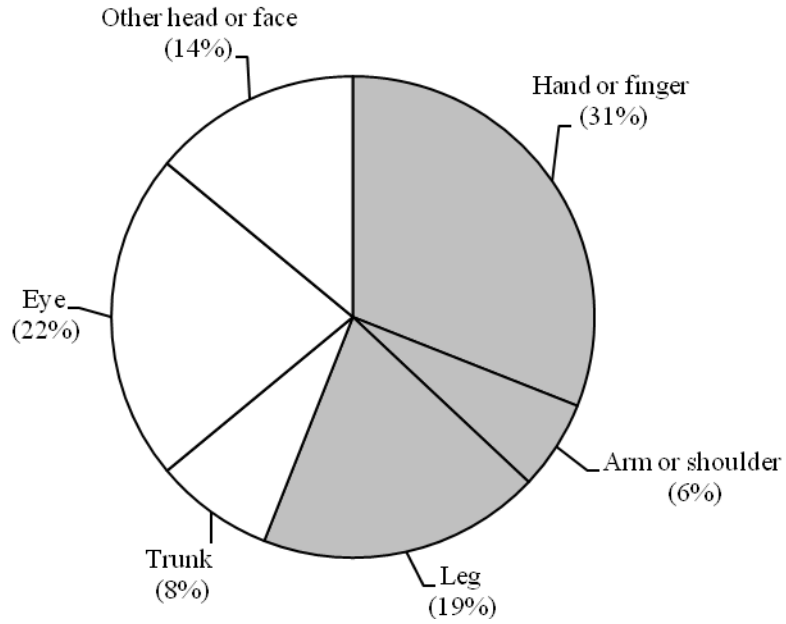
It is possible that limited laws, such as the current Federal law, are actually more difficult to enforce than a broader law would be, because the existence of some legal fireworks for the public encourages a climate of acceptance and creates a distribution network, both of which make it easier for amateurs to obtain illegal fireworks.

Since at least 1910, NFPA has crusaded to stop the dangerous private use of fireworks, which as noted accounts for nearly all of the injuries from fireworks in most years. Many states still permit untrained citizens to purchase and use fireworks – objects designed to explode, throw off showers of hot sparks, or reach surface temperatures as high as 1,200°F (nearly 650°C). The thousands of serious injuries and extensive property loss nearly all arise from this misguided activity, rather than the only acceptably safe way to enjoy fireworks, which is in public fireworks displays conducted in accordance with NFPA 1123, *Code for Fireworks Display*. Anything else is a violation of IFMA's (International Fire Marshals Association's) *Model Fireworks Law*, which reflects NFPA's zero-tolerance policy for consumer use of fireworks.

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<sup>3</sup> Adapted from Kenneth J. Tremblay, “Firewatch,” *NFPA Journal*, March/April 1997, p. 21.

**Figure 2.**  
**2007 Fireworks-Related Injuries\***  
**by Part of Body Injured**

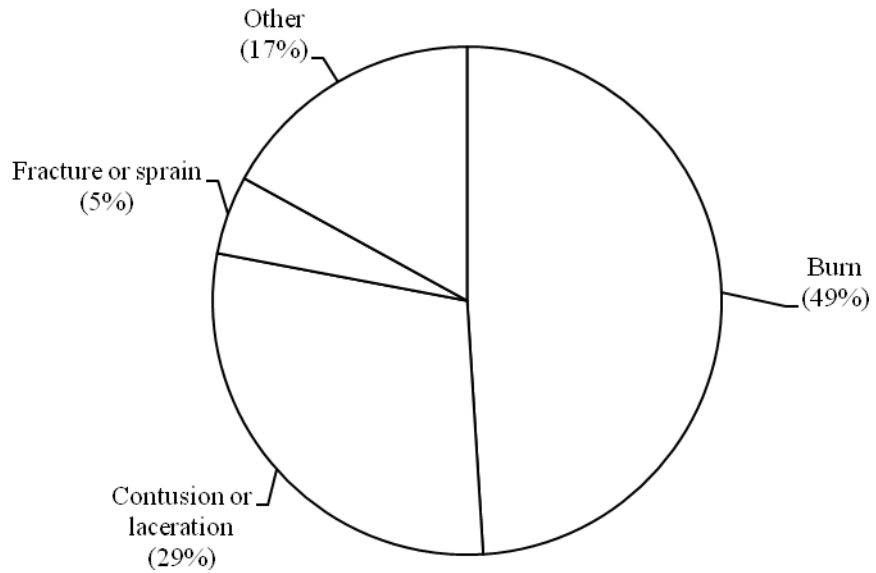


Source: CPSC's NEISS

\*Based on injuries during the month around July 4.

Note: Shaded areas are extremities.

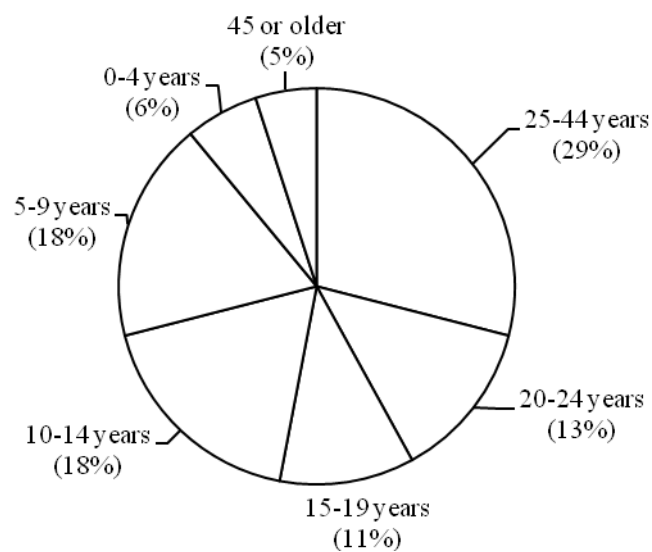
**Figure 3.**  
**2007 Fireworks-Related Injuries\***  
**by Type of Injury**



Source: CPSC's NEISS

\*Based on injuries during the month around July 4.

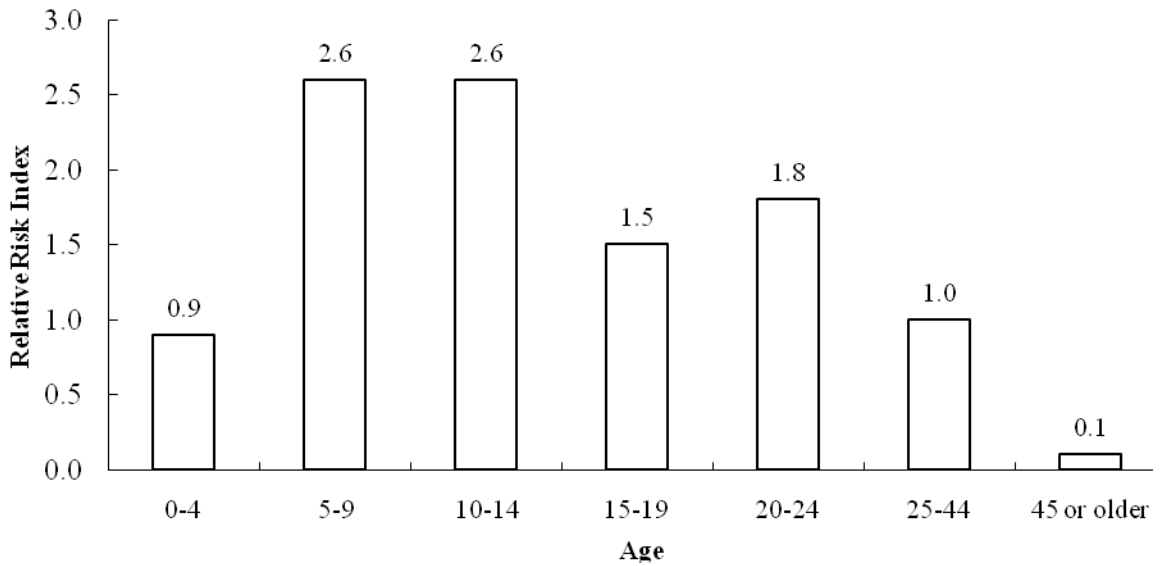
**Figure 4.**  
**2007 Fireworks-Related Injuries\***  
**by Age of Victim**



Source: CPSC's NEISS

\*Based on injuries during the month around July 4.

