Madani, Mo

From: Joseph Garrity <jgarrity@garritytraina.com>
Sent: Friday, August 02, 2019 4:59 PM
To: Madani, Mo
Cc: Joseph Garrity; C.C. Traina
Subject: Pull Off Request PROPOSED AMENDMENT SP8038
Attachments: Proposed Amenment Pull Off Request.pdf; ossprinklers.pdf

Dear Mr. Madani:

Please see the attached documents. Should you have any questions please do not hesitate to call me.

Thanks,

Joseph D. Garrity, Esq.
Founding Partner
GARRITY TRAINA
www.GarrityTraina.com
5485 Wiles Road, Unit 404
Coconut Creek, Fl 33073
Office: (954) 753-6666
Cell: (954) 821-7204

August 2, 2019

REQUEST THAT PROPOSED AMENDMENT SP8038
BE PULLED OFF AND PLACED ON THE CONSENT 2 CALENDAR

Submitted to:
Mo Madani
Florida Building Code: Technical Unit Manager
mo.madani@myfloridalicense.com

Dear Mr. Madani:

The TAC for Special Occupancy made a No Affirmative Recommendation regarding the above referenced proposed Amendment SP8038. This is a request for proposed Amendment SP8038 to the Florida Building Code to be Pulled Off and placed on the Consent 2 calendar as there was a comment received regarding the Amendment. The Amendment reads:

> 453.27.3 Construction type. All new relocatables constructed, purchased or otherwise acquired by a board shall be noncombustible Type I, II, or IV construction, or Type V Construction if fully protected by a NFPA 13 Fire Sprinkler System and is (a) constructed of material not susceptible to decay and termite damage or (b) is fully compliant with all sections of Florida Building Code regarding protection against decay and termites related to material and construction methods used.

In support of allowing proposed Amendment SP8038 petitioner request the Commission look first to intent of the code, which is to establish minimum standards, as evidence in:

> [A]101.3 Intent.
> The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, public health and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

The inclusion of Type V Construction broadens the minimum requirements of the existing code. However, it does so while providing a reasonable level of safety to life and property from fire and other hazards attributable to the built environment. The proposed amendment falls well with the minimum requirements contained in the intent established by the Code. Indeed, it is the type of amendment that the Florida Building Code is intended to provide for as evidence above.

In addition, Amendments to the Florida Building Code should be considered in like manner as all technical amendments are considered to the code, namely:

> (9)(a) The commission may approve technical amendments to the Florida Building Code once each year for statewide or regional application upon a finding that the amendment:
> 1. Is needed in order to accommodate the specific needs of this state.

2. Has a reasonable and substantial connection with the health, safety, and welfare of the general public.
3. Strengthens or improves the Florida Building Code, or in the case of innovation or new technology, will provide equivalent or better products or methods or systems of construction.
4. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.
5. Does not degrade the effectiveness of the Florida Building Code.

The proposed amendment in this case meets all the criteria in section (9)(a) that should be considered in allowing an amendment as further discussed herein below.

1. Is needed in order to accommodate the specific needs of this state.

The proposed amendment accommodates the specific needs of this state. The amendment was born out of necessity. The Type V Construction, that provides both fire and decay resistance, is far more rapidly deployable than Type I, II, or IV. However, for Type V Construction to be used for relocatables in the State of Florida currently the deploying parties must seek discretionary waivers on a case by case basis by local officials. This process is time consuming and needless given the safeguards contained in proposed Amendment SP8038

This time-consuming effort was exemplified in a recent deployment of a Type V structures used as a relocatable on the campus of the Marjory Stoneman Douglas High School Campus. After the events of February 14, 2018, the school lost the use of the scene of the crime, Building 12. The school was left with significant needs regarding space that were immediate. The Type V Construction contemplated in proposed Amendment SP8038 would have easily meet the needs of the school.

However, the District was unable to deploy any type of relocatable structures in an immediate fashion because there was no option in the Florida Building Code to utilize rapidly deployable Type V Construction contemplated in this proposed amendment. The relocatables were not deployed until the start of the new school year in September. Among the relocatables where two Type V units that were used only for therapy and only after a discretionary waiver. The time for deployment of the Type V units would have days if the Type V units contemplated in proposed Amendment SP8038 existed. However, because of current code restrictions requiring a case by case approval it took approximately (6) months to deploy. This type of deployment also leads to inconsistency in the built-in safety features contained in proposed Amendment SP8038.

