LIGHTNING FIRES AND LIGHTNING STRIKES

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June 2013

National Fire Protection Association
Fire Analysis and Research Division

EXHIBIT C

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Abstract

During the five-year-period of 2007-2011, NFPA estimates that U.S. local fire departments responded to an estimated average of 22,600 fires started by lightning per year. These fires caused an estimated average of nine civilian deaths, 53 civilian injuries and $451 million in direct property damage per year. These estimates are based on data from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual fire department experience survey. Only 19% of reported lightning fires occurred in homes, but these fires caused a majority of the associated losses. Lightning is also a major factor in wildland fires, and the average number of acres burned per fire is much higher in lightning fires than in fires caused by humans. Most lightning fatalities do not result from fire, but from individuals being directly hit by lightning. Most of these victims were outside when lightning struck.

Keywords: Fire statistics, lightning

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. I would also like thank Dr. Rita Fahy for providing the analysis of firefighter fatalities associated with fires caused by lightning.

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NFPA No. USS51

Executive Summary

During 2007-2011, U.S. local fire departments responded to an estimated average of 22,600 fires per year that were started by lightning. These fires caused an average of nine civilian deaths, 53 civilian injuries, and $451 million in direct property damage per year. Most of these fires occurred outdoors, but most associated deaths, injuries, and property damage were associated with home fires. Fires started by lightning peak in the summer months and in the later afternoon and early evening. The January 2006 West Virginia coal mine explosion that claimed 12 lives was the deadliest U.S. fire started by lightning in recent years. Nine firefighters were killed in an August 2008 helicopter crash as they were being evacuated from a California wildland fire started by lightning.

Lightning-related fires are more common in June through August and in the late afternoon and evening. Peak seasons for lightning-related fires vary by region, as do weather patterns in general.

In addition to the fires reported to local fire departments, federal and state wildland firefighting agencies reported an average of 9,000 wildland fires started by lightning to the National Interagency Fire Center per year in 2008-2012. These fires tended to be larger than fires started by human causes. The average lightning-caused fire burned 402 acres, nine times the average of 45 acres seen in human-caused wildland fires.

Over the 10 years from 2003-2012, 42 U.S. firefighters were killed as a result of lightning-caused fires. These deaths include fatalities during fireground activities, as well as responding or returning to fires. Four of these deaths occurred at structure fires, and the remaining 38 were killed as the result of wildland fires. Eleven of these deaths occurred in helicopter crashes.

In addition to causing fires, lightning is dangerous on its own. Data from the National Weather Service show that in 2008-2012, an average of 29 people per year died as a result of lightning strikes. The most common location for these deaths was outside or in an open area. The average number of lightning flashes per square mile varies considerably by state, as does the death rate from lightning incidents. See http://www.lightningsafety.noaa.gov for more information.

In 2003, the last year for which data about fire department responses to non-fire incidents is currently available, 10,200 non-fire lightning strikes were reported to local fire departments. The majority of these, 62%, occurred at home properties.

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Lightning Fires and Lightning Strikes Fact Sheet

During 2007-2011, U.S. fire departments responded to an estimated annual average of 22,600 fires started by lightning. These fires caused annual averages of

- 9 civilian deaths
- 53 civilian injuries
- $451 million in direct property damage.

The January 2006 West Virginia coal mine explosion that claimed 12 lives was the deadliest U.S. fire started by lightning in recent years. Nine firefighters were killed in an August 2008 helicopter crash as they were being evacuated from a California wildland fire started by lightning.

In 2007-2011, only 19% of reported lightning fires occurred in homes, but these accounted for 86% of the associated lightning fire civilian deaths, 76% of the associated injuries and 68% of the direct property damage.

Almost two-thirds (63%) of the lightning fires reported to local fire departments were outside vegetation fires.

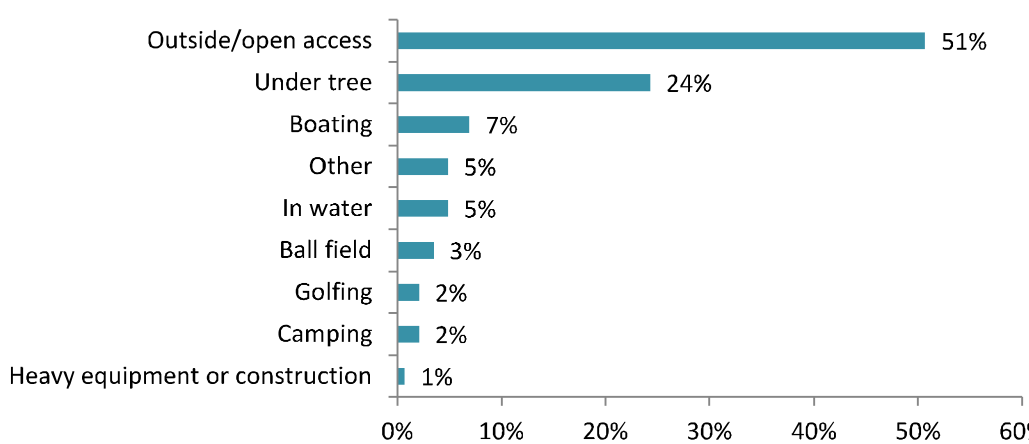
Fires started by lightning peak in the summer months and in the late afternoon and early evening.

National Interagency Fire Center statistics show that in 2008-2012, an average of 9,000 (12%) of reported wildland fires were started by lightning per year. However, the average lightning-caused wildfire burned 402 acres, nine times the average of 45 acres per-human-caused fire.

Non-Fire Lightning Fatalities

Lightning also causes non-fire deaths and injuries. According to the National Weather Service reports, lightning caused an average of 29 deaths per year in 2008-2012.

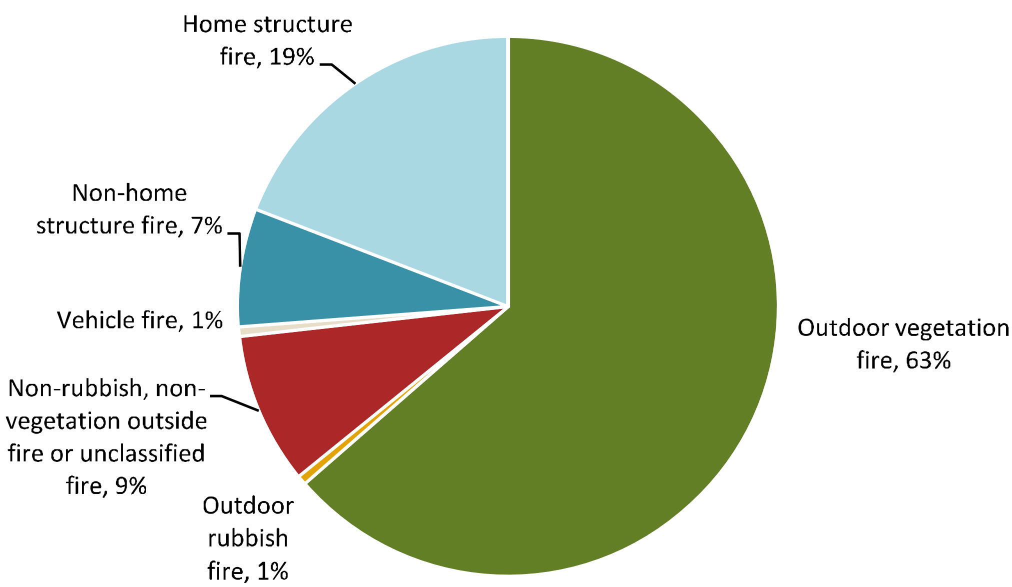
Lightning Fatalities by Activity/Location: 2008-2012



Source: Lightning fatality statistics are compiled by the Office of Services and the National Climatic Data Center from information contained in *Storm Data*. Online at http://www.weather.gov/os/hazstats.shtml.

22,600 lightning fires, on average, were reported to local fire departments per year.
During 2007-2011, U.S. local fire departments responded to an estimated average of 22,600 fires per year that were started by lightning. These fires caused an average of nine civilian deaths, 53 civilian injuries, and $451 million in direct property damage per year. Figure 1 shows that almost two-thirds (63%) of these fires were outdoor vegetation fires. Table 1 shows that home structure fires accounted for only 4,300 (19%) of the lightning fires, but these incidents caused 86% of the associated civilian fire deaths, 76% of the civilian fire injuries, and 68% of the direct property damage resulting from lightning fires reported to local departments annually. Table 2 shows the frequency of structure fires started by lightning in properties other than homes.

Figure 1. Lightning Fires by Incident Type
2007-2011



2006 coal mine explosion was the deadliest U.S. lightning incident in the past decade.
In January 2006, a West Virginia fire in an underground coal mine claimed 12 lives. The incident occurred approximately two miles (3.2 kilometers) in from the mine entrance. Methane gas was ignited by a lightning strike that occurred a distance from the mine and followed a cable into the mine. The fire was reported at 6:26 a.m. The explosion killed one miner and a collapse forced the other 12 miners to retreat and await rescue behind a barricade curtain they built. Approximately 41 hours after the explosion, rescuers located one survivor and the bodies of the other 11 miners.[1] A detailed report written by the U.S. Department of Labor's Mine Safety and Health Administration's Coal Mine Safety and Health Division is available at http://www.msha.gov/Fatals/2006/Sago/sagoreport.asp.

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[1] Stephen G. Badger, 2007, "*Catastrophic Multiple-Death Fires for 2006*" NFPA, Fire Analysis and Research, Quincy, MA.

Fire department statistics are derived from NFIRS and NFPA survey.
The estimates presented thus far (except for trend data) are projections derived from the detailed information reported in Version 5.0 of the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) combined with data from NFPA's annual fire department experience survey. NFIRS 5.0 does not require causal information for 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 information is not required for these incidents, it is provided in some cases. These fires were excluded from the analysis.

In NFIRS 5.0, fires started by lightning discharges were identified by heat source code 73. In 1980-1998, these fires were identified by form of heat of ignition code 73. Estimates include a proportional share of fires with unknown data. Annual averages were calculated from the five-year totals rather than the individual year's estimates. Wildland fires handled by state, federal, or tribal agencies are not included in estimates of fires handled by local fire departments.