**Figure 5.**  
**Relative Risk of 2007 Fireworks-Related Injury\***  
**by Age of Victim**

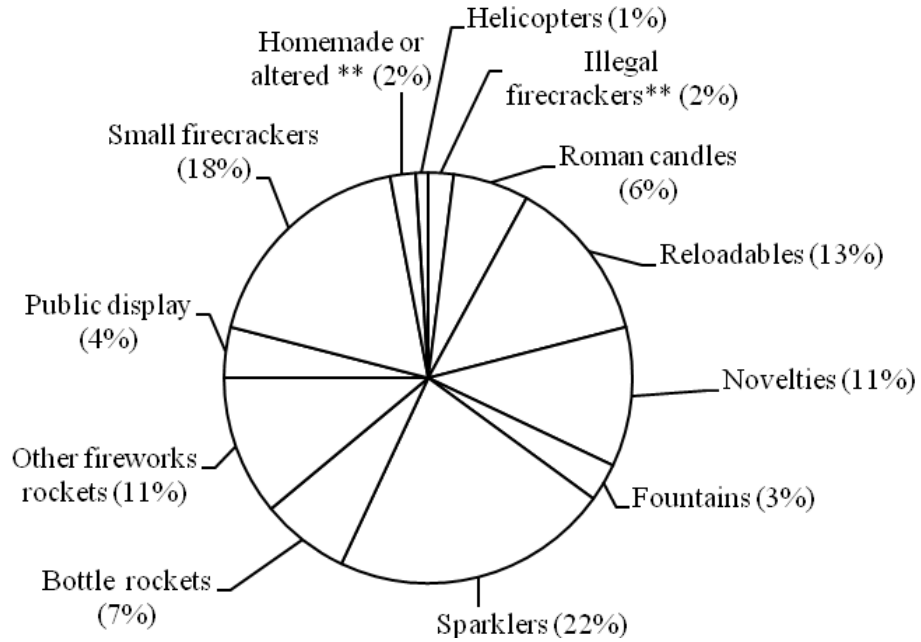


Source: CPSC's NEISS

\*Based on injuries during the month around July 4.

Note: Relative risk index is injuries per million population for the age group divided by injuries per million population for all ages combined.

**Figure 6.**  
**2007 Fireworks-Related Injuries\* by Type of Fireworks**  
**(Unknowns Allocated)**



Source: CPSC's NEISS

\*Based on injuries during the month around July 4.

\*\*Illegal under Federal law.

## Risks of Private Fireworks Use

**The usage and risks of fireworks are primarily concentrated around holiday celebrations.**

Roughly half (49%) of all reported fireworks fires occur during the week centered on the July 4<sup>th</sup> Independence Day holiday, and two-thirds (65%) occur in the 31-day month centered on July 4. Another 10% occur during the period from Christmas Eve through January 4, with the peak on New Year's Day.

On July 4 alone, reported fireworks fires are roughly twice as numerous as the daily average of all types of reported fires combined. On July 4, when consumer fireworks use is at its peak, fireworks are the leading cause of fires and a leading cause of all types of related loss. For most people, exposure to fireworks is limited to a very short period of time.

**Table B. Leading Dates for Fires Started by Fireworks  
Annual Average of 2003-2006 Fires Reported to U.S. Fire Departments**

July 4	7,050	(22.2%)
July 5	3,070	(9.7%)
July 3	2,100	(6.6%)
July 2	1,200	(3.8%)
January 1	1,090	(3.4%)
July 1	870	(2.8%)
July 6	780	(2.4%)
December 31	700	(2.2%)
June 30	570	(1.8%)
June 29	500	(1.6%)
July 7	500	(1.6%)
June 28	400	(1.3%)
July 8	340	(1.1%)
June 27	310	(1.0%)
June 26	280	(0.9%)
July 9	270	(0.8%)
January 2	250	(0.8%)
July 10	240	(0.7%)
June 25	210	(0.7%)
July 12	190	(0.6%)
July 11	180	(0.6%)
July 14	160	(0.5%)
June 24	160	(0.5%)
December 30	150	(0.5%)
December 28	140	(0.5%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Fires are rounded to the nearest hundred. Figures reflect a proportional share of fires with heat source unknown. Totals may not equal sums because of rounding error.

Source: NFIRS and NFPA survey

Some neighborhoods may see heightened fireworks usage on Chinese New Year or Mardi Gras – two dates that vary from year to year – but these events do not account for a national-level spike in fireworks fires.

In the United Kingdom, a tradition exists for fireworks use on November 5, sometimes called “Bonfire Night.” In Canada, fireworks injuries peak on Halloween, Victoria Day (a Monday in late May), and Canada Day (July 1).<sup>4</sup> Many countries see heightened fireworks use around Chinese New Year (late January or early February), and India uses fireworks to celebrate the new year. Greeks see a jump in usage and injuries on Greek Orthodox Easter. But relatively few countries (China and Mexico may be among the exceptions) see substantial fireworks use year-round.

**The risk of fire death relative to exposure shows fireworks as the most risky consumer product.**

Risk estimates relative to exposure time are very rough, but even an estimate designed to give fireworks the benefit of the doubt supports the above conclusion.

For example, the risk of fire death from cigarettes relative to time people spend in the vicinity of lit cigarettes can be compared to the analogous risk from time spent in the vicinity of ignited fireworks. In 2003, an estimated 400 billion cigarettes were smoked by a smoker population that numbered roughly 46.8 million adults.<sup>5</sup> This translates into 23 cigarettes per smoker per day. Assuming it takes at least 5 minutes on average to smoke a cigarette, this translates into 1.95 hours per day of exposure to fire risk from a burning cigarette. (Cigarettes that are abandoned rather than being put out would add to the exposure time, hence reduce the estimated risk relative to exposure time, and abandoned cigarettes account for most of the cigarette fires.) The 2003 cigarette fire death toll was estimated as 760.<sup>5</sup> The risk is therefore estimated as  $(760 \text{ deaths}) / (1.95 \text{ hours/day} \times 365 \text{ days}) / (46.8 \text{ million smokers}) = 2.3 \text{ deaths per hundred million person-hours of exposure.}$

Now consider fireworks. Consumption in 2000-2006 averaged 217 million pounds, including 38 million pounds of display fireworks per year and 179 million pounds of consumer fireworks per year.<sup>6</sup> (The APA website lists consumption figures for 2000-2007. Because fireworks-related fire deaths vary so much year-to-year, the maximum number of years is used to smooth out the average.) Fireworks are typically used by households, so assume that, on average, 2.5 people (the average size of a household in 2003) are exposed in any use of fireworks.<sup>7</sup> A pound of fireworks will translate into a range of different numbers of different devices, but estimate that on average a pound of fireworks burns for no more than 20 minutes. (The real average is probably shorter, which means this assumption is conservative on the side of under-estimating the risk relative to exposure time.) In 2000-2006, fires started by fireworks caused an estimated 5.9 deaths per year. (See Table 2.) The risk is therefore estimated as  $(5.9 \text{ deaths}) / (2.5 \text{ people/exposure} \times 1/3 \text{ exposure-hour/pound} \times 179 \text{ million pounds}) =$

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<sup>4</sup> Health Canada, “Injuries associated with fireworks,” at <http://www.hc-sc.gc.ca>.

<sup>5</sup> John R. Hall, Jr., *The Smoking Material Fire Problem*, NFPA Fire Analysis and Research Division, Quincy, MA, August 2006.

<sup>6</sup> American Pyrotechnics Association website, [www.americanpyro.com](http://www.americanpyro.com)

<sup>7</sup> Statistical Abstract of the United States 2004-2005, U.S. Census Bureau, October 2004, Table 46.

4.0 deaths per hundred million person-hours of exposure.

The cigarette calculation errs on the side of overestimating the risk, because 5 minutes is a low-end estimate of smoking time per cigarette, particularly if one factors in the long smolder time of imperfectly extinguished cigarettes, which are a common scenario for fire. The fireworks calculation errs on the side of underestimating the risk, because 20 minutes is a high-end estimate of the average burn time for a pound of fireworks. The fireworks fire death toll varies considerably from year to year but does not include deaths directly due to fireworks with no larger fire. Yet, even with these assumptions, the risk while fireworks are burning that a fire death will result is considerably higher than the corresponding risk when cigarettes are burning.