While the shooting at Marjory Stoneman Doulas is not typic, it unfortunately is not an isolated incident. The inability to rapidly deploy classrooms and therapy treatment rooms had a significant impact on residents of this State as noted by Broward School Board Superintendent Robert Runcie. "Those who were in the 1200 building, they're going through a tremendous amount of trauma," Runcie said. "The [teachers] are further impacted by not having any stability, moving around classroom to classroom in carts.", Stoneman Douglas to get portables by mid-summer after teachers, alumni complain, By Scott

Travis, Sun Sentinel, May 29, 2018; https://www.sun-sentinel.com/local/broward/parkland/florida-school-shooting/fl-florida-school-shooting-douglas-portables-20180529-story.html

The same is true for other residents of Florida who may need rapidly deployable relocatables for schools. This immediate need has occurred in instances of fire, vandalism, and all to often hurricanes.

Students, staff saddened by building destroyed in middle school fire. By Marco Villarreal, News Channel 8 (WFLA), Brandon, Fla. Posted: Jul 22, 2019; https://www.wfla.com/news/hillsborough-county/students-staff-saddened-by-building-destroyed-in-middle-school-fire/

360 students displaced after Florida school vandalized, News Channel 27 (WTXL), DAYTONA BEACH, Fla. (AP), Posted: 3:25 AM, Jan 18, 2018; https://www.wtxl.com/news/students-displaced-after-florida-school-vandalized/article_28e3bdea-fc29-11e7-8afd-0fe2caaee0bf.html

Florida Schools Still 'Begging for Help' after Hurricane Michael, Spotlight on Poverty and Opportunity, Karyn Wofford, posted on June 12, 2019; https://spotlightonpoverty.org/spotlight-exclusives/florida-schools-still-begging-for-help-after-hurricane-michael/

Thus, proposed Amendment SP8038 addresses a specific need of this state.

2. Has a reasonable and substantial connection with the health, safety, and welfare of the general public.

As stated above, Broward School Board Superintendent Robert Runcie, recognized that trauma would be helped by deploying classrooms rapidly. Helping children, families, and communities reestablish routines and roles can help return normalcy to a child's life, providing reassurance and a sense of safety. Resuming regular mealtimes and bedtimes, returning to school, renewing friendships and leisure activities, and playing in a safe environment can all help in this regard. All of this is achieved more rapidly by allowing proposed Amendment SP8038. Indeed, in the example cited at Marjory Stoneman Douglas High School the ultimately deployed Type V relocatables were used as therapy rooms. However, this needed space was significantly delayed because of the current code.

3. Strengthens or improves the Florida Building Code, or in the case of innovation or new technology, will provide equivalent or better products or methods or systems of construction.

Proposed Amendment SP8038 would strengthen or improve the Florida Building Code because it would allow for the use of new technology for rapidly deploying relocatables that provide equivalent of better methods of construction. This is achieved by requiring any Type V Construction used to be fully protected by a NFPA 13 Fire Sprinkler System. Current Florida Building Code for relocatables does not require a fire sprinkler system at all. Therefore, there is no fire suppression, rather a fire rating that allows for a fire suppression response like a fire department's arrival. Automatic sprinkler systems installed in accordance with NFPA 13 are intended to serve two functions, property protection and life safety, automatically, without further response.

Simply stated, proposed Amendment SP8038 provides equivalent or better method of construction.

4. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Proposed Amendment SP8038 does not discriminate against materials or otherwise. In fact, proposed Amendment SP8038 addresses 453.27.3 Construction Type discrimination that currently exists, which discriminates against combustible material even where the method of using the same is equivalent or better than the existing Code.

5. Does not degrade the effectiveness of the Florida Building Code.

Proposed Amendment SP8038 does not degrade the Florida Building Code. In fact, the requirement for the units to be fully protected by a NFPA 13 Fire Sprinkler System is more effective in protecting life and property from fire than the current code.