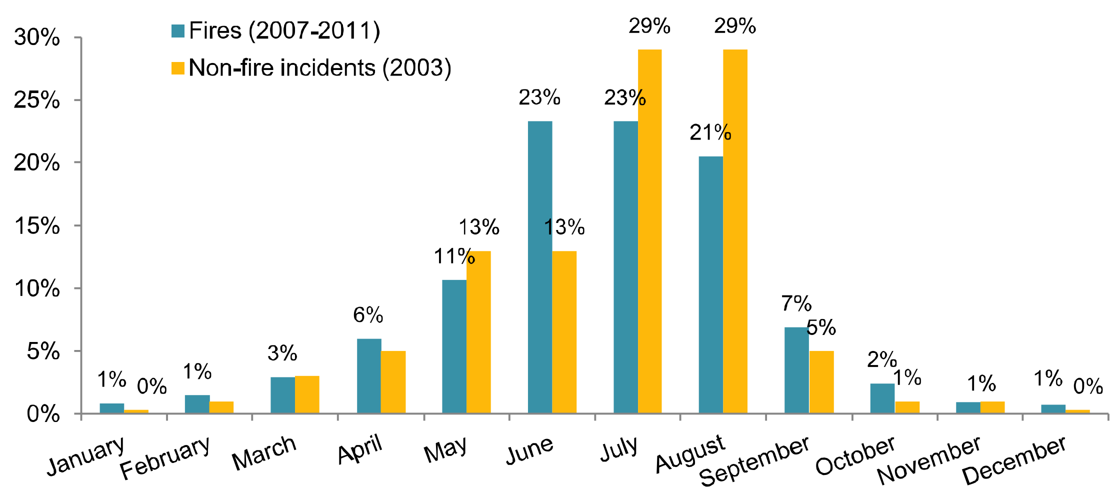
The 2003 national public data release file was the last to include all non-fire incidents reported to NFIRS. Consequently, non-fire incidents are shown for 2003 only. Lightning strikes that did not result in fire are identified by NFIRS 5.0 incident type 814. A detailed description of the national estimates methodology may be found in Appendix A.

Lightning started 4% of vegetation fires reported to local fire departments.
During 2007-2011 lightning caused 1% of reported home structure fires, less than 1% of the home fire casualties, and 4% of the direct property damage from home fires. Lightning started 4% of outside vegetation fires.

10,200 non-fire lightning strikes were reported to local fire departments in 2003.
In 2003, U.S. fire departments responded to an estimated 10,200 lightning strikes that did not result in fire. Sixty-two percent, or 6,300, of these incidents were at home properties. Table 3 shows that 17% of the non-home non-fire lightning strikes occurred on highways, streets or parking areas. NFIRS does not collect property damage or casualty data for non-fire incidents. Non-fire incidents have not been included in the public NFIRS file since 2003.

Lightning incidents are more common in summer late afternoons and evenings.
Not surprisingly, lightning fires and non-fire lightning incidents are much more common in the summer months. Figure 2 shows that June and July were the peak months for lightning fires, followed closely by August. Non-fire lightning incidents were most common in July and August; May and June tied for third place. Ninety-one percent of the fires and 94% of the non-fire lightning strikes occurred in the six months of April through September. It is important to remember that these are the patterns for the country as a whole and may not apply to specific regions.

Figure 2. Lightning Incidents by Month



In their article, "Climate and Wildfire in the Western United States," Westling, Gersunov. Cayan, and Dettinger describe factors that apply to the frequency, size and timing of wildfires, such as the availability of fuel, weather patterns, particularly lightning, but also precipitation, wind and humidity. They note that the fire season tends to start and end earlier in the Southwest than the Northwest and wildland fires are more common at the hottest, driest times of the year.[2] Many of these factors would apply to fires handled by local fire departments. Particularly outside vegetation fires.

Figure 3 shows that lightning fires peak in the late afternoon and early evening. More than half of all fires started by lightning occurred between the hours of 3:00 p.m. and 9:00 p.m. The National Weather Service has noted that lightning fatalities are most common during summer afternoons and evenings.[3]

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[2] A.L Westerling, A., Gershunov, T.J Brown, D.R. Cayan, and M.D. Dettinger. "Climate and Wildfire in the Western United States," *American Meterological Society,* May 2003, DOI: 10.1175/BAMS-84-5-595, accessed at http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-84-5-595 on May 21, 2013.
[3] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, *Thunderstorms, Tornadoes, Lightning…Nature's Most Violent Storms: A Preparedness Guide,* accessed at http://www.nws.noaa.gov/os/severeweather/resources/ttl6-10.pdf on May 21, 2013.

Figure 3. Lightning Fires by Hour of Day
2007-2011 Annual Averages

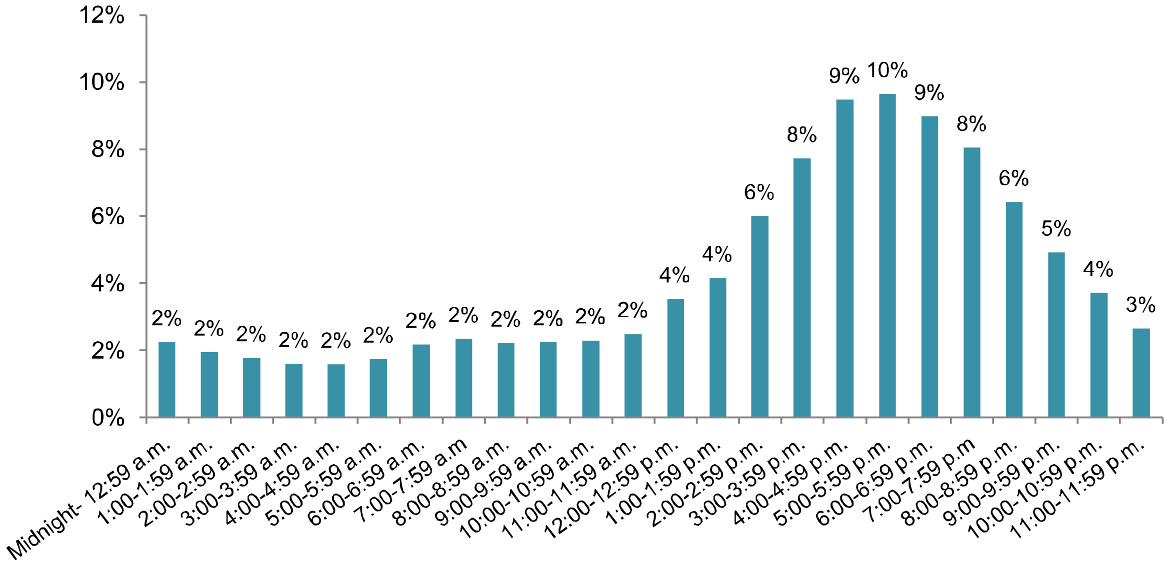


Table 4 shows the estimates of lightning fires by year and type of fire. Figure 4 shows that both home and non-home structure fires were higher in 1980 and then fairly stable through the remainder of the 1980s and 1990s. Since 2002, the numbers had been falling, but both types of structure fires increased from 2010 to 2011. Due to the small portion of fires collected in NFIRS 5.0 in 1999-2001, statistics for these years are omitted from Figures 4 and 5.

Figure 4. Structure Fires Started by Lightning by Year

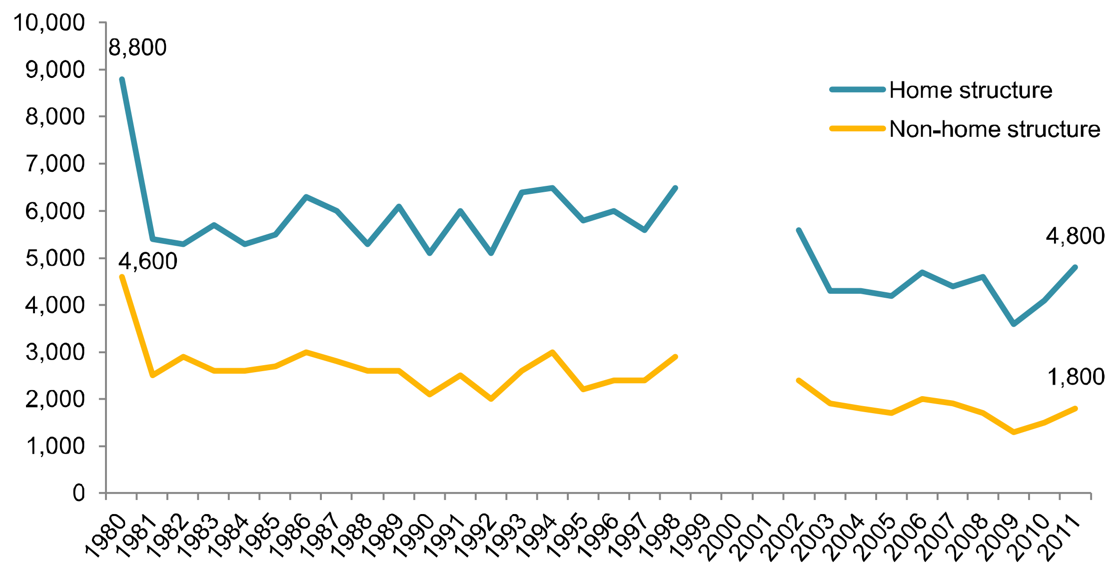
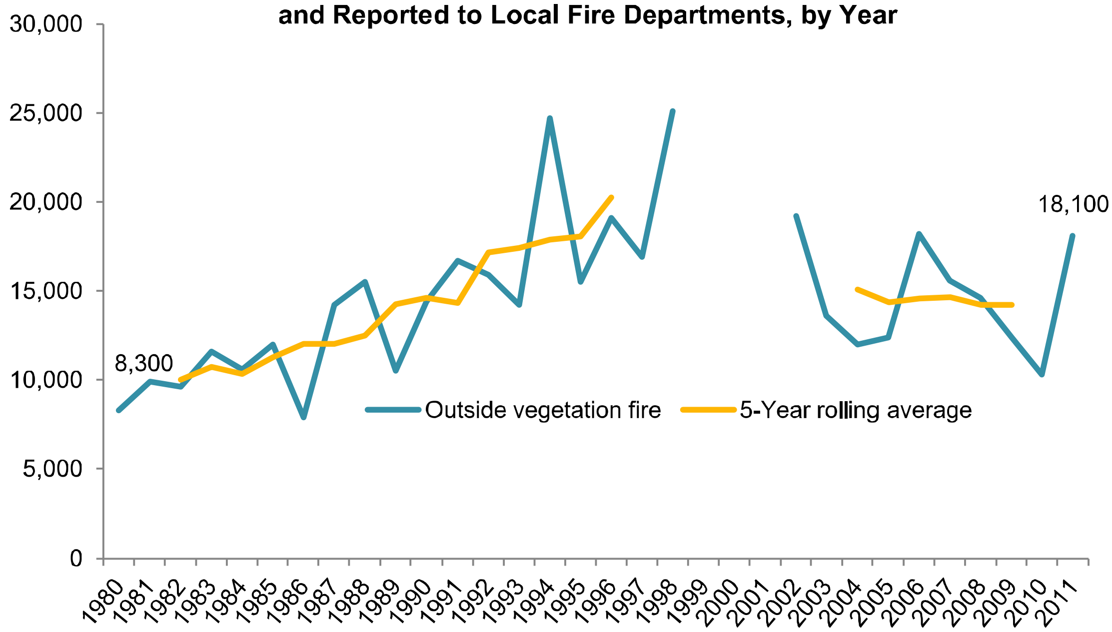


Figure 5. Vegetation Fires Started by Lightning and Reported to Local Fire Departments, by Year



The number of outside vegetation fires started by lightning and reported to local fire departments had been on an upward trend through the 1980s and 1990s. In recent years, they have been below the peak, but the 18,100 such fires in 2011 was the sixth highest seen over these decades.