In recent years, the industry has asserted a risk-type argument based on the fact that fireworks consumption (in pounds) is many times as high as it was in 1976 while hospital emergency-room injuries due to fireworks have shown no consistent increase over the same period. The above calculation shows the fallacy of this reasoning. The risk relative to exposure time may not be increasing, but it is and always has been extremely high.

**The risks associated with fireworks are not limited to displays, public or private.**

Risks also exist wherever fireworks are manufactured, transported or stored. Most but not all such losses in recent decades have occurred in other countries, where fireworks activity is not controlled as tightly – or kept as separate from highly populated areas – as it tends to be in the U.S. The following incident descriptions are taken from NFPA's Fire Incident Data Organization (FIDO) database:

- In 2006, 36 people were killed in Linqi, China, when fireworks ignited an explosion at a fireworks warehouse, resulting in a pressure wave that flattened a nearby temple. The victims had been in the temple at the time and were killed.
- In 2003, three people were killed in a Texas fireworks warehouse explosion and fire, which also destroyed the complete-coverage sprinkler system. Fires involving at least three deaths in a fully sprinklered property are quite rare and typically involve explosions and/or firefighting activity by the victims.
- In 2002, three separate incidents in India involved explosions at fireworks storage facilities, killing 14, 13, and 12 people, respectively. The first incident involved storage at an ordinary home, while the last incident involved storage in a straw-thatched warehouse where a short circuit ignited a fire that then led to an explosion when fire spread to fireworks.
- In 2000, 18-20 people were killed in the Netherlands when a residential fire spread to a fireworks warehouse located next to the neighborhood.
- In 1996, nine people died in an Ohio fire when a customer ignited a fireworks device in the sales display area of a fireworks retail facility. The resulting fire quickly spread to the entire store inventory. (See *NFPA Journal*, September/October 1997, p. 52.)

- In 1983, two separate massive fireworks explosion incidents in Mexico killed 34 and 21 people, respectively, the latter reportedly coming when a fireworks display flare ignited fireworks stored in the back room of a church. Fireworks displays are a traditional part of a religious festival called the Feast of the Holy Cross.

## Data Sources

### **Changes in NFIRS pose opportunities and challenges in describing and tracking the problem.**

The statistics in this report are national estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) in combination with NFPA's annual fire department survey. In Version 4.1, "fireworks" were usually understood to include two categories under form of heat of ignition – code 63 (fireworks) and code 64 (paper cap or party popper). In Version 5.0, these two groups of devices are combined into one – Heat Source code 54 (fireworks). Detailed information about NFIRS, including Version 4.1 and 5.0 codes and conversion tables, can be obtained from <http://www.usfa.fema.gov/>.

### **Data on injuries at hospital emergency rooms come from NEISS.**

All fireworks-related injury statistics from hospital emergency rooms come from reports by the U.S. Consumer Product Safety Commission (CPSC) and private communications from Linda Smith and Michael Greene of the CPSC. Linda Smith also provided the rules for setting the range of fireworks injury estimates during the period from 1985 to 1989, reflecting the change in the sample, and in 1991 to 1996, reflecting the latest change in the sample. Reports referenced include Michael A. Greene and James Joholske, *2007, 2006, 2005, 2004 and 2003 Fireworks Annual Report*; Michael A. Greene and Patrick M. Race, *1999 Fireworks Annual Report*; Michael A. Greene, *1998 Fireworks-Related Injuries*; Ron Monticone and Linda Smith, *1997 Fireworks-Related Injuries*; Sheila L. Kelly, *Fireworks Injuries, 1994*; Dr. Terry L. Kissinger, *Fireworks Injuries - Results of a 1992 NEISS Study*; Linda Smith and Sheila Kelly, *Fireworks Injuries, 1990*; Deborah Kale and Beatrice Harwood, *Fireworks Injuries - 1981*; and the May/June 1974 issue of *NEISS News*. All were published by CPSC.

### **Data on deaths directly attributable to fireworks come from NCHS.**

The National Center for Health Statistics maintains the death certificate database. Since 1999, fireworks discharge has been coded as External Cause of Mortality W39. From 1980 to 1999, firework discharge was coded as E923.0.



## **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](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 *Fireworks, 5/09*

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

### **Projecting NFIRS to National Estimates**

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

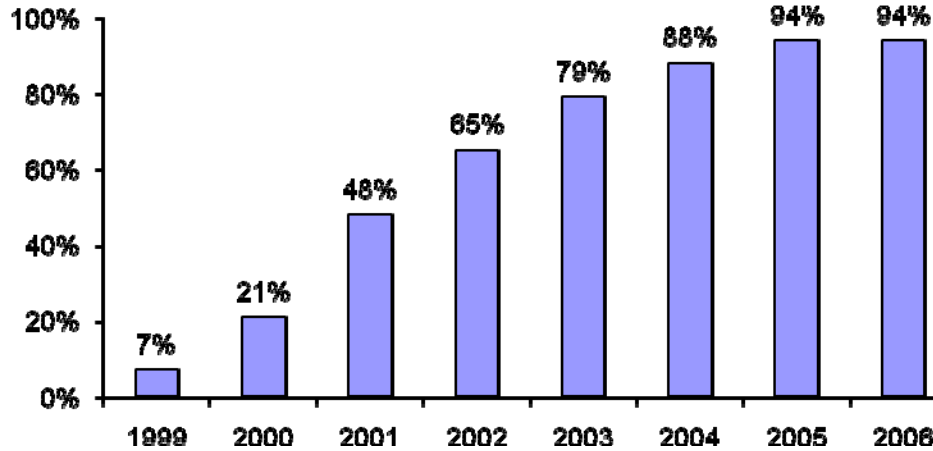
Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific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

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission developed the specific basic analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates. A copy of the article is available online at <http://www.nfpa.org/osds> or through NFPA's One-Stop Data Shop.

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

31. Water-caused short circuit arc;
32. Short-circuit arc from mechanical damage;
33. Short-circuit arc from defective or worn insulation;
34. Unspecified short circuit arc;
35. Arc from faulty contact or broken connector, including broken power lines and loose connections;
36. Arc or spark from operating equipment, switch, or electric fence;
37. Fluorescent light ballast; and
30. Electrical failure or malfunction, other.

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

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

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

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

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

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

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

**Equipment Involved in Ignition (EII).** NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment malfunctioned or was used improperly. In 2006, the definition was modified to “the piece of equipment that provided the principal heat source to cause ignition.” However, much of the data predates the change. Individuals who have already been trained with the older definition may not change their practices. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

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

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

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

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

Central heat	132	Furnace or central heating unit
	133	Boiler (power, process or heating)
Fixed or portable space heater	131	Furnace, local heating unit, built-in
	123	Fireplace with insert or stove
	124	Heating stove
	141	Heater, excluding catalytic and oil-filled
	142	Catalytic heater
	143	Oil-filled heater
Fireplace or chimney	121	Fireplace, masonry
	122	Fireplace, factory-built
	125	Chimney connector or vent connector
	126	Chimney – brick, stone or masonry
	127	Chimney-metal, including stovepipe or flue
Wiring, switch or outlet	210	Unclassified electrical wiring
	211	Electrical power or utility line
	212	Electrical service supply wires from utility
	214	Wiring from meter box to circuit breaker
	216	Electrical branch circuit
	217	Outlet, receptacle
	218	Wall switch
Power switch gear or overcurrent protection device	215	Panel board, switch board, circuit breaker board
	219	Ground fault interrupter
	222	Overcurrent, disconnect equipment
	227	Surge protector
Lamp, bulb or lighting	230	Unclassified lamp or lighting
	231	Lamp-tabletop, floor or desk
	232	Lantern or flashlight
	233	Incandescent lighting fixture
	234	Fluorescent light fixture or ballast
	235	Halogen light fixture or lamp
	236	Sodium or mercury vapor light fixture or lamp
	237	Work or trouble light
	238	Light bulb
	241	Nightlight
	242	Decorative lights – line voltage
	243	Decorative or landscape lighting – low voltage
	244	Sign
Cord or plug	260	Unclassified cord or plug
	261	Power cord or plug, detachable from appliance

	262	Power cord or plug- permanently attached
	263	Extension cord
Torch, burner or soldering iron	331	Welding torch
	332	Cutting torch
	333	Burner, including Bunsen burners
	334	Soldering equipment
Portable cooking or warming equipment	631	Coffee maker or teapot
	632	Food warmer or hot plate
	633	Kettle
	634	Popcorn popper
	635	Pressure cooker or canner
	636	Slow cooker
	637	Toaster, toaster oven, counter-top broiler
	638	Waffle iron, griddle
	639	Wok, frying pan, skillet
	641	Breadmaking machine

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

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

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

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



## **Appendix B.**

### **Selected Published Incidents Involving Fireworks**

Included are articles from NFPA publications about fires involving fireworks. Included are short articles from the “Firewatch” or “Bi-monthly” columns in *NFPA Journal* or its predecessor *Fire Journal* and incidents from either the large-loss fires report or catastrophic fires report. If available, investigation reports or NFPA Alert Bulletins are included and provide detailed information about the fires.