According to a report by Marty Ahrens, July 2017, National Fire Protection Association, titled, U.S. Experience with Sprinklers:

> Sprinklers are a highly effective and reliable part of a building's fire protection system. National estimates of reported fires derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey show that in 2010-2014 sprinklers were present in 10% of reported U.S. fires. The death rate per 1,000 reported fires was 87% lower in properties with sprinklers than in properties with no automatic extinguishing systems (AES). The civilian injury rate was 27% lower and the firefighter fireground injury rate per 1,000 fires was 67% lower in sprinklered properties than in fires in properties without AES.

(Copy of Report - Submitted with this response)

Proposed Amendment SP8038 does not degrade the Florida Building Code. It provides a much more effective and reliable fire protection system.

Response to Public Comment

There was one public comment received regarding the proposed amendment. The comment focused on the concern that this proposed amendment would allow for wood structures to be used for relocatables and the dangers that would be associated with proposal including decay and insect infestation. In response to the comment the alternative language was suggested:

...and is (a) constructed of material not susceptible to decay and termite damage or (b) is fully compliant with all sections of Florida Building Code regarding protection against decay and termites related to material and construction methods used.

It is believed that this additional language meets the concerns of the public comment regarding proposed Amendment SP8038. In addition, the valid concern stated an ongoing inspection and maintenance issue. It described compromised wood structures that had been observed in the field. However, these comprised wood structures are not what the Code intent is meant to address, which is:

> ...to establish the minimum requirements to provide a reasonable level of safety, public health and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

The field example related to an issue of improper inspection and maintenance of the relocatables. Further, nothing in proposed Amendment SP8038 requires that Type V Construction be chosen for relocatables. However, proposed Amendment SP8038 gives the option to choose an alternate Construction type given the parameters of time to deploy, cost, ongoing inspection requirements, maintenance concerns, or any other factor. Proposed Amendment SP8038 provides this choice without sacrificing safety to life and property.

Finally, prior to any relocatable being used at public educational facilities, the Type V Constructed units as described in proposed Amendment SP8038 would still have to go through a full review by the State Requirements for Educational Facilities (SREF). However, proper consideration by the Florida Building Code Commission, and adoption of proposed Amendment SP8038, is required prior to SREF review.

For the reasons stated herein we believe proposed Amendment SP8038 should be considered and approved by the Commission for inclusion in the Florida Building Code.

Thank You for your time and consideration.

Respectfully Submitted,

Joseph D. Garrity, Esq.
Garrity Traina PLLC

RESEARCH

U.S. Experience with Sprinklers

July 2017

Marty Ahrens

Abstract

Sprinklers are a highly effective and reliable part of a building's fire protection system. National estimates of reported fires derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey show that in 2010-2014 sprinklers were present in 10% of reported U.S. fires. The death rate per 1,000 reported fires was 87% lower in properties with sprinklers than in properties with no automatic extinguishing systems (AES). The civilian injury rate was 27% lower and the firefighter fireground injury rate per 1,000 fires was 67% lower in sprinklered properties than in fires in properties without AES.

In fires considered large enough to activate the sprinkler, sprinklers operated 92% of the time. Sprinklers were effective in controlling the fire in 96% of the fires in which they operated. Taken together, sprinklers both operated and were effective in 88% of the fires large enough to operate them. In three-fifths of the fires in which the sprinkler failed to operate, the system had been shut off.

This report provides information about the performance of sprinklers in general as well as wet pipe and dry pipe sprinklers. Estimates are provided of sprinkler performance in all fires, with additional details provided about fires in all homes. Properties under construction are excluded from these estimates.

Keywords: Fire suppression, sprinklers, fire statistics, sprinkler performance, home fires

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.

To learn more about research at NFPA visit www.nfpa.org/research.

Copies of this report are available from:
NFPA Research, Data and Analytics Division
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org
E-mail: research@nfpa.org
Phone: 617-984-7451

NFPA No. USS14

FACT SHEET » RESEARCH

Sprinklers in Reported U.S. Fires during 2010 to 2014

Fire sprinklers can control a fire while the fire is still small. Some type of sprinkler was present in an estimated average of 49,840 (10%) reported structure fires during 2010 to 2014. Automatic extinguishing systems (AES) are designed to control fires until the fire department arrives. Sprinklers are a type of AES that uses water to control fires. Other types of AES use something other than water.