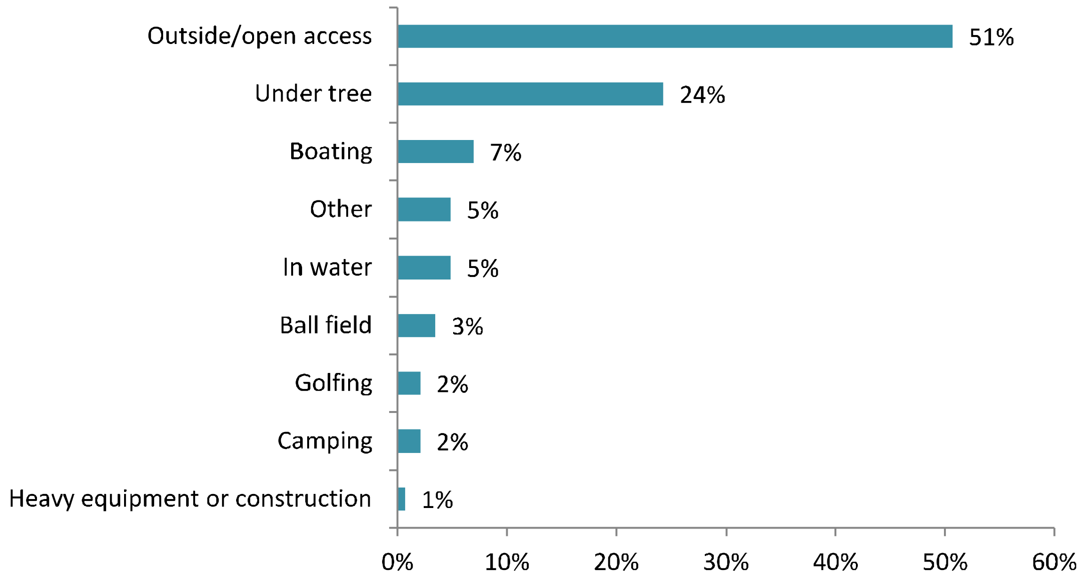
29 people, on average, were killed by lightning strikes per year in 2008-2012.
Lightning also causes non-fire injuries and deaths. According to data extracted from *Storm Data* and presented by the National Weather Service, during 2008-2012, an average of 29 people were killed by lightning per year.[4] Figure 6 shows that most of the people killed by lightning were outside, with half in an outside open area. The data also show that 4 out of five people killed by lightning strikes were male, and six out of seven victims were between 10 and 59 years of age. The National Safety Council uses death certificate data to track deaths from lightning strikes. According to their analysis, from 2007 through 2009, 35 people per year were killed by lightning.[5]

Table 5 shows the average number of lightning deaths by state over the ten-year period of 2003-2012, as well as the death rate per million population for these deaths by state.[6] This data was obtained from the National Oceanic and Atmospheric Administration's website at http://www.lightningsafety.noaa.gov. State data is also shown for 1997-2012 average cloud-to-ground lightning flashes per year and average flashes per square mile.[7] The top five in each category are in bold print. Florida led the country in number of deaths and average lightning flashes per

[4]Office of Climate, Water, and Weather Services and the National Climatic Data Center. *Lightning Fatalities* series for 2008-2012, accessed online at http://www.weather.gov/os/hazstats.shtml on May 30, 2103.
[5] National Safety Council. *Injury Facts, 2013 Edition,* table - Mortality by Selected External Causes, United States, 2007-2009, p 21.
[6] Lightning Deaths by State" data collected by National Oceanic and Atmospheric Administration and compiled by Ron Holle, Vaisala, In c. Accessed at http://www.lightningsafety.noaa.gov/stats/03-12_deaths_by_state.pdf on May 30 2013.
[7] Vaisala's National Lightning Detection Network® (NLDN®) "Number of Cloud-To-Ground Flashes by State from 1997 to 2012" and "Rank of Cloud-To-Ground Flash Densities by State from 1997 to 2012." Accessed at http://www.lightningsafety.noaa.gov/stats/97-12Flash_DensitybyState.pdf on May 30, 2013.

square mile. Florida ranked second in average total cloud-to ground flashes, and eighth in lightning deaths per million population. Wyoming ranked first in lightning deaths per million population but was below the median for the remainder of the measures. A small number of deaths in states with small populations such as Wyoming can result in unusually high rates of deaths per million population.

Figure 6.
Lightning Fatalities by Activity/Location: 2008-2012



Source: These statistics are compiled by the Office of Services and the National Climatic Data Center from information contained in *Storm Data*. Online at http://www.weather.gov/os/hazstats.shtml.

The top five states for total lightning deaths were Florida, Colorado, Texas, North Carolina, and Georgia. The top five states for lightning deaths per million population were Wyoming, Colorado, Rhode Island, Utah, with two states, Vermont and Montana, tied for the fifth spot. The top five for total cloud-to-ground lightning flashes were Texas, Florida, Oklahoma, Missouri, and Kansas, while the top five for lightning flashes per square mile were Florida, Louisiana, Mississippi, Alabama, and Arkansas.

The average number of acres burned per fire handled by wildland firefighting agencies was nine times higher for fires started by lightning than the average for human-caused fires. On average, 9,000, or 12% of the 74,300 wildland fires reported per year to the National Interagency Coordination Center (NICC) by federal and state wildland firefighting agencies in 2008-2012 were started by lightning.[8] Lightning fires burned an average of 3.6 million acres, or 55%, of the 6.5 million wildland fire acres burned per year during this period. The average lightning-caused wildfire burned 402 acres, nine times the average of 45 acres per-human-caused fire.

[8] National Interagency Fire Center. "Lightning vd. Human Caused Fires and Acres", sourced to the National Interagency Coordination Center, and accessed at http://www.nifc.gov/fireInfo/fireInfo_stats_lightng.html on May 30, 2013.

Firefighter Fatalities Associated with Fires Started by Lightning

From 2003 through 2012, 42 U.S. firefighters, in total, were killed as a result of lightning-caused fires.
NFPA collects data about every firefighter fatality in the US. The statistics in this section are *totals*, not averages, from the ten year period of 2003-2012.

Four of the 42 firefighters fatally injured were killed at structure fires and the other 38 died as the result of 25 wildland fires caused by lightning.[9] At the structure fires, one of the firefighters suffered a fatal heart attack while pulling hose from an engine; one firefighter died as a result of smoke inhalation after falling through the fire-weakened floor into the basement of the structure; one died when the roof collapsed in a church fire; and one suffered a fatal heart attack while directing traffic at a chemical plant fire.

Thirteen firefighters died while responding to or returning from lightning-caused wildland fires: 11 in two helicopter crashes, one in a road vehicle crash, and one of a heart attack. Five firefighters were killed in three aircraft crashes during suppression activities, and two were killed in helicopter crashes while ferrying supplies at wildland fires. Two firefighters died while at wildland fire base camps – one due to a heart attack and the other as a result of a long-term illness. During suppression activities on the ground, seven firefighters suffered fatal burn or smoke inhalation injuries in five fires, four suffered fatal heart attacks, two were struck and killed by falling tree limbs, one fell from a bulldozer when its brakes failed, one died from hypothermia, and one came into contact with a downed power line and was electrocuted.

Helicopter crash killed nine firefighters shuttling from a 2008 wildfire started by lightning. At approximately 7:40 p.m. on an August night in 2008, firefighters were being evacuated, due to deteriorating weather conditions, from a California wildfire that had started when lightning ignited grass and leaves. The helicopter crashed after take-off. The crash resulted in a fire that consumed the aircraft. The incident killed nine firefighters and injured the four other occupants.[10]

1994 Colorado wildland lightning fire claimed the lives of 14 firefighters.
In July 1994, lightning ignited a fire on a steep and rugged mountain ridge between two canyons. The blaze was allowed to burn for two days. As it grew, additional resources were deployed. Four days after ignition, as firefighters were establishing lines on a ridge, a cold front moved through the area, creating winds up to 45 miles per hour. A major blowup occurred, spreading flames at a rate of 18 miles per hour and as high as 200 to 300 feet. The rapid flame spread made escape extremely difficult. The combination of extremely dry fuels, high winds, steep topography and the fact that fire-behavior information wasn't provided to the fire crews, created a hazardous situation. Two of

[9] National Fire Protection Association's Fire Incident Data Organization (firefighter fatality database), accessed May 28, 2013 and analyzed by NFPA's Dr. Rita F. Fahy.
[10] Extracted from two 2009 NFPA reports: Stephen G. Badger's *Catastrophic Multiple Death Fires for 2008,* and NFPA's report *Firefighter Fatalities in the United States –2008,* by Rita F. Fahy, Paul R. LeBlanc and Joseph L. Molis. Both reports used the National Transportation Safety Board's *Aircraft Accident Report: Crash During Takeoff of Carson Helicopters, Inc., Firefighting Helicopter Under Contract to the U.S. Forest Service Sikorsky S-61N, N612AZ Near Weaverville, California, August 5, 2008* (http://www.ntsb.gov/doclib/reports/2010/AAR1006.pdf) as source material about this incident.

the 14 firefighters who died deployed their fire shelters but succumbed to smoke inhalation and heat. The other 12 had no time to open their shelters. [11,]

Additional information on this incident may be found in "The Whole Canyon Blew Up…" by William Baden and Michael Isner, published in the March/April 1995 issue of *NFPA Journal.*

Previously published descriptions of lightning fires show what can happen.
Appendix B contains additional incident descriptions that were previously published in NFPA publications. Some from studies of large loss or catastrophic fires were originally published in a matrix format. These incidents have been extracted into a text format. The incidents shown here tend to be far more serious than average. They are included to show what *can* happen, not what is typical.