It is important to remember that this is anecdotal information. Anecdotes show what can happen; they are not a source to learn about what typically occurs.

NFPA’s Fire Incident Data Organization (FIDO) identifies significant fires through a clipping service, the Internet and other sources. Additional information is obtained from the fire service and federal and state agencies. FIDO is the source for articles published in the “Firewatch” column of the *NFPA Journal* and many of the articles in this report.

## **Fireworks inside a residence ignite deadly fire, Missouri**

A 6-year old boy and a 40-year old male died when fireworks ignited the interior of their home. Investigators believe hot embers from fireworks ignited an upholstered sofa and quickly spread, trapping the occupants. Firefighters fought through the fire and heavy smoke coming from the front door and quickly found one victim and later a second, but both had succumbed to smoke inhalation and burn injuries.

The single-family home was constructed of wood framing with a wooden roof and asphalt shingles. The 1,200-square-foot (111-square-meter) home lacked smoke alarms and sprinklers.

The fire department received a call from a passerby at 11:50 p.m. and arrived five minutes later to find police on scene reporting a person possibly trapped. As flames came out the front door and window, firefighters advanced a hose line into the front door knocking down the heavy fire as they went.

Within 10 feet (3 meters) of the door, the first victim was found and removed to the front lawn. Firefighters suppressed the fire and continued the primary search. A second victim was found in the kitchen and removed. The fire was contained to the first floor and the dwelling ventilated as the investigation began. Damages to the home were not reported.

Kenneth J. Tremblay, 2007, "Firewatch," *NFPA Journal*, September/October 26.

## **Fireworks ignite plastic bins, Washington**

Two juveniles were charged with arson when fireworks they ignited spread to large plastic trash bins and then to the exterior of an elementary school. Fire spread to the wooden roof structure and to the interior of the school before being detected and extinguished.

The single-story school was constructed in phases over several years with concrete block walls, a brick veneer, and a wooden roof with a built-up roof deck. There were no detection or suppression systems installed in the school, only a burglar alarm that sounded only after the fire was well developed.

The plastic recycle bins with hinged-plastic covers were placed against the school. A lit firework was placed within a bin and it ignited the combustibles and spread to the bin itself. Flame heights reached the roofline and spread to concealed spaces involving structural wood framing.

Police investigating the burglar alarm arrived at 10:34 p.m. and alerted the fire department when smoke and fire was observed. Four minutes later, firefighters arrived and found heavy smoke and fire coming from the north section of the school. They advanced an interior hose line. Crews had some success in extinguishing fire in two of the classrooms and alcove, but fire spread in the concealed ceiling and roof spaces was too extensive. Command ordered an evacuation and began a defensive attack.

A trench cut separated the involved north section of the school from the main building, as aerial master streams were used to control the fire. Firefighters fought the fire for four hours before it was declared under control. Damage to the school was estimated at \$2.5 million for combined structural and contents losses. One firefighter suffered minor injuries during suppression activities.

Kenneth J. Tremblay, 2007, "Firewatch," *NFPA Journal*, May/June, 24.

## **Fireworks kill 4-year-old, Missouri**

A family celebration at which people were setting off consumer fireworks ended tragically when a 4-year-old girl was killed by a projectile launched from a mortar. The girl was on a walkway near a porch 148 feet (45 meters) from the area where fireworks were being ignited when she was struck in the face.

There were no other injuries or property damage.

Kenneth J. Tremblay, 2005, "Firewatch," *NFPA Journal*, July /August, 20.

## **Disco fire in Buenos Aires, Argentina**

by Eduardo Alvarez, SFPE

Last December 30, a fire at a rock concert in an unsprinklered disco in Buenos Aires, killed 191 people, the largest loss of life in a fire in Argentina's history. The Republica Cromagnon disco was a one-story building of approximately 1,500 square meters (16,150 square feet), with an occupancy permit for 1,037 spectators, but an estimated 3,000 people were inside on the night of the fire.

The fire started at 10:50 p.m., a few minutes after the concert had started, when fireworks thrown by a spectator set fire to the combustible acoustic lining of the ceiling, presumably made with polyurethane foam. The fire spread quickly through the ceiling. Smoke inhalation claimed the most victims. There was a lack of compliance with local codes regarding the combustible acoustic lining and the use of fireworks inside buildings.

Other factors contributing to the large loss of life included a main exit door that had been closed with a padlock, and the lack of emergency lighting and exit signs. In fact, a few minutes after the fire had started, electrical power was cut off and there was total darkness inside the overcrowded space, making a chaotic situation even worse.

NFPA, in cooperation with International Fire Safety Consulting (IFSC), is documenting this fire. A Summary Report should be available in late February.

Eduardo Alvarez is a practicing fire protection engineer based in Buenos Aires, Argentina. He is Regional Director of IFSC del Cono Sur, a member of NFPA's Latin American Section Board of Directors, Second Vice President of NFPA's Argentinean Chapter, and an NFPA instructor for NFPA 101 in Latin America.

*NFPA Journal*, March/April 2005, Page 52.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Setting</b>	<b>Climate Conditions</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Kansas; August, 2005; 10:00 a.m. 3 deaths	Fireworks were being transferred from a storage trailer to a 29-foot goose neck trailer for transport to a fireworks show.	None reported.	As a safety officer for the loading stood outside the goose neck trailer, he heard a lift charge from one of the boxed fireworks function. As the box was set down, it began to burn, and then exploded, igniting the 17 other boxes that had been transferred. As these fireworks began to ignite and explode, flaming debris and shells were propelled into the storage trailer. The storage trailer then exploded. Investigators believe the pre-wiring of the fireworks was the most plausible ignition source in the box.	Two of the victims were in the storage trailer and the third was located in the goose neck trailer.

*Multiple-Death Fires For 2005, September, 2006, NFPA Fire Analysis and Research, 14.*

### **Fireworks explosion in Florida causes five deaths**

Around 2:10 p.m. on a sunny and warm July day, workers unloaded fireworks from one truck to another. An explosion occurred in the cargo area of the truck. Five people were killed when the explosion prevented their escape. The cause is under investigation.

Adapted from Stephen G. Badger's 2004, "Catastrophic Multi-Death Fires of 2003" *NFPA Journal*, September/October, 73.

### **Fireworks ignite roof, Michigan**

Fireworks from a private, unpermitted Independence Day display ignited the roof of a single-family house, nearly destroying the \$3 million home. A neighbor alerted a resident, and then called 911 at 11 p.m.

The two-story, wood-framed dwelling, each floor of which covered approximately 2,400 square feet (222 square meters), had a wood-flamed roof topped with cedar-shake shingles. Smoke detectors had been installed in the unsprinklered house, but they didn't sound since the fire started on the roof.

A fireworks shell, blown onto the roof, ignited the shingles. The fire burned through the roof into the attic. From there, the blaze spread throughout the house at roof level, doing nearly \$2.5 million in damage to the home. Before the fire, the home and its contents were valued at \$3 million. No injuries were reported.

Kenneth J. Tremblay, 2004, "Firewatch," *NFPA Journal*, July/August, 16.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Rhode Island; February, 2003 11:00 p.m. 100 deaths	One-story nightclub of unprotected wood-frame construction. Operating.	There was automatic detection equipment, but the type wasn't reported.	None present.	A rock band's pyrotechnics display ignited foam material used on the wall of the stage for soundproofing. The fire spread throughout the structure in a matter of minutes.	Flammable soundproofing materials.