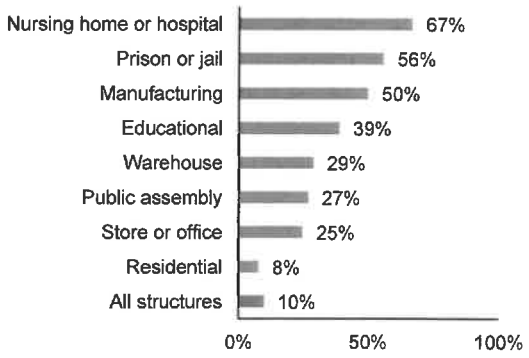
Sprinkler Presence

Sprinklers were most likely to be found in institutional occupancies such as nursing homes, hospitals, and prisons or jails.

Most structure fires and fire deaths occurred in residential properties, particularly homes, but only 8% of the reported residential fires were in properties with sprinklers.

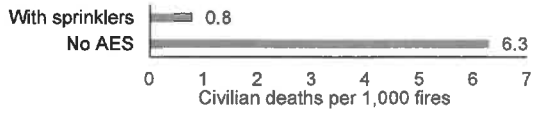
Wet pipe sprinklers accounted for 87% of the sprinklers in reported structure fires, dry pipe systems accounted for 10%, and other types of sprinklers accounted for 3%.

Presence of sprinklers in reported fires by occupancy



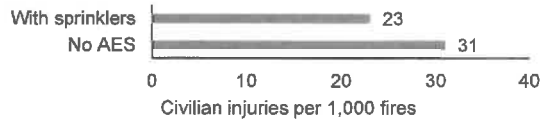
Impact of Sprinklers

Civilian death rates per 1,000 fires in properties with sprinklers and with no AES



The civilian fire death rate of 0.8 per 1,000 reported fires was 87% lower in properties with sprinklers than in properties with no AES.

Civilian injury rates per 1,000 fires in properties with sprinklers and with no AES



The civilian injury rate of 23 per 1,000 reported fires was 27% lower in properties with sprinklers than in properties with no AES. Many injuries occurred in fires that were too small to activate the sprinkler or in the first moments of a fire before the sprinkler operated.

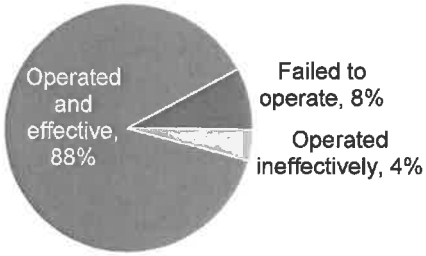
Firefighter injury rates per 1,000 fires in properties with sprinklers and with no AES

The average firefighter fireground injury rate of 20 per 1,000 reported fires was 67% lower where sprinklers were present than in fires with no AES.

NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards

Sprinkler Operation and Effectiveness

Sprinkler operation and effectiveness

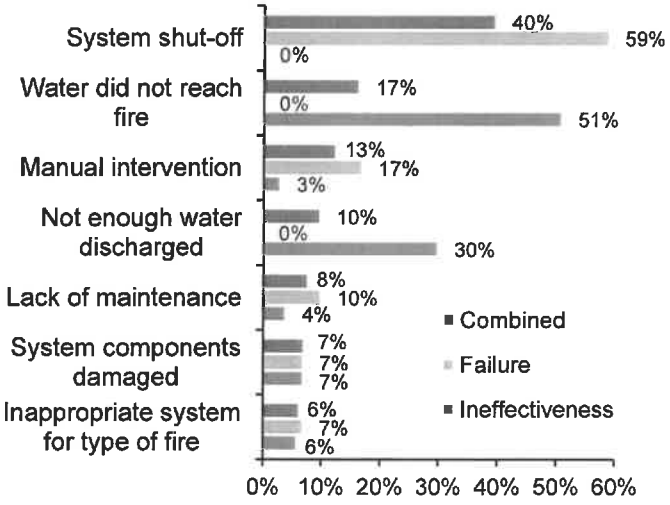


Sprinklers operated in 92% of the fires in which sprinklers were present and the fire was large enough to activate them.