Protect Yourself from Lightning

Follow the guidelines below to protect yourself from lightning.

Indoor Safety

- Stay off corded phones, computers, and other electronic equipment that put you in direct contact with electricity or plumbing.
- Avoid washing your hands, showering, bathing, doing laundry, or washing dishes.
- Stay away from windows and doors.

Outdoor Safety

- Seek shelter immediately in a building or a hard-topped vehicle.
- If you are in or on open water, go to land and seek shelter immediately.
- If you cannot get to shelter and you feel your hair stand on end, indicating that lightning is about to strike, squat low to the ground on the balls of your feet. Place your hands over your ears and put your head between your knees. Make yourself the smallest target possible and minimize your contact with the ground. This is a last resort when a building or hard-topped vehicle is not available.

If a person is struck by lightning,

Call 9-1-1 and get medical care immediately. Victims of lightning strikes carry no electrical charge, so attend to them immediately. Administer CPR if needed.

[11] Kenneth J. Tremblay, 1995, "*Catastrophic Fires of 1994," NFPA Journal, September/October*, p. 67,

Table 1.
Lightning Fires Reported to Local Fire Departments, by Type of Fire
2007-2011 Annual Averages

Type of Fire	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Structure fire	5,900	(26%)	9	(100%)	49	(93%)	$413	(92%)
Home structure fire	4,300	(19%)	7	(86%)	40	(76%)	$305	(68%)
Non-home structure fire	1,600	(7%)	1	(14%)	9	(17%)	$108	(24%)
Outdoor or unclassified fire	16,500	(73%)	0	(0%)	1	(2%)	$35	(8%)
Outdoor vegetation fire	14,200	(63%)	0	(0%)	1	(2%)	$19	(4%)
Outdoor rubbish fire	300	(1%)	0	(0%)	0	(0%)	$0	(0%)
Non-rubbish, non-vegetation outside fire or unclassified fire	2,000	(9%)	0	(0%)	0	(0%)	$16	(4%)
Vehicle fire	100	(1%)	0	(0%)	2	(4%)	$2	(0%)
Total	22,600	(100%)	9	(100%)	53	(100%)	$451	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. 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, civilian deaths and injuries are rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage has not been adjusted for inflation. These statistics include a proportional share of fires in which the heat source was undetermined or not reported. Lightning fires were identified by heat source code 73. Sums may not equal due to rounding. Estimates of zero mean that the actual number rounded to zero – it may or may not actually have been zero.

Source: NFIRS and NFPA survey.

Table 2.
Lightning Fires in Non-Home Structures, by Property Use
2007-2011 Annual Averages

Property Use	Fires		Direct Property Damage (in Millions)	
Storage	**820**	**(50%)**	**$28**	**(26%)**
Shed, outside material storage or unclassified storage	610	(37%)	$15	(14%)
Vehicle storage, garage or fire station	130	(8%)	$5	(5%)
Grain or livestock storage	40	(3%)	$2	(2%)
Residential or self-storage warehouse	30	(2%)	$6	(6%)
Other known storage property	10	(0%)	$0	(0%)
Non-home residential	**210**	**(13%)**	**$19**	**(17%)**
Unclassified or unknown-type residential	180	(11%)	$17	(16%)
Hotel or motel	10	(1%)	$1	(1%)
Other defined residential structure	10	(1%)	$1	(0%)
Public assembly	**120**	**(8%)**	**$22**	**(21%)**
Place of worship or funeral property	70	(4%)	$20	(19%)
Eating or drinking establishment	20	(1%)	$1	(1%)
Club	10	(1%)	$0	(0%)
Other known assembly property	20	(1%)	$1	(1%)
Mercantile and Business	**120**	**(7%)**	**$15**	**(14%)**
Office, bank or mail facility	30	(2%)	$5	(4%)
Service station or vehicle sales, service or repair	20	(1%)	$5	(5%)
Grocery or convenience store	20	(1%)	$1	(1%)
Unclassified mercantile or business	10	(1%)	$1	(1%)
Specialty shop	10	(1%)	$1	(1%)
Other known mercantile or office property	20	(2%)	$3	(3%)
Outside or special property	**120**	**(7%)**	**$3**	**(3%)**
Bridge, tunnel, or outbuilding	60	(4%)	$1	(1%)
Open land, beach, or campsite	20	(1%)	$0	(0%)
Highway, street or parking area	20	(1%)	$0	(0%)
Construction site, oil or gas field, pipeline, power line, or industrial plant yard	10	(1%)	$2	(1%)
Unclassified special property	10	(1%)	$0	(0%)
Other known outside or special property	0	(0%)	$0	(0%)

Table 2. (continued)
Lightning Fires in Non-Home Structures, by Property Use
2007-2011 Annual Averages

Property Use	Fires		Direct Property Damage (in Millions)	
Industrial, utility, defense, agriculture, mining	**80**	**(5%)**	**$10**	**(9%)**
Agricultural property	40	(2%)	$2	(2%)
Unclassified or unknown type industrial, utility, defense, agriculture, mining property	20	(1%)	$4	(4%)
Utility or distribution system	10	(1%)	$1	(1%)
Other known industrial, utility, defense, agriculture or mining property	0	(0%)	$2	(2%)
Manufacturing or processing facility	**40**	**(3%)**	**$5**	**(4%)**
Educational	**20**	**(1%)**	**$1**	**(1%)**
Preschool through grade 12	20	(1%)	$1	(1%)
Other known educational property	10	(0%)	$0	(0%)
Health care, detention or correctional facility	**20**	**(1%)**	**$2**	**(2%)**
Nursing home	10	(1%)	$0	(0%)
Other known health care or correctional facility	10	(1%)	$2	(2%)
Unclassified or unknown-property use	**80**	**(5%)**	**$3**	**(3%)**
Total	**1,630**	**(100%)**	**$108**	**(100%)**

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten and direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation. These statistics include a proportional share of fires in which the heat source was undetermined or not reported. Lightning fires were identified by heat source code 73. Sums may not equal due to rounding. Only properties with at least 1% of the incidents are shown.

Source: NFIRS and NFPA survey.

Table 3.
Non-Home Lightning Strikes without Fire
Reported to Local Fire Departments in 2003
by Property Use

Property Use	Incidents	
Outside or special property	**1,130**	**(29%)**
Highway, street or parking area	650	(17%)
Open land, beach or campsite	270	(7%)
Unclassified or unknown-type special property	100	(3%)
Construction site, oil or gas field, pipeline or industrial plant yard	90	(2%)
Non-home residential	**380**	**(10%)**
Unclassified or unknown-type residential	260	(7%)
Hotel or motel	70	(2%)
Dormitory, fraternity, sorority or barracks	30	(1%)
Residential board and care	20	(1%)
Mercantile and business	**380**	**(10%)**
Office, bank or mail facility	150	(4%)
Grocery or convenience store	50	(1%)
Unclassified or unknown-type mercantile or business	50	(1%)
Department store or unclassified general retail	40	(1%)
Service station or vehicle sales, service or repair	30	(1%)
Specialty shop	20	(1%)
Assembly	**260**	**(7%)**
Place of worship or funeral property	110	(3%)
Eating or drinking place	70	(2%)
Industrial, utility, defense, agriculture or mining property	**200**	**(5%)**
Utility or distribution system	120	(3%)
Educational	**150**	**(4%)**
Preschool through grade 12	100	(3%)
Day care	30	(1%)
Institutional	**150**	**(4%)**
Nursing home	70	(2%)
Clinic or doctor's office	30	(1%)
Hospital or hospice	20	(1%)
Storage	**150**	**(4%)**
Vehicle storage, garage or fire station	50	(1%)
Residential or self-storage warehouse	40	(1%)
Unclassified or unknown-type storage property, including outbuildings, sheds, outside material storage areas	40	(1%)

Table 3. (continued)
Non-Home Lightning Strikes without Fire
Reported to Local Fire Departments in 2003,
By Property Use

Property Use	Incidents	
Manufacturing or processing	60	(2%)
Completely unclassified, unreported or unknown-type property use	1,060	(27%)
Total	3,920	(100%)

Note: These are national estimates of incidents reported to U.S. municipal fire departments and so exclude incidents reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Incidents are rounded to the nearest ten. Non-fire lightning strikes were identified by incident type 814. Sums may not equal due to rounding. Only properties with at least 1% of the incidents are shown.

Source: NFIRS and NFPA survey.

Table 4.
Lightning Fires Reported to Local Fire Departments
by Year and Type of Fire: 1980-2011

Year	Home Structure	Non-Home Structure	Total Structure	Vehicle	Outside Vegetation	Outside Rubbish	Outside Non-Vegetation, and Non-Rubbish and Other	Total Outside and Other	Total
1980	8,800	4,600	13,400	100	8,300	100	2,100	10,500	24,000
1981	5,400	2,500	7,900	100	9,900	200	1,800	11,800	19,800
1982	5,300	2,900	8,200	100	9,600	100	2,000	11,800	20,100
1983	5,700	2,600	8,300	100	11,600	100	2,400	14,100	22,500
1984	5,300	2,600	7,900	100	10,600	200	1,800	12,600	20,600
1985	5,500	2,700	8,200	100	12,000	100	1,900	14,000	22,300
1986	6,300	3,000	9,300	100	7,900	200	2,100	10,200	19,600
1987	6,000	2,800	8,900	200	14,200	400	2,300	16,900	25,900
1988	5,300	2,600	7,900	200	15,500	400	2,100	18,000	26,100
1989	6,100	2,600	8,700	200	10,500	300	2,100	12,900	21,800
1990	5,100	2,100	7,200	200	14,400	200	2,200	16,900	24,300
1991	6,000	2,500	8,500	200	16,700	300	2,500	19,400	28,100
1992	5,100	2,000	7,100	100	15,900	200	2,400	18,500	25,700
1993	6,400	2,600	9,000	200	14,200	200	2,300	16,800	26,000
1994	6,500	3,000	9,500	200	24,700	600	3,200	28,500	38,200
1995	5,800	2,200	8,000	100	15,500	200	2,800	18,500	26,600
1996	6,000	2,400	8,400	100	19,100	300	2,700	22,000	30,500
1997	5,600	2,400	8,000	200	16,900	400	2,800	20,200	28,400
1998	6,500	2,900	9,400	200	25,100	500	3,400	29,000	38,600
1999*	3,300	1,400	4,700	100	11,300	0	1,900	13,200	18,000
2000	4,100	2,500	6,600	100	27,000	300	2,800	30,000	36,700
2001	5,500	2,100	7,600	100	21,600	300	3,400	25,300	33,100
2002	5,600	2,400	8,000	100	19,200	100	3,900	23,200	31,400
2003	4,300	1,900	6,200	100	13,600	200	3,700	17,500	23,700
2004	4,300	1,800	6,100	200	12,000	200	3,200	15,400	21,600
2005	4,200	1,700	5,900	100	12,400	200	3,300	15,900	21,900
2006	4,700	2,000	6,600	100	18,200	300	3,700	22,200	29,000
2007	4,400	1,900	6,300	200	15,600	300	3,600	19,500	25,900
2008	4,600	1,700	6,300	100	14,600	200	1,800	16,600	23,000
2009	3,600	1,300	4,900	100	12,400	200	1,700	14,300	19,300
2010	4,100	1,500	5,600	100	10,300	300	1,600	12,300	17,900
2011	4,800	1,800	6,600	100	18,100	300	2,000	20,400	27,100

* Version 5.0 of NFIRS was first introduced in 1999. Estimates from 1999 on are based on data originally collected in NFIRS 5.0. Due to the small portion of fires from 1999 through 2002 collected in NFIRS 5.0, estimates for these years should be viewed with caution.
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. These statistics include a proportional share of fires in which the heat source was undetermined or not reported. Sums may not equal due to rounding.
Source: NFIRS and NFPA survey.