Stephen G. Badger, September, 2004, "Catastrophic Multiple-Death Fires 2003", *NFPA Fire Analysis and Research*, 14.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Texas; July, 2003; 5:00 p.m. 3 deaths	One-story fireworks warehouse of unprotected-noncombustible construction. Full operation.	None.	There was a complete coverage wet-pipe sprinkler system present, but it was destroyed in the explosion.	Office personnel heard a sound as a charge went off in a room used to prepare fireworks for a display.	Fire department investigators estimate that the workers had only five seconds to evacuate before the explosion.

Stephen G. Badger, September, 2004, "Catastrophic Multiple-Death Fires 2003", *NFPA Fire Analysis and Research*, 19.

## **Fireworks ignite roof, California**

A fire that began when a bottle rocket landed on the wood-shake roof of a single-family home burned for nearly 30 minutes before neighbors smelled smoke and called 911. No one was home when the fire started. The ranch-style, wood-framed house and its attached garage covered approximately 2,330 square feet (217 square meters). It had no smoke alarms or sprinklers.

The fire department received several 911 calls around 1:30 p.m. from passersby and neighbors reporting the fire. An off-duty battalion chief also saw the smoke and drove to the house, where he found flames coming from the rear roof of the home. Before fire crews reached the scene, the battalion chief entered the house to confirm that no one was inside. Firefighters arrived within five minutes and deployed several hose lines to protect the exposures and attack the fire.

The flames burned through the roof into the attic and spread down to the living and sleeping areas. A 14-mile-per-hour (22.5-kilometer-an-hour) wind contributed to the fire spread, carrying flying brands into the neighborhood. The house, valued at an estimated \$300,000, sustained losses of \$200,000. Its contents, valued at \$50,000, were destroyed. There were no injuries.

NFPA's Fire Incident Data Organization, 2003, *NFPA Fire Analysis and Research*, May 2004.

## **Fireworks starts house fire, Michigan**

A family using legal fireworks on the rear deck of their single-family home to celebrate Independence Day may have inadvertently ignited the deck, sunroom, and rear of their house. However, a number of people in the neighborhood were using illegal fireworks at the same time, so it remains unclear which fireworks actually started the fire.

The two-story, wood-framed house was 35 feet (11 meters) long and 45 feet (14 meters) wide with a wood-truss roof and aluminum and brick siding. There were no fire sprinklers, but smoke alarms had been installed on both floors.

The family used the fireworks between 10 and 11 p.m. Hours later, a resident was awoken by the sound of scratching at the back of the house and went to investigate. When she discovered the fire, she called 911 and roused the other four residents, all of whom escaped.

Firefighters arrived four minutes after the 4:22 a.m. call and found smoke and flames coming from the back of the house and the roof of the attached garage. They stretched a hose line to the second floor, where the smoke, which was light on the first floor, became thicker as fire spread through the attic. When the firefighters opened the ceiling, they encountered heavy fire.

The incident commander evacuated the building when the fire crews failed to extinguish the blaze and used a ladder pipe to knock the fire down. Firefighters then reentered the house and extinguished hot spots.

Investigators believe the fire started when lit fireworks ignited the wooden deck and spread up the decorative wooden lattice into the attic above the sunroom, garage, and family room.

The house, valued at \$186,000, had \$100,000 in damage, and its contents, valued at \$90,000, suffered a \$45,000 loss. Radiant heat did \$5,000 damage to an adjacent home. There were no injuries.

Kenneth J. Tremblay, 2003, *NFPA Journal*, July/August, 14.

## **Explosion in home kills one, Missouri**

A 41-year-old man died when ingredients used to manufacture fireworks exploded in the basement of his single-family house. The man conducted fireworks displays and illegally manufactured and stored his homemade fireworks in his dwelling. The one-story, wood-framed house had a concrete block foundation and a brick veneer on the front. It had no smoke alarms or sprinklers.

At 5:50 p.m., firefighters responded to an alarm sounded by a passerby, who reported the explosion and fire. The house sustained major structural damage, as flames spread first to a detached garage, then to another house to the east, and ultimately throughout a six-block area.

Firefighters, who controlled the blaze with large-diameter deck guns and small attack lines, discovered the victim in the basement, along with fireworks manufacturing supplies. Several explosive items were discovered, including flash powder, metallic chlorates, antimony sulfides, barium/calcium carbonate, potassium nitrate, red gum, sulfur powder, and potassium chlorate.

Damage to the house, valued at \$80,000, was \$34,000. Damage to its contents was extensive but not reported. Total loss estimates to all affected properties weren't disclosed. In addition to the fatality, two other people suffered minor cuts.

Kenneth J. Tremblay, 2001, "Firewatch," *NFPA Journal*, January/February, 21.

## **Fireworks start fire on apartment roof, Ohio**

One or more airborne fireworks landed on the roof of an apartment building, starting a fire that burned into the attic, heavily damaging the building. Firefighters tried an interior fire attack, but partial collapses forced them down and finally out, into a defensive attack.

The two-story; 12-unit, wood-framed apartment building had a brick veneer and an asphalt shingle-on-plywood roof. There were smoke alarms in the hallways, but none in the units or attic and there were no sprinklers.

A resident reported seeing a glow on a balcony and called 911 at 12:57 a.m. Firefighters arrived four minutes later to find that flames were showing from a second-story balcony and that the building's occupants had reportedly been evacuated. Advancing a preconnected hose line into the unit of origin, they discovered that the fire on the balcony had spread along the soffit from a well-involved attic fire.

Pulling the ceiling down to gain access to the attic, the firefighters attacked the flames until they were driven out by a partial roof collapse. A second collapse forced them from the second floor, and so firefighters moved to the southern section of the building, where a fire wall held the flames in check. When they opened ceilings, however, they found that the fire had burned off the roof and circumvented the fire wall, forcing them to leave as the ceilings began to collapse.

Firefighters used elevated master streams and deck guns to knock down the fire in the attic and second floor, allowing crews to re-enter the building. They extinguished the blaze in four second-floor units, which were heavily damaged.

Investigators determined fireworks ignited the roofing material. They declared the fire incendiary. Damage to the building and its contents, which had an estimated combined value of \$800,000, came to \$320,000. One firefighter suffered heat related injuries. All the residents escaped safely from the building.

Kenneth J. Tremblay, 2001, "Firewatch," *NFPA Journal*, July/August, 24.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Smoke Alarms and Other Fire Protection Devices</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Alabama; July, 1999; 1:15 p.m. 5 deaths	Single-family house; unprotected wood-frame construction; one story.	The home had a smoke alarm, but it didn't work because the battery was missing.	Discarded fireworks on or around garbage cans near an outside wall started a fire that burned up the wall and into the attic.	The two adults in the house were intoxicated. There were no working smoke alarms to warn the occupants. Three children were found in two bedrooms, one adult was found in the hallway, and the other adult was in the third bedroom.

Robert S. McCarthy, September, 2000, "1999 Catastrophic Fires", *NFPA Journal*, September/October, 58.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Michigan; March, 1999; 8:30 a.m. 5 deaths	Fireworks manufacturing plant; unprotected wood-frame construction; one story; operating.	None.	None.	Something ignited a highly volatile explosive powder, and the resulting fire spread to other explosives, consuming the structure.	The presence of highly volatile explosive powders contributed to the severity of this incident.

Robert S. McCarthy, September, 2000, "1999 Catastrophic Fires", *NFPA Journal*, September/October, 59.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Arkansas; July, 1999; 9:00 p.m. 3 deaths	Fireworks storage trailer at a speedway.	None.	None.	A mortar round misfired, shooting into an open trailer where fireworks were stored.	When the rocket misfired, the victims sought refuge in the trailer.

Robert S. McCarthy, September, 2000, "1999 Catastrophic Fires", *NFPA Journal*, September/October, 60.