Table 5.
Lightning Deaths and Flashes by State

State	2003-2012 Total Lightning Deaths		2003-2012 Lightning Deaths per Million Population		1997-2012 Average Cloud-to-Ground Flashes per Year		1997-2012 Average Flashes per Square Mile per Year	
Alabama	11	(7)	0.24	(11)	821,365	(9)	**15.9**	**(4)**
Alaska	0	(44)	0.00	(44)	N/A	N/A	N/A	
Arizona	8	(14)	0.14	(22)	643,743	(13)	5.6	(28)
Arkansas	6	(20)	0.21	(13)	799,034	(11)	**15.0**	**(5)**
California	7	(17)	0.02	(42)	84,490	(37)	0.5	(47)
Colorado	**24**	**(2)**	**0.51**	**(2)**	506,131	(19)	4.9	(32)
Connecticut	2	(37)	0.06	(34)	20,599	(46)	4.2	(35)
Delaware	0	(44)	0.00	(44)	15,840	(47)	8.0	(23)
Florida	**52**	**(1)**	0.30	(8)	**1,383,228**	**(2)**	**24.1**	**(1)**
Georgia	**17**	**(5)**	0.19	(16)	797,159	(12)	13.5	(13)
Hawaii	0	(44)	0.00	(44)	N/A	N/A	N/A	
Idaho	1	(40)	0.07	(31)	80,563	(38)	1.0	(46)
Illinois	5	(21)	0.04	(40)	808,047	(10)	14.3	(9)
Indiana	4	(25)	0.06	(34)	504,167	(20)	14.0	(10)
Iowa	3	(25)	0.10	(26)	628,511	(14)	11.1	(15)
Kansas	5	(21)	0.18	(19)	**910,740**	**(5)**	11.1	(15)
Kentucky	8	(14)	0.19	(16)	551,572	(16)	13.8	(12)
Louisiana	9	(12)	0.20	(15)	909,274	(6)	**19.6**	**(2)**
Maine	4	(25)	0.31	(7)	49,254	(40)	1.5	(44)
Maryland	3	(34)	0.05	(39)	88,782	(36)	8.9	(20)
Massachusetts	4	(25)	0.06	(34)	25,351	(43)	3.1	(37)
Michigan	7	(17)	0.07	(31)	297,422	(29)	5.1	(30)
Minnesota	4	(25)	0.08	(30)	384,869	(24)	4.6	(33)
Mississippi	8	(14)	0.28	(9)	866,997	(7)	**18.2**	**(3)**
Missouri	11	(7)	0.19	(16)	**1,026,432**	**(4)**	14.8	(6)
Montana	3	(34)	**0.32**	**(5)**	347,203	(26)	2.4	(42)
Nebraska	1	(40)	0.06	(34)	546,162	(17)	7.1	(24)
Nevada	1	(40)	0.04	(40)	155,780	(35)	1.4	(45)
New Hampshire	0	(44)	0.00	(44)	23,460	(44)	2.5	(41)
New Jersey	13	(6)	0.15	(21)	47,628	(41)	6.2	(27)
New Mexico	3	(34)	0.16	(20)	854,227	(8)	7.0	(25)
New York	4	(25)	0.02	(42)	220,834	(33)	4.6	(33)
North Carolina	**18**	**(4)**	0.21	(13)	528,092	(18)	10.6	(19)
North Dakota	0	(44)	0.00	(44)	291,277	(31)	4.1	(36)
Ohio	11	(7)	0.10	(26)	460,074	(21)	11.1	(15)
Oklahoma	4	(25)	0.11	(24)	**1,034,890**	**(3)**	14.8	(6)

N/A – Not applicable because data was collected for 48 contiguous states, but not Alaska or Hawaii.

Table 5. (continued)
Lightning Deaths and Flashes by State

State	2003-2012 Total Lightning Deaths		2003-2012 Lightning Deaths per Million Population		1997-2012 Average Cloud-to-Ground Flashes per Year		1997-2012 Average Flashes per Square Mile per Year	
Oregon	0	(44)	0.00	(44)	51,954	(39)	0.5	(47)
Pennsylvania	11	(7)	0.09	(28)	317,964	(27)	7.0	(25)
Rhode Island	4	(25)	**0.38**	**(3)**	2,579	(48)	2.4	(42)
South Carolina	10	(11)	0.23	(12)	447,014	(22)	14.4	(8)
South Dakota	2	(37)	0.25	(10)	394,697	(23)	5.1	(30)
Tennessee	7	(17)	0.12	(23)	588,187	(15)	14.0	(10)
Texas	**24**	**(2)**	0.11	(24)	**2,892,486**	**(1)**	10.9	(18)
Utah	9	(12)	**0.35**	**(4)**	242,192	(32)	2.9	(40)
Vermont	2	(37)	**0.32**	**(5)**	28,352	(42)	3.0	(38)
Virginia	5	(21)	0.07	(31)	348,233	(25)	8.7	(21)
Washington	0	(44)	0.00	(44)	21,418	(45)	0.3	(49)
Washington, DC	0	(44)	0.00	(44)	783	(49)	11.5	(14)
West Virginia	1	(40)	0.06	(34)	210,169	(34)	8.7	(21)
Wisconsin	5	(21)	0.09	(28)	299,518	(28)	5.4	(29)
Wyoming	4	(32)	**0.77**	**(1)**	291,409	(30)	3.0	(38)

Note: Top 5 states in each category are in bold
Update sources e-mail
Sources: Lightning Deaths by State" data collected by National Oceanic and Atmospheric Administration and compiled by Ron Holle, Vaisala, Inc.

Vaisala's National Lightning Detection Network® (NLDN®) "Number of Cloud-To-Ground Flashes by State from 1997 to 2012" and "Rank of Cloud-To-Ground Flash Densities by State from 1997 to 2012."

Both are available online at http://www.lightningsafety.noaa.gov/more.htm. Cloud-to-ground flashes were not collected for Alaska and Hawaii. Average cloud-to-ground flashes per year were rounded to the nearest thousand by the author of this study.

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.

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_2012.pdf.

Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are sent to all municipal departments protecting populations of 50,000 or more and a random sample, stratified by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) 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.

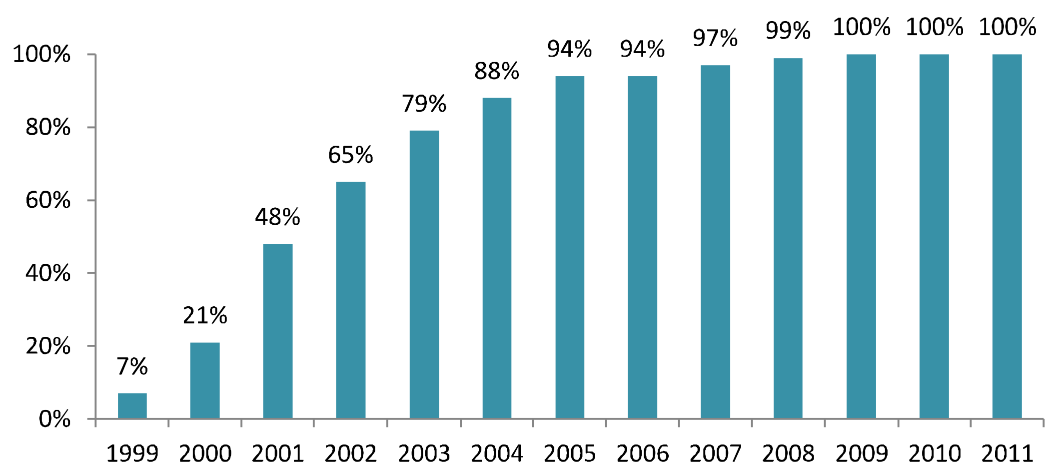
Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific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

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission have developed the specific 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.

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



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

NFPA survey projections
NFIRS totals (Version 5.0)

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

A second option is to omit year estimates for 1999-2001 from year tables.

NFIRS 5.0 has 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. In order for that limited detail to be used to characterize the confined fires, they must be analyzed separately from non-confined fires. Otherwise, the patterns in a factor for the more numerous non-confined fires with factor known will dominate the allocation of the unknown factor fires for both non-confined and confined fires. If the pattern is different for confined fires, which is often the case, that fact will be lost unless analysis is done separately.

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.

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. Values that appear identical may be associated with different percentages, and identical percentages may be associated with slightly different values.

Appendix B.
Selected Published Incidents

The following are selected published incidents involving lightning fires. Included are short articles from the "Firewatch" or "Bi-monthly" columns in *NFPA Journal* or it 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.

Incidents are grouped into the following categories:

- Wildland Fires Started by Lightning
- Home or Residential Fires Started by Lightning
- Non-Residential Fires Started by Lightning, Excluding Church Fires
- Church Fires Started by Lightning

Wildland Fires Started by Lightning

Helicopter crash killed nine firefighters shuttling from a 2008 wildfire started by lightning.
At approximately 7:40 p.m. on an August night in 2008, firefighters were being evacuated, due to deteriorating weather conditions, from a California wildfire that had started when lightning ignited grass and leaves. The helicopter crashed after take-off. The crash resulted in a fire that consumed the aircraft. The incident killed nine firefighters and injured the four other occupants.

[1] Extracted from two 2009 NFPA reports: Stephen G. Badger's *Catastrophic Multiple Death Fires for 2008,* and NFPA's report *Firefighter Fatalities in the United States –2008,* by Rita F. Fahy, Paul R. LeBlanc and Joseph L. Molis. Both reports used the National Transportation Safety Board's *Aircraft Accident Report: Crash During Takeoff of Carson Helicopters, Inc., Firefighting Helicopter Under Contract to the U.S. Forest Service Sikorsky S-61N, N612AZ Near Weaverville, California, August 5, 2008* (http://www.ntsb.gov/doclib/reports/2010/AAR1006.pdf) as source material about this incident.

Wildland fire's rapid spread kills two firefighters
On July 22, the third day of a wildland fire, two temporary forest technicians, ages 22 and 24, rappelled onto a rugged ridgeline above the fire to clear a helispot. The fire, ignited by a lightning strike, had grown from three acres (1.2 hectares) to 5,000 acres (2023 hectares). The technicians were clearing the helispot by cutting down trees with chain saws. Two helicopters assigned to the fire ferried firefighters to a helispot on the opposite side of the fire and made water drops.

At midday, a spot fire was reported developing a half-mile downhill from the area being cleared by the two technicians. The temperature was 91 ° F (33 ° C) with humidity at 18 percent and 6 mph (10 kph) winds. Firefighters working on the fire were pulled back from the fire line due to the increase in fire intensity.

Weather conditions changed and winds were gusting from 15 to 30 mph (24 to 48 kph). The technicians contacted the hell-base and asked to be picked up, stating that their location was getting very smoky. Before the arrival of the helicopter they sent another radio message stating, "Send them in a hurry" When the helicopter arrived, fire conditions didn't permit the pilot to land. A pilot in a spotter plane observed tall flames approaching the area where the helispot was being cleared. The fire overran the technicians' position in the next few minutes.

The fire continued to burn for the rest of the afternoon. Later in the day, two firefighters rappelled into the area to find the technicians. Guided by aerial observation from a helicopter the two firefighters found the bodies of the two technicians. The technicians had started to deploy their fire shelters, but were overrun by the rapid flame spread before the shelters were fully deployed.

Rita F. Fahy and Paul R. LeBlanc, 2004, "Firefighter Fatalities I the United States 2003", *NFPA Journal*, July/August, 57.

Lightning caused large loss wildland fire in Montana, 2000
A July 2000 wildland fire in Montana national forest caused an estimated $16,258,725 in direct property damage. Lightning started the fire, which burned through 61,000 acres (roughly 25,000 hectares) of Ponderosa pine and conifers. The fuel moistures were low, the winds were strong, and the topography made the fire hard to reach. Multiple lightning strikes stretched resources thin. Timber loss was reported to be $16,153,725, structural losses amounted to $100,000, and there was $5,000 in vehicle losses.

Stephen G. Badger, 2001, "Large-Loss Fires of 2000," *NFPA Journal,* November/December, 64.

Large loss wildland fire in California grew from four fires started by ligthning, 1999
An October 1999 California wildland fire burned 140,000 acres and caused $121,365,000 in direct property damage. Lightning ignited four fires that burned into one, burning timber and recreation lands. One civilian camp worker died of a heart attack as a result of this fire and one firefighter was injured. Inaccessible areas, wilderness with limited access, and steep terrain made getting to the fire difficult. Resources were limited because of other fires burning in the state.

Stephen G. Badger and Thomas Johnson, 2000, "1999 Large-Loss Fires and Explosions," *NFPA Journal,* November/December, 94.

Fourteen firefighters were killed by Colorado wildland fire started by lightning, 1994
In July 1994, lightning ignited a fire on a steep and rugged mountain ridge between two canyons. The fuel was initially pinyon-jumper, but the fire spread to grambel oak. The blaze was allowed to burn for two days. As it grew, additional resources were deployed. Four days after ignition, as firefighters were establishing lines on a ridge, a cold front moved through the area, creating winds up to 45 mph. A major blowup occurred, spreading flames at a rate of 18mph and as high as 200 to 300 feet. The rapid flame spread made escape extremely difficult.

The combination of extremely dry fuels, high winds, steep topography and the fact that fire-behavior information wasn't provided to the fire crews, created a hazardous situation. Several aspects of incident management were identified as casual factors, including lack of proper escape routes and safety zones, inability to adjust strategy and tactics, compromise of standard firefighting orders, and Watch Out situations, and improper briefings. Personal protective equipment performed within design limitations, but those limits were exceeded by wind turbulence and the intensity and rapid advance of the fire. Two of the 14 firefighters who died deployed their fire shelters but succumbed to smoke inhalation and heat. The other 12 had no time to open their shelters.

Additional information on this incident may be found in "The Whole Canyon Blew Up…" by William Baden and Michael Isner, published in the March/April 1995 issue of *NFPA Journal.*

Kenneth J. Tremblay, 1995, "Catastrophic Fires of 1994," *NFPA Journal,* September/October, 67.

Washington WUI complex fire included some started by lightning, 1994
In July 1994, a Washington state wildland/urban interface complex included at least six major fires. The fire was reported at 7:24 p.m. A total of 41,000 acres were burned, 19 homes and 18 outbuildings were destroyed, and 2 homes and 3 outbuildings were damaged. Losses were estimated at $37,700,000.

A fire lookout spotted 18 lightning strikes during a dry thunderstorm that ignited downed timber, brush, and grass. One human-caused fire also contributed to this complex. The fire spread rapidly through heavy Ponderosa pine and Douglas fir. Up-canyon winds ventilated the blaze, and it overran the fire lines. One fire developed into a crown fire and destroyed several homes in the canyon. These fires burned for more than a month, although the main spread and most activity occurred in the first 3 weeks. Dry weather, low moisture, limited access, and steep terrain contributed to this complex.

Stephen G. Badger and Rita F, Fahy, 1995, "Billion Dollar Drop in Large-Loss Property Fires," *NFPA Journal,* November/December, 98.

Firefighter dies in Washington WUI fire started by lightning in national forest, 1994
A July 1994 Washington wildland/urban interface fire was started by lightning during a thunderstorm in a national forest. The fire was reported at 3:30 p.m. Fire spread to structures, private land, and state-protected-land. This lightning-caused fire occurred in an area full of logging debris, dead trees, and 20-foot reproduction from a fire more than 20 years before. Weather and fuel conditions contributed to the fire. Burning material fell down steep slopes, starting fires below. One firefighter suffered a fatal heart attack in the staging area. Approximately 140,000 acres burned. Direct property damage was estimated at $39,500,000.

Stephen G. Badger and Rita F, Fahy, 1995, "Billion Dollar Drop in Large-Loss Property Fires," *NFPA Journal,* November/December, 111.

Wildfire destroys $1.8 million in timber, Florida
Wildfire destroyed more than 2,000 acres of timber and pulpwood when lightning ignited underbrush and the duff layer, the finely divided combustible organic material on the forest floor. The fire smoldered for some time before erupting in flames the following day. Hot, dry conditions and a heavy fuel load contributed to the fire's spread.

At 1:01 p.m., personnel at a fire tower detected the fire and within 2 minutes notified the forestry division by radio. Firefighting efforts were delayed about 1 hour because of the fire's remote location. Swampy terrain and combustible muck complicated extinguishment by making control lines difficult to establish.

Officials believe that a lightning strike was the most likely ignition source and that the fire smoldered for a day before it was detected by the lookout. Once it was burning freely, the fire spread through available fuels, destroying 2,200 acres of timber.

Extinguished 11 days after operations began, the fire destroyed an estimated $1.8 million of commercial timber. No injuries were reported.

Kenneth J. Tremblay, 1993, "Firewatch," *NFPA Journal,* May/June, 36.

Arizona, 1990

In June 1990, an Arizona wildland/urban interface fire was reported by a U.S. Forest Service reconnaissance aircraft at 12:30 p.m. A lightning strike ignited a decaying tree in a national forest with standing timber without logging operations. Flames spread to nearby dry brush and grass. The fire spread rapidly because of low humidity and dry conditions. It continued to burn for 5 days. High temperatures, low humidity, and dry fuel conditions contributed to the rapid fire spread. Steep slopes and rough terrain hampered firefighting efforts.

The fire destroyed 53 homes and more than 28,000 acres of valuable timber before it was brought under control. Six firefighters were killed and five were injured. Direct property damage was estimated at $10,596,200.

Kenneth T. Taylor and Michael J. Sullivan, 1991, "Large-Loss Fires in the United States in 1990," *NFPA Journal,* November/December, 78.

Home or Residential Fires Started by Lightning

Sprinkler controls apartment building lightning fire, Connecticut

One sprinkler controlled a fire in a 39-unit apartment building for older adults that began when a bolt of lightning struck the building during a summer storm, igniting the roof and attic.

The apartments occupied four floors of the wood-frame building, which also contained a fifth half-story, with a maintenance office built into part of the attic. The building, which was 150 feet (46 meters) long and 72 feet (22 meters) wide, had a brick exterior and a flat roof covered with a rubber membrane. Local smoke alarms were installed in each unit, and a fire detection and alarm system protected the common areas. The alarm system was monitored by a central station alarm company, which also monitored the complete-coverage wet-pipe sprinkler system.

Just after midnight, a fourth-floor resident was awakened by a large bang and saw sparks coming from the roof. Shortly afterward, the sprinkler tripped the water flow alarm, alerting the monitoring company, which notified the fire department at 12:17 a.m. On arrival two minutes later, firefighters discovered that the roof was on fire and called for additional support. With the help of aerial apparatus lines, fire crews used a hose line to extinguish the remaining fire.

Investigators determined that the lightning entered the attic and ignited several wooden roof joists, which burned until a sprinkler protecting the space activated and controlled the fire. Water damaged the units below the fire, but the building, valued at $4 million, sustained only $500,000 in damage. There were no injuries.

Ken Tremblay, 2010, "Firewatch", *NFPA Journal*, July/August, 30-31.