## Firefighter struck by fireworks

At approximately 9:45 one night in July, a firefighter in full protective clothing was acting as fire watch at the control panel of a public fire works display. His duty was to extinguish any grass fires that errant sparks might ignite with a 1 1/2-inch handline. To do this, he held the handle of a gate valve to the handline's pistol-grip nozzle in his left hand and the pistol grip in his right. An ember from one of the expended fireworks fell into a ready box, igniting a shell 10 inches (254 millimeters) in diameter. The shell rocketed out of the box into the firefighter's left hand, shredding his middle and ring fingers, then flew up to strike his helmet and face shield, tearing the helmet from the foam liner. The shell also ignited 10 to 12 other boxes of unexpended shells.

The firefighter was taken to the local hospital, where he remained for two weeks. The remaining portions of his middle and ring fingers were surgically removed, and he lost the hearing in his left ear. He also sustained minor burns and contusions to the left side of his face. Fortunately, his protective coat and trousers protected him from further burns, although the clothing itself was burned in several places. He has yet to return to duty.

Michael J. Karter, Jr. and Paul R. LeBlanc, 1999, "1998 Firefighter Injuries", *NFPA Journal*, November/December, 55

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Michigan; December, 1998; 2:00 p.m. 7 deaths	Fireworks manufacturing plant; unprotected wood-frame construction; one story; operating.	None.	None.	An unknown source ignited an assortment of explosive powders used to manufacture fireworks. The explosion destroyed the building, and material that had been in it was found up to 900 feet (274meters) from the concrete foundation.	None reported.

Kenneth J. Tremblay, 1999, "The Catastrophic Fires of 1998", *NFPA Journal*, September/October, 54.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Tennessee; June, 1997; 12:00 p.m. 4 deaths	Storage and manufacturing facility for pyrotechnic devices; unprotected, noncombustible construction; 8 feet (2.4 meters) wide, 40 feet (12.2 meters ) long, and 8 feet (2.4 meters) high; operating.	None.	None.	An undetermined source ignited powder stored in one of four magazines. An explosion set off a larger explosion that destroyed the four magazines, scattering debris over a large area and damaging several exposures.	Three people working the magazine died instantly. A fourth survived the blast but succumbed to his injuries shortly after medical help arrived. Two of the victims were men, ages 48 and 22, and the other two were women, ages 20 and 19.

Kenneth J. Tremblay and Rita F. Fahy, 1998, "1997 Catastrophic Fires", *NFPA Journal*, September/October, 53.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Setting</b>	<b>Climate Conditions</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors</b>
Illinois; July, 1997; 9:38 p.m. 3 deaths	A non-self propelled steel barge in a river was being used to stage a public fireworks display.	None reported.	An 8-inch (20-centimeter) mortar misfired at a low altitude and fell into a mortar bank of 5- and 6-inch (13 and 15-centimeter shells, causing them to explode. Crews were in the process of reloading the 6-inch mortars, which ignited and, along with other stored fireworks, caused a larger explosion.	An employee near the area where the explosion occurred died of thermal burns. Two others jumped into the river to escape and drowned.

Kenneth J. Tremblay and Rita F. Fahy, 1998, "1997 Catastrophic Fires", *NFPA Journal*, September/October, 55.

## Fireworks ignite deadly blaze, Arkansas

Fireworks started a fire that killed a 39-year-old man and destroyed a single-story, 1,200-square-foot (111.5-squaremeter) house of unprotected, wood-frame construction. The dwelling had no smoke detectors or sprinklers.

Occupants of the single-family home were discharging fireworks when one of the rockets landed on a couch on the front porch. Thinking that heat from the rocket wasn't significant enough to cause damage, they retired for the evening. The couch smoldered for hours before flames spread inside the house, waking the occupants, who called 911 at 1:56 a.m.

Arriving firefighters found that the fire had consumed the entire house, which was valued at \$25,000. The man who died of smoke inhalation is believed to have been under the influence of alcohol, which may have contributed to his inability to escape.

Kenneth J. Tremblay, 1998, Firewatch, *NFPA Journal*, July/August, 19.

## Fireworks ignite barge, Massachusetts

Shortly after a public fireworks display began off a heavy steel barge anchored off the coast, a rocket exploded in the air prematurely, showering the barge and cardboard boxes containing reserve fireworks with sparks. Numerous fireworks detonated, burning all 10 people aboard the barge. Rescue personnel had to rescue the workers, including three who jumped into the ocean to escape.

The state fire marshal later cited several violations on board the barge. The deputy chief said two contributing factors were the improper storage of reserve fireworks and inadequate spacing between fireworks for separate displays.

Kenneth J. Tremblay, 1998, Firewatch, *NFPA Journal*, July/August, 22.

<b>State, Date, Time of Alarm, Dollar Loss</b>	<b>Property Characteristics and Operating Status</b>	<b>Fire Protection Systems and Fire Development</b>	<b>Contributing Factors</b>
Alaska; June, 1996 Time not reported. \$9,163,300	This wildland-urban interface fire spread to a residential area.	This fire, believed to have been started by fireworks, quickly spread across 60 acres, although the final number of acres burned wasn't reported. An area of single-family homes of various types of construction became involved.	High winds caused the fire to escape a perimeter and spread rapidly. Low relative humidity created dry conditions that contributed to fire spread.

Stephen G. Badger, 1997, "The Large-Loss Fires and Explosions of 1996", *NFPA Journal*, November/December, 59.

<b>Location, Date, Time of Alarm, Number of Deaths</b>	<b>Occupancy Type and Use, Construction Type, Number of Stories, and Operating Status</b>	<b>Detection Systems</b>	<b>Suppression Systems</b>	<b>Fire Origin and Path</b>	<b>Contributing Factors and Victim Locations</b>
Ohio; July, 1996; 1:59 p.m. 9 deaths	Fireworks retail sales; unprotected ordinary construction; one story; operating.	None.	There was a wet-pipe sprinkler system, but it had been shut off.	A customer lit a fireworks item in the sales display area of the store. The initial combustion ignited other stored fireworks, consuming the entire inventory in a matter of seconds.	The store was crowded with pre-holiday customers. When the fire started, many were able to escape, but nine died, including three children, ages 2, 8, 9, and 14. Five adults, whose ages ranged from 21 to 71, also died.

Kenneth J. Tremblay, 1997, "1996 Catastrophic Fires", *NFPA Journal*, September/October, 52.

## **Arson blaze started by fireworks kills three, Ohio**

According to news accounts, a 13-year-old threw six fireworks through the broken windows of an apartment, starting a fire that blocked the apartment's only exit, killing three occupants.

The single-story building, which measured 75 by 24 feet, was constructed of concrete block walls and wood roof framing and decking. Asphalt shingles covered the roof. A single battery-operated smoke detector was in the room of origin, but it's not known whether it operated. There were no sprinklers.

A neighbor detected the blaze and called 911 at 2:42 p.m. The fireworks ignited drapes and a couch, and the fire quickly reached flashover, then spread down the hall to the kitchen. Because the blaze spread so quickly, firefighters couldn't save the three trapped occupants.

Flames, smoke, and heat spread from the apartment to the attic. The extent of the property damage wasn't reported.

Kenneth J. Tremblay, 1997, "Firewatch," *NFPA Journal*, July/August, 20.

## **Fireworks ignite apartment building, California**

Two 16-year-old girls started a four-alarm blaze when they discharged illegal fireworks that ignited the wood-shingle roof of an occupied apartment building.

The two-story, 37-unit building was of unprotected, wood-frame construction. Most of the roof was covered with wood-shake shingles, except for one part that consisted of a plywood base covered with tar and gravel. Located in a complex of similar buildings, the apartment building was rectangular, with an open courtyard in the center. Five exterior stairways led from the second floor to the courtyard. The building had no detectors or sprinklers.

Occupants discovered the fire and called 911 at 3:56 p.m. Hot, dry weather and 10-mph winds caused the flames to spread quickly and penetrate the attic, eventually causing the roof to collapse.

Investigators interviewed witnesses who reported having seen two girls igniting aerial fireworks shortly before the fire started. The girls were questioned and admitted to using the fireworks. Investigators discovered the remains of fireworks near the area of fire origin, which, in addition to the girls' statements, provided enough evidence to charge them with starting the blaze.

Nine units, including the one used as the manager's office, were heavily damaged when the roof collapsed. The fire also damaged six other units. Damage to the building, valued at \$2 million, and its contents, valued at \$1 million, was estimated at \$1 million and \$100,000, respectively.

A 40-year-old firefighter was injured while fighting the blaze.