Lightning strike ignites siding, Connecticut
A building containing eight townhouses was struck by lightning, which damaged its cedar wall siding and started a fire in the concealed chimney space that soon spread to the building's wall and ceiling voids. The two-and-a-half story, wood-framed building, which was 120 feet long (36 meters) and 30 feet (9 meters) wide, had an asphalt shingle roof. It had no smoke detectors or sprinklers, although firewalls divided the attic space. All units were occupied at the time of the early-morning fire.
At 2:01 a.m., approximately 15 minutes after he saw a brilliant flash of light and heard a "horrific" clash of thunder, a resident discovered the fire and called 911. Responding firefighters found the exterior of the building in flames and, with the help of the police, evacuated the building's occupants. They then used a 1 3/4-inch hose line to extinguish the exterior fire and advanced a second hose line into the first floor of the end unit, where they opened the ceiling and walls to stop the fire spread. A third hose line was stretched to the second floor. The fire reached the attic before firefighters finally extinguished it. Damage to the building, valued at $560,000, was estimated at $20,000, while damage to the contents came to $6,000. No one was injured.

Kenneth J. Tremblay, 2003, "Firewatch," *NFPA Journal,* May/June, 16.

Lightning strikes occupied dwelling, ignites fire, Massachusetts
A newly constructed, single-family dwelling located on a hill suffered severe fire damage when lightning struck its roof peak. The lightning was part of a squall line that passed through the area, causing numerous lightning strikes and simultaneous alarms for firefighters.

The two-and-a-half-story dwelling of unprotected, wood-frame construction contained a hardwired smoke detection system on every level, including the basement. It had no sprinklers.

A man and his two young children were at home when they heard a violent explosion. The father went outside with his son to investigate and noticed that the roof peak, clapboards, moldings, and an attic window had been damaged and that debris was strewn between 15 to 50 feet from the house. He then heard smoke detectors operating inside and re-entered the house. Smelling smoke, the father grabbed his other child, who was 9 months old, and the three of them escaped to a neighbor's home and called 911.

Firefighters responding to other calls in the area arrived within two minutes of the alarm and found heavy, black smoke issuing from the roof and fire showing from two rear, second-floor windows. Fire companies established a water supply and advanced two hose lines inside to try to reach the attic. They were able to control flames on the second floor, but intense fire conditions kept them from reaching the attic, which was fully engulfed.

Ladder crews ventilated windows in the attic and the second floor, but deteriorating conditions prevented them from opening up the roof. Seeing that an interior attack was impossible, the incident commander pulled firefighters from the dwelling and set up a defensive attack using ladder pipes and additional handlines to darken the fire. Once the fire had burned away the roof, crews entered the dwelling and extinguished the remaining fire on the second floor.

The temperature outside the house reached 88°F while firefighters were fighting the blaze. This oppressive heat, combined with an extremely high dew point and the fact that the dwelling was located high on a hill and engines had to be parked at a distance, quickly fatigued firefighters. Multiple alarms were struck to bring additional resources to the scene, including emergency medical technicians, paramedics, a doctor, and a nurse who formed a rehabilitation area. One firefighter suffered from heat exhaustion, and another sustained burns to the back of his neck.

Fire damage was limited to two second-floor bedrooms and the entire attic and roof. The first floor sustained heavy smoke and water damage. Damage to the home, valued at $750,000, and its contents, valued at $100,000, was estimated at $300,000.

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

Non-Residential Fires (except Churches) Started by Lightning

Lightning strike destroys unprotected barn, Ohio

Firefighters facing a fully involved fire spreading from a barn to nearby buildings during a thunderstorm had to use relays to supply water 3,000 feet (914 meters) away from the barn.

The single-story, wood-frame barn, which was 520 feet (158 meters) long and 50 feet (15 meters) wide, had a metal-covered roof and metal walls. It had no fire detection or suppression systems.

A series of thunderstorms was passing through the area at the time of the fire, and at least two lightning strikes hit the farm buildings. Up to seven lightning strikes were documented at or near the property some 30 minutes before the fire alarm was called at 10:49 p.m.

Based on multiple reports of fire, firefighters struck a second and third alarm before they arrived nine minutes later to find one barn completely engulfed in flames, with its roof collapsing. As the fire threatened other buildings nearby, the incident commander ordered hose lines to protect exposures, and six fire engines were set up to relay water to the fire. As the heavy rain poured down and lightning continued to strike, 16 tankers and 18 fire departments worked together to prevent the fire from spreading further.

The barn, in which the farmer stored farm equipment, straw, hay, and recreational equipment totaling $2.5 million, was valued at $100,000. Both the barn and its contents were destroyed. There were no injuries.

Kenneth J. Tremblay, 2011, "Firewatch," NFPA Journal, November/December, 23.

Lightning causes $25 million fire in manufacturing plant, Arkansas

At 4:43 a.m. on a July morning, the fire department was notified of a fire in a one-story machinery parts manufacturing plant that covered 250,000 square feet (23,226 square meters). No one was at the site when the fire broke out. Neither automatic detection nor suppression equipment was present.

Lightning had struck a roof vent and started a fire in the storage area. A security guard in a nearby facility detected the fire nearly 3½ hours after the lightning strike and called the fire department to report smoke in the area. By the time firefighters arrived, the factory was heavily involved in flames. The delayed discovery, as well as the high-rack storage, made fighting the blaze difficult. Damage to the structure was estimated at $15 million, and damage to its contents was estimated at $10 million. The large monetary loss was due to a large number of machines and a warehouse full of finished product.

Adapted from Stephen G. Badger's 2010 report, *" Large-Loss Fires in the United States in 2009", NFPA* Fire Analysis and Research, Quincy, MA.

Vacant hospital fire causes $60 million in direct property damage, New York
A New York fire in a vacant, six-story, historic psychiatric hospital made of unprotected, ordinary construction was reported at 7:32 p.m. on a May 2007 evening. No one was in the building at the time of the fire. No automatic detection or suppression equipment was present. This fire started when lightning struck the building during a thunderstorm. Firefighters were faced with a rapidly spreading fire and approximately 26 exposed buildings, many of which were interconnected. The yard hydrant system had been shut down years earlier, forcing firefighters to locate hydrants a distance away. The fire caused $60,000,000 in direct property damage.

Adapted from Stephen G. Badger's "Large-Loss Fires in the United States in 2007," NFPA Fire Analysis and Research, Quincy, MA, 2008

Twelve killed in coal mine fire, West Virginia, 2006
A West Virginia, January 2006 fire in an underground coal mine approximately two miles (3.2 kilometers) in from the mine entrance claimed 12 lives. Methane gas was ignited by a lightning strike that occurred a distance from the mine and followed a cable into the mine. The fire was reported at 6:26 a.m. The explosion killed one miner and a collapse forced the other 12 miners to retreat and await rescue behind a barricade curtain they built. Rescuers located one survivor and the bodies of the other 11 miners approximately 41 hours after the explosion.

Stephen G. Badger, 2007, "Catastrophic Multiple-Death Fires for 2006," NFPA, Fire Analysis and Research, Quincy, MA.

Refinery storage tank fire was started by lightning, Minnesota, 2004
In July 2004, lightning struck the top of a 120,000-gallon slurry oil storage tank in an operating Minnesota refinery. The top of the tank lifted off and oil ignited. The fire melted part of the side of the tank and some product escaped. The incident was reported at 5:50 a.m. Direct property damage was estimated at $8,000,000.

Stephen G. Badger, 2005, "Large-Loss Fires in the United States-2004," *NFPA Journal,* November/December, 47.

Underground storage tank explodes, South Carolina
Lightning struck the vent pipe of a 10,000-gallon (37,853-1iter) underground tank once used to store gasoline, igniting the residual gas vapors and triggering an explosion so powerful that it lifted a 15-by-30-foot (4.5-by-9-meter) section of concrete over the tank 10 feet (3 meters) in the air. An 18-by-18-inch (46-by-46-centimeter) steel plate covering a submersible pump and a leak detection monitor were also blown about 125 feet (38 meters) into the air, landing 70 feet (21 meters) from the concrete pad covering the tank.

The privately owned fueling station's pumps and electricity had been disconnected, and the contents of the single-wall fiberglass tank had been pumped out to within an inch (3 centimeters) of the bottom.

At about 7 p.m., witnesses reported that a squall line passed through the area, followed by a brilliant flash and a large explosion. Shortly after the explosion, they saw black smoke coming from the tank's fill port. One witness called the fire department at 7:04 p.m.

Responding firefighters taped off the area and confirmed that the dispenser's power had been disconnected and tagged correctly. Investigators interviewed the witnesses and confirmed that a single lightning strike caused the blast.

The fueling station's owners had complied with temporary closure requirements. However, a report produced by a private investigation company notes, "The fact that the UST [underground storage tank] was empty increased the likelihood that the tank environment would have been in the combustible range. Had the tank held fuel, it is very likely the tank atmosphere would have been above the upper explosive limit indicating the atmosphere was too rich for combustion." Experts believe that purging tanks with nitrogen or carbon dioxide would cause them to remain inert and eliminate the risk of a similar explosion. Property damage was estimated at $13,000.

Kenneth J. Tremblay, 2005, "Firewatch," *NFPA Journal,* May/June, 32.

College building fire started by lightning, Tennessee, 1999

In May 1999, lightning struck the roof eaves near the chimney of this Tennessee college campus four-story business office and student center. The resulting fire spread rapidly through the upper floors and attic. At the time of the fire, the offices were closed. The structure was made of protected ordinary construction and covered a ground-floor area of 10,000 square feet (929 square meters). The building had no automatic detection or suppression systems. The structure was more than 100 years old. The wood was very dry and allowed rapid fire spread.

The fire was reported at 6:19 p.m. Firefighters were able to stop the downward spread and protect the first two floors. No injuries were reported. Direct property damage was estimated at $6,050,000.

Stephen G. Badger and Thomas Johnson, 2000, "1999 Large-Loss Fires and Explosions," *NFPA Journal,* November/December, 92.

Lightning started $6 million fire, Indiana, 1999

In April 1999, lightning hit a one-story Indiana store of unprotected wood-frame construction, starting a fire that spread rapidly in the unprotected open attic space. Open construction in the attic allowed for rapid fire spread. The store, located in a mini strip mall with four to five other businesses, covered a ground-floor area of 19,500 square feet (1,812 square meters). It was closed for the night when the 3:57 a.m. incident was reported. Direct property damage was estimated at $6,000,000.

Stephen G. Badger and Thomas Johnson, 2000, "1999 Large-Loss Fires and Explosions," *NFPA Journal,* November/December, 92.

Lightning causes warehouse fire, Indiana ,1997

In March 1997, an Indiana fire began when lightning struck a metal structure on the roof of the warehouse. No information was available on fire spread, but it's estimated to have burned for two hours before an automatic detection system in an adjacent building activated. The fire was reported at 5:31 a.m. The warehouse itself, made of unprotected, ordinary construction with a ground-floor area of 300,000 square feet (28,000 square meters), had no automatic detection or suppression systems. The building, which was 20 feet (6 meters) high, was closed when the fire broke out. Direct property damage was estimated at $7,000,000. No injuries were reported.