Kenneth J. Tremblay, 1997, "Firewatch," *NFPA Journal*, May/June, 30.

## **Sparkler ignites apartment blaze, Connecticut**

A fire that started in the bedroom of a first-floor apartment when a lit sparkler ignited a combustible bed skirt caused extensive damage to the building. The apartment's resident had placed the sparkler in a cupcake for her 10-year-old daughter's birthday. After sparks ignited the bed skirt, flames spread to bedding and other combustibles. The occupants detected the fire before smoke detectors could operate and escaped.

The six-story, 66-unit apartment building of noncombustible construction had masonry walls and steel bar, floor, and roof joists. It contained an automatic fire alarm

system that consisted of smoke and heat detectors and pull stations in the common hallways and storage areas. Standpipes were located on each floor, and sprinklers protected the basement. A central station alarm company monitored the detection and suppressions systems.

Firefighters arrived two minutes after a 911 call reporting the fire at 8:14 a.m. There was a delay in alarm notification from the central monitoring station. Firefighters evacuated residents, then extinguished the fire and ventilated the building.

Flames heavily damaged the bedroom of origin and other rooms in the apartment, while the structural steel elements sustained significant heat damage. Smoke extensively damaged the first floor and spread to the upper floors through a construction deficiency around a vertical ventilation shaft. Water damaged the lower floors. Damages were estimated at \$1.6 million. There were no injuries.

Kenneth J. Tremblay, 1997, "Firewatch," *NFPA Journal*, March/April, 21.

### **Illegal fireworks ignite blaze that damages residential dwelling, Idaho**

A single-family dwelling was damaged when a consumer firework landed in a hammock on the house's deck, igniting it. Flames spread along the deck and, fueled by propane gas from a grill, inside the house. A group of boys admitted that they'd been playing with consumer fireworks nearby.

The 22-year-old, 1,600-square-foot, one-story dwelling of wood-frame construction had veneer walls covered with combination brick and steel siding on three sides and steel siding in the rear. The roof consisted of 2- by 6-inch wood roof trusses located 16 inches on center with two layers of fiberglass roof shingles. The redwood deck attached to the rear of the house measured 12 by 20 feet. Patio furniture, a hot tub, and a propane-gas-fired barbecue grill and dutch oven cooking stove were located on the deck. A battery-operated smoke detector was installed on the first floor of the house, and another was located in the basement. There were no sprinklers.

No one was at home when seven boys, ages 12, 13, and 14, were igniting bottle rockets in the street in front of the house. According to the boys, they would randomly toss the lighted rockets into the air, and the rockets would either fire into the air or toward the street. They noticed that one of the bottle rockets went over the house and landed behind it. About 30 minutes later, the boys saw smoke coming from the back of the house. They investigated, and finding a fire, went to one of their homes to call 911.

The fire department received the call at 3:20 p.m., and firefighters arrived four minutes later to find the deck and the exterior sidewall in flames. Determining that the fire had spread to the attic, they entered the garage, where they found an access panel to the attic. By now, the flames had vented through the roof. Firefighters controlled the fire spread in the attic, extinguished the exterior flames, and ventilated the property.

Firefighters determined that the rocket had landed on a hammock on the deck and that the burning cotton netting had dropped onto the deck, which had recently been treated with a linseed-oil-based preservative. A light breeze then fanned the flames toward the dwelling under a propane gas-fired grill and stove, each of which contained a 20-pound propane cylinder. Heat from the fire ignited a plastic boot holding one of the cylinders, both of whose valves had been left open, even though the appliances were shut off.

The hose that connected the cylinder to the dutch oven failed, releasing propane, which fueled the flames. The intensified heat on the sidewall caused the steel siding soffits to fail, allowing the fire to spread to the attic. Several lightweight wood trusses collapsed into several rooms, and flames vented through the roof. The steel siding covering the exterior walls provided some protection and limited fire spread into these areas.

Flames also impinged on a kitchen window, which broke, allowing the fire to spread inside the house. The configuration of the cabinet soffits prevented the kitchen ceiling from collapsing, but the ceilings in the dining and living rooms did collapse.

Damage to the structure and its contents, which were valued at \$180,000, was estimated at \$80,000. The owners were forced to spend the next two months in a hotel while the house was repaired.

One firefighter fractured a vertebra when he tripped over the hammock.

Kenneth J. Tremblay, 1996, "Firewatch," *NFPA Journal*, July/August, 22-23.

### **Firework fails to explode, kills child, South Dakota**

An aerial shell that was fired into the sky during a racetrack's annual Fourth of July fireworks display celebration failed to explode and descended into a crowded grandstand, killing a young girl.

The fireworks display, which had been delayed for a few days due to rain, started at approximately 11:00 p.m., following the evening's racing events. Racetrack employees fired commercially produced display fireworks from the racetrack oval as the crowd watched from the grandstands. Two employees loaded the various-sized display fireworks into 5-, 4-, and 3-inch mortars that were partially buried in the ground, then backed away from the launching site as a third worker used a road flare to ignite the fuses. The aerial shell that failed was egg-shaped and was fired from a 5-inch mortar approximately 2 1/2, to 3 feet long.

Witnesses stated that when the aerial shell was fired into the air, it was followed by a trail of sparks and failed to explode. Just as another round was fired, witnesses saw the shell fall towards the grandstand. The aerial shell landed in the fourth row, striking a 10-year-old girl in the head. She screamed and collapsed onto the seats. Despite immediate medical assistance from several people present, including a doctor, off-duty firefighters, and police officers, the girl died from her injuries after she was transported to a local hospital. No one else was hurt.

The aerial shell that struck the child was picked up by a bystander and immediately confiscated by police officers. The reason it failed to ignite wasn't reported.

Kenneth J. Tremblay, 1996, "Firewatch," *NFPA Journal*, July/August, 24.

### **Fireworks company employee killed setting up fireworks display, New Hampshire**

A 40-year-old employee of a fireworks display company died when he improperly loaded two 3-inch fireworks mortars while setting up a public fireworks display. According to news accounts, the company had been hired to provide a fireworks display in a field for a town event.

The employee, who was using a staple gun to secure detonating cord to a wooden mortar rack, was leaning over the rack when a spark or the concussion from the staple gun detonated the aerial shells in the mortar. A bystander ran to a municipal fire alarm box to call in the alarm at 6:45 p.m. The man suffered severe facial trauma and burns and died from his injuries. There was no loss to property.

By using the staple gun and placing his body over the mortar rack, the employee was going against both company policy and industry standards. The fire chief stated that "fire departments need to educate themselves on display fireworks operations and perform inspections during loading and all other phases." He added that this accident could have been prevented.

Kenneth J. Tremblay, 1996, "Firewatch," *NFPA Journal*, July/August, 24.

## **Fireworks ignite wood roof shingles, flames spread to neighboring dwellings, Texas**

Consumer fireworks ignited the wood roof shingles of a single-family dwelling, starting a blaze that spread to the combustible roofs of 12 other homes in the neighborhood cul-de-sac.

The fire originated in a 2,400-square-foot, single-story house of unprotected, wood-frame construction. Brick veneer covered the exterior walls, and wood shingles covered the roof. The house contained hardwired smoke detectors, which operated, but it had no sprinklers.

Consumer fireworks discharged from nearby landed on the roof and ignited the wood shingles. The fire burned for approximately five minutes before the occupants detected it. Firefighters received multiple calls reporting the fire at 6:41 p.m. The fire spread quickly to other roofs, eventually destroying five dwellings and damaging eight others.

Ironically, one house with a composition roof acted as a fire break, preventing further fire spread. This home wasn't damaged. The combined property damage was estimated at \$2,149,200, and the combined contents damage at \$5.5 million.

One firefighter injured his ankle during suppression operations.

Kenneth J. Tremblay, 1996, "Firewatch," *NFPA Journal*, July/August, 21.

## **Children playing with fireworks ignite exterior of building, Massachusetts**

A rocket-type firework that lodged in the plastic seal of a building's door started a fire that damaged the structure's exterior. A group of children had been playing with fireworks nearby.

The three-story building, which was used to manufacture electronic switches, measured 450 by 50 feet and consisted of two sections. The older section was of unprotected, wood-frame construction and was protected by a dry-pipe sprinkler system. A wet-pipe sprinkler system was installed in the newer section, which was of noncombustible construction. A complete fire detection system was installed throughout the building. All of the systems were supervised.