Stephen G. Badger, 1998, "1997 Large-Loss Fires and Explosions," *NFPA Journal,* November/December, 88.

Two firefighter fatalities at oil storage tank fire in Oklahoma

A burning crude oil storage tank in Oklahoma boiled over, sending a river of burning petroleum down a recessed dirt road, where it overtook two members of a U.S. Air Force aircraft crash/rescue crew. Both crewmen, a 34-year-old career firefighter and his 20-year-old partner, died of severe burns while trying to escape.

The storage tank was one of four used for blending and storing heavy and light sweet crude, which is then pumped into a pipeline for distribution to refineries. The tank was struck by lightning at approximately 4:00 p.m., and several area volunteer fire departments responded to the scene. When they arrived, firefighters noted that the cone-shaped roof of the steel-riveted, 55,000-gallon tank had been blown off and landed in the overflow dike that surrounded the tank, which was located on top of a ridge. The only water supply was a pond about 2,000 feet from the tanks down a recessed dirt road.

During the afternoon and into the early evening, firefighting was limited to containing the grass fires that occurred around the overflow dike. At 7:30 p.m., fire officials called a U.S. Air Force base approximately 50 miles away and requested help in extinguishing the fire. The base dispatched a 1,000-gallon foam trailer with four firefighters in a utility vehicle at 9:30 p.m. The firefighters arrived on the scene about an hour later. After determining there wasn't enough water for firefighting, the crew decided not to attempt any further operations.

An aircraft crash/rescue vehicle was requested at 11:00 p.m., bringing two more firefighters to the scene. Before this unit arrived, however, the burning crude oil slopped over the top of the tank into the dike, and some of the burning oil escaped. Firefighters mixed foam concentrate into the apparatus' water tanks and were able to control the fire outside the dike. When the crash unit arrived, it took a position on the road approximately 600 feet from the burning tank.

At 1:05 a.m., while firefighters were planning their attack, the burning crude oil boiled over the top of the tank into the dike and overflowed, creating two rivers of burning crude. One river moved down the road, threatening everything in its path. To give the rest of the firefighters, with their equipment, and an oil company pump house operator time to escape the fire's path, the crash unit moved up the road and began attacking the blaze. However, the crash unit crew quickly realized that it couldn't contain the fire and began to back down the road. When the unit went off the side of the road and got stuck in the mud, both firefighters jumped from the apparatus and tried to outrun the fast-moving flames. They were completely engulfed within 25 feet of their truck and died at the scene.

The burning crude continued to travel downhill and into a creek, where it was finally extinguished, and the burning oil in the storage tank was allowed to burn out. The remaining exposed tanks, while threatened, weren't damaged.

Arthur E. Washburn, Paul R. LeBlanc, and Rita F. Fahy, 1996, "1995 Firefighter Fatalities," *NFPA Journal*, July/August, 76-77.

Lightning sparks fire in historic mansion, causes $1.5 million loss, Pennsylvania
A mansion that was an historical landmark was severely damaged during an electrical storm when lightning struck its roof.

The city-owned mansion contained priceless 18th century antiques and was used for exhibitions and tours. The three-story building measured 45 feet by 60 feet and was of stone and stucco construction with wood structural members. It had a raised-seam tin roof. The building contained heat and smoke detectors and a burglar alarm system, which were supervised by a central station alarm company. It did not contain any sprinklers.

The mansion was closed and unoccupied around 8:00 p.m. when the caretaker, who lived in a nearby cottage, saw a large flash of light. He looked outside toward the mansion, but detected nothing unusual. A short time later, however, the property's alarm activated. The caretaker walked around the mansion before he called the security company. Someone there advised him to check inside the mansion because most of their security officers were investigating numerous other alarm activations that had been caused by the storm. The caretaker did not have access to the mansion, so he waited for the alarm to reset. While waiting, he saw smoke coming from the chimney and cornice and called 911 at 9:03 p.m.

Fire investigators determined that lightning had struck the mansion and ignited a fire in the cockloft. The fire spread from the attic and roof to two rooms and a second-floor stairway. Unobstructed horizontal openings in the cockloft allowed the blaze to spread rapidly in the early stages.

Damage to the property was conservatively estimated at $1.5 million.

Kenneth J. Tremblay, 1994, "Firewatch," *NFPA Journal,* July/August, 31.

Lightning started fire in ,ulti-use university building, Kansas, 1991

In June 1991, lightning struck and ignited the roof of the auditorium in a multi-use building at a Kansas university. The fire then spread into the concealed ceiling space of the building. The steel truss roof framing failed and collapsed, spreading burning debris to floors below, and forcing the firefighters out of the building.

The single-story building, measuring 150 feet by 150 feet, had a 160-foot ceiling. The walls were brick, the floor was masonry, and the roof framing was wood with steel trusses. The structure contained an auditorium, lecture hall, offices and storage. There was no automatic detection, suppression equipment or lightning protection present. The building was closed at the time of the fire. A passerby discovered the fire and reported it to 911 by emergency telephone at 3:20 p.m. Because of this incident and another unrelated fire that occurred simultaneously, the fire department recalled off-duty personnel and requested mutual aid. Forty minutes elapsed before firefighting personnel had enough additional support to fight the fire effectively.

Direct property damage was estimated at $12,870,000.

John R. Hall, Kenneth T. Taylor and Michael J. Sullivan, 1992, "Large-Loss Fires in the United States in 1991," *NFPA Journal,* November/December, 78.

Church Fires Started by Lightning

Lightning ignites church, Texas

A motorist driving by a church during an intense thunderstorm noticed flames coming from the roof above the sanctuary and called the fire department at 12:46 a.m. Despite firefighters' efforts, the blaze quickly engulfed the church, whose roof collapsed.

The one-story, wood-framed building, which measured 100 feet (30 meters) by 40 feet (12 meters), had brick-veneer exterior walls. It had no fire detection or suppression system.

Firefighters arrived seven minutes after the 911 call to find flames coming from the roof above the sanctuary. They entered the burning building to fight the fire from inside, but the incident commander ordered them out in just five minutes just before the roof collapsed.

Investigators determined that the fire started in the attic and quickly spread to other areas of the church. After eliminating other sources of ignition, they determined lightning was responsible for the blaze.

Building losses were estimated at $600,000.

Kenneth J. Tremblay, 2004, "Firewatch," *NFPA Journal,* May/June, 22.

Lightning strikes start church fire, Florida

A church sustained $1.3 million in structural damage after lightning struck the building in two places, igniting it and causing a power surge through the electrical wiring. These events led to numerous points of ignition in the attic and a second ignition at a corner of the second-floor day school area.

The 51-year-old, two-story church had concrete-and-block walls, wood roof trusses, and a slate roof. It was 122 feet (d37 meters) long and 80 feet (24 meters) wide, and contained a workshop and a day care center. Only the day care center had a fire detection system, which operated after firefighters began suppression activities. There were no sprinklers.

Nearby lightning strikes caused a massive power surge in the building's electrical system and first-floor main power room, causing all the wiring and fuses in one of three main circuit breaker boxes to melt. The surge continued through the building's internal wiring and arced at several points in the electrical distribution system. A second, more direct, lightning bolt struck a second-floor corner of the building, causing the roof overhang to smolder. The current also spread through and out of the conduit, igniting several areas of wood truss in the attic.

A passerby called 911 at 1:12 a.m. The building, valued at $3 million, sustained an estimated $1.3 million in damage. Contents, valued at $500,000, sustained an estimated $250,000 in losses. A National Weather Service Doppler radar map showed 500 lightning strikes within one-half mile (0.8 kilometers) of the church during the storm.

Kenneth J. Tremblay, 2002, "Firewatch," *NFPA Journal,* May/June, 34.

Lightning damages historic church, Iowa

A fire destroyed a historic church when lightning struck its steeple and ignited wood shingles and structural framing. Winds of more than 40 miles (65 kilometers) per hour helped fan the flames.

The single-story, wood-frame structure measured 40 by 30 feet (12 by 9 meters) and had no sprinklers or automatic detection systems. Located in a restored historic district along with a school and a barn, the church was a popular tourist attraction.

Storms had been passing through the area for about an hour, dumping more than an inch of rain, when a farmer noticed a light coming from the historic district. He drove toward the light until he saw flames coming from the church steeple. He then drove to a neighbor's house and called the county sheriff's office at 7:07 a.m. The sheriff's office notified the fire department, and firefighters arrived within five minutes to find that the fire had already engulfed the steeple and spread to the roof and attic. The ceiling was collapsing, and the wind was blowing sparks around, threatening exposures.

The first-arriving engine company attacked the fire and summoned additional units for water because there weren't any hydrants in the area. A second pumper arrived and began to wet down the wood-shake shingles of a nearby barn and provide a water curtain to keep sparks from igniting exposures.

Additional units set up dump tanks and began to shuttle water to the site.

Firefighters maintained a defensive attack as flames engulfed the church. Despite the high winds that intensified the fire, firefighters were able to protect the exposures.
The church, valued at $45,000, and its contents, valued at $20,000, were destroyed. More important, however, the local fire chief said, "we have lost a piece of our history."

Kenneth J. Tremblay, 1999, "Firewatch," *NFPA Journal,* May/June, 43-44.

Lightning started fire in church steeple, Virginia, 1994
In July, 1994, lightning struck the steeple of a two-story church made of heavy timber construction. It traveled along the ridge of the metal roof, igniting combustible rafters. Within minutes, smoke was billowing from the roof and steeple. The fire department was notified by a 911 call at 6:04 p.m. The church had a ground-floor area of 20,000 square feet and a steeple 200 feet high. The church wasn't occupied at the time of the fire.

The structure had no automatic fire detection system. There were no sprinklers in the church itself, but there was a partial system of an unreported type in a classroom. Fusible-link fire doors did activate.

When firefighters arrived, they found heavy smoke and fire pouring from the roof. Crews made an aggressive attack, but were driven back when the roof collapsed. The presence of large, open areas contributed to fire spread. The fire involved hard-to-reach areas in the church. The sanctuary was destroyed, but the classrooms were saved. Direct property damage was estimated at $7,700,000. Three firefighters were injured.

Stephen G. Badger and Rita F, Fahy, 1995, "Billion Dollar Drop in Large-Loss Property Fires," *NFPA Journal,* November/December, 98.