A group of children was playing with fireworks in a nearby housing project when one of the rocket-type fireworks landed on the building's loading dock, lodging itself in the plastic seal of the trailer-truck service door. Heat from the firework ignited the plastic seal, and flames spread to another service door and to an overhead facade.

One of the children reported the blaze to his mother, who called the fire department at 6:47 p.m. Arriving firefighters, finding overlapping fire and two overhead doors ablaze, called for an additional alarm, as surrounding communities were asked to send mutual aid.

Firefighters attacked the blaze with handlines, and a second engine laid a feeder line from a hydrant to support the sprinkler system in the newer section of the building. Firefighters quickly extinguished the blaze, which was confined to the exterior of the building. Smoke filled the newer section of the building, and ladder companies helped ventilate it. The sprinkler system did not activate.

Damage to the building was estimated at \$10,000.

Kenneth J. Tremblay, 1995, "Firewatch," *NFPA Journal*, May/June, 40.

## **Firefighter injured at fireworks display, Wisconsin**

A Wisconsin firefighter was seriously injured on July 4, 1993 when he and four colleagues were setting off fireworks for the city's Fourth of July celebration. One of the firefighters had ignited eight mortars. After waiting approximately 1 to 3 minutes, he approached the tubes with a flashlight to inspect them for misfires or burning debris. As he

*Fireworks*, 5/09

neared the mortars, one of the aerial salutes lifted off from a tube after a delayed ignition, striking the firefighter in the face.

The firefighter sustained extensive injuries to his forehead and midface. He was brought to a local hospital and later medivaced to a larger facility. He has undergone numerous facial reconstruction operations and has lost his eyesight. He still needs more surgery and has been retired from the fire service.

Michael J. Karter, Jr. and Paul R. LeBlanc, 1994, "U.S. Firefighter Injuries in 1993", *NFPA Journal*, November/December, 64.

## **Two injured in fireworks explosion and fire, New Hampshire**

Two workers were injured in an explosion and fire in a trailer where fireworks were stored on the grounds of a fireworks manufacturing facility and retail store. Ten years earlier, four people had died in another fireworks explosion at the plant.

The 40-foot-long steel-frame tractor trailer contained packaged Class C fireworks and empty cardboard tubes. It was constructed of sheet-metal walls and roof decking, and its 320-square foot floor was covered with wood. The trailer, which was not equipped with fire detection or suppression equipment, was 3 feet from a concrete bunker containing 2,000 pounds of black powder.

At about 10:00 a.m., a worker, who was smoking, was loading cartons of Class C fireworks into the trailer. Investigators believe that he dropped either the cigarette or a hot ash on a box of fireworks, igniting them. After trying unsuccessfully for 10 minutes to extinguish the fire using water extinguishers, the worker and another employee notified the fire department.

Firefighters responded immediately and were able to limit the fire to the forward section of the trailer, where it consumed cardboard boxes, tubes, and a limited amount of fireworks. No further damage or explosions occurred.

One of the workers sustained second-degree burns on his hands; the other suffered chest pains and smoke inhalation. Both were treated at the scene and taken to a hospital.

The amount of the loss was not reported.

Kenneth J. Tremblay, 1993, "Firewatch," *NFPA Journal*, May/June, 35.

## **Children playing with fireworks ignite fire, Connecticut**

A small fire occurred when children playing outside a building ignited fireworks that entered an open bedroom window and subsequently ignited bedding.

The eight-story, 56-unit apartment building of protected noncombustible construction was one of four city-owned high-rises containing low-income housing in an area surrounded by two-story residential dwellings.

The children ignited the fireworks device, which then entered an open window of a first-floor bedroom, landed on a bed, and ignited the sheets. Five to eight minutes later, a smoke detector outside the room activated and an occupant of the unit discovered the fire.

The single-alarm fire department response consisted of three fire engines, two ladder trucks, and a rescue unit. The fire was limited to the unit of origin and did not extend vertically.

There was minimal structural damage; the total loss was estimated at \$8,000.

Kenneth J. Tremblay, 1992, "Firewatch," *NFPA Journal*, July/August, 26.

## **Two workers killed in fireworks plant explosion, Mississippi**

An early-morning explosion on a fireworks production line killed two male employees, ages 65 and 38, and seriously injured a female coworker, age 32, as they worked to fill an order for 1,500 aerial display fireworks.

The three were assembling and packaging fireworks in the center of the single-story, 200-by-60-foot masonry building. As the 9:00 a.m. coffee break bell sounded, the woman looked away from her work momentarily. When she looked back, she saw the fuses of the fireworks she had been working on burning like "the candles of a birthday cake."

As she ran to an exit, she yelled "Fire!" But before she could escape, an explosion occurred. It was soon followed by another. The woman, who sustained multiple lacerations and contusions and severe burns to her back, was later found outside the building by firefighters.

News accounts say that police evacuated a 1-mile area around the plant, because of the possibility of additional explosions. Firefighters extinguished perimeter fires that had burned a large area of vegetation around the building and threatened to spread to a powder magazine 500 feet from the structure.

Federal and state officials who were called in arrived later on the day of the fire and into the next day. The investigation stretched over several days, with guarded concern over the potential of new explosions from still-unexploded fireworks.

Investigators believe that the electric-powered hot-glue gun the woman had been using to assemble the fireworks started the fire when electrical sparks from the gun ignited the fuses of the in-process fireworks. Officials believe that the first explosion probably resulted from the amount of material and finished product in the assembly area; the second probably occurred when a larger quantity of stored flashpowder became involved.

The loss was estimated at \$1.1 million, because the structure and its contents were completely destroyed. The building had no automatic detection or suppression equipment. (None would be required by NFPA 1124, *Manufacture, Transportation, and Storage of Fireworks*.)

Kenneth J. Tremblay, 1991, "Firewatch," *NFPA Journal*, July/August, 30.

## **Two killed in illegal fireworks explosion in garage, Ohio**

A residential neighborhood was rocked by a late-morning explosion that killed 2 civilians in the blast zone, injured 23 civilians and firefighters, and damaged a number of homes.

At 11:40 a.m., the on-duty crew at a local fire station felt the blast's shock wave and went outside to investigate. When they saw a white mushroom cloud off in the distance, they immediately responded to the general area.

A radio message from a passing ambulance advised them that two houses were burning nearby and gave them the address. Because the incident appeared to be severe, the firefighters summoned additional apparatus and ambulances to the scene even before they arrived.

After fire crews had extinguished the fires, attended to the injured, and located the bodies of the dead, the fire chief requested the assistance of the U.S. Bureau of Alcohol, Tobacco, and Firearms in determining the cause of the explosion. The investigators theorized that one of the victims, a 50-year-old man, had been manufacturing illegal fireworks in his garage when something ignited a large quantity of black powder and chemicals he had stored there. The second victim was a 63-year-old woman who lived in a nearby house. She had been thrown down a cellar stairway by the explosion's concussion and died as a result of head injuries.

Seventy-two homes were damaged by the explosion. Two of these were destroyed by the fires, and the garage itself was leveled. The total dollar loss was placed at \$2.125 million.

Kenneth J. Tremblay, 1991, "Firewatch," *NFPA Journal*, January/February, 31.

### **Marina, Fireworks Cause Boat Fire, Michigan**

Three boats were destroyed and six others were damaged when fire erupted aboard a vessel at this marina complex.

A witness to the fire said that he saw what he thought was a bottle rocket land on a canvas boat cover at about 1:11 am and that he watched the cover ignite moments later. The fire then spread to a succession of boats, igniting the fiberglass of each in turn. Another witness evidently tried to swim to one of the burning boats with a portable fire extinguisher, but he was forced back by the fire's intensity.

By the time the fire department arrived at 1:15 am, three boats were fully involved. Firefighters had to stretch hose lines 300 feet from shore out onto the pier in order to reach the boats, but they had the fire under control within 30 minutes.

Three fiberglass boats between 24 and 27 feet long were destroyed, and the pier and six other boats were damaged. The loss amounted to \$84,850. One firefighter was taken to a local hospital and treated for smoke inhalation.

Neil Courtney, 1989, "Fire Record," *Fire Journal*, July/August, 19.