- Sprinklers were effective at controlling the fire in 96% of fires in which they operated.
- Sprinklers operated effectively in 88% of the fires large enough to activate them.

Only one sprinkler head operated in four out of five (79%) fires in which sprinklers operated. In 97% of fires with operating sprinklers, five or fewer heads operated.

Reasons for combined sprinkler failure and ineffectiveness



Source: *U.S. Experience with Sprinklers*, National Fire Protection Association report, 2017.

Reported sprinkler failures (660 per year) were twice as common as reported fires in which sprinklers were ineffective and did not control the fire.

- 40% of the combined sprinkler problems were due to system shut-offs.
- In three of every five (59%) incidents in which sprinklers failed to operate, the system had been shut off.
- In half (51%) of the fires in which sprinklers were ineffective, the water did not reach the fire.

Source: NFPA Research: www.nfpa.org/research
Contact information: 617-984-7451 or research@nfpa.org

FACT SHEET » RESEARCH

Sprinklers in Reported U.S. Home Fires During 2010 to 2014

Some type of sprinkler was present in an estimated total of 24,440 (7%) reported home structure fires during 2010 to 2014. These fires caused an average of 35 (1%) civilian deaths, 616 (5%) civilian injuries, and $198 million (3%) in direct property damage per year. Homes include one- or two-family homes and apartments or other multi-family homes. Properties under construction were excluded from the analysis.

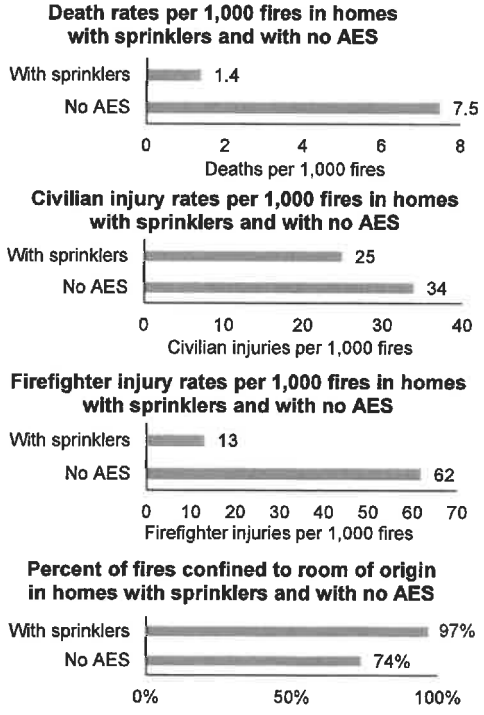
Sprinkler Presence

Automatic extinguishing systems (AES) are designed to control fires until the fire department arrives. Sprinklers are a type of AES that uses water to control fires. Other types of AES use something other than water.

According to the 2011 American Housing Survey, 5% of all occupied housing units had sprinklers. Buildings with more housing units were more likely to have sprinklers. Almost one-third (31%) of units in buildings with 50 or more units were sprinklered.

Wet pipe sprinklers accounted for 89% of the sprinklers in reported home fires, dry pipe systems accounted for 9%, and other types of sprinklers accounted for 2%.

Impact of Sprinklers



The civilian death rate of 1.4 per 1,000 reported fires was 81% lower in homes with sprinklers than in homes with no AES.

The civilian injury rate of 25 per 1,000 reported fires was 31% lower in homes with sprinklers than in homes with no AES. Many of the injuries occurred in fires that were too small to activate the sprinkler or in the first moments of a fire before the sprinkler operated.

The average firefighter injury rate of 13 per 1,000 reported home fires was 79% lower where sprinklers were present than in fires with no AES.

Where sprinklers were present, flame damage was confined to the room of origin in 97% of fires compared to 74% of fires without AES.

NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards

Sprinkler Operation and Effectiveness

Sprinkler operation and effectiveness in home fires

Sprinklers operated in 94% of home fires in which sprinklers were present and the fire was considered large enough to activate them.

- They were effective at controlling the fire in 96% of fires in which they operated.
- Sprinklers operated effectively in 91% of the fires large enough to activate them.

Only one sprinkler head operated in 88% of home fires with operating sprinklers. In 98% of fires with operating sprinklers, five or fewer sprinkler heads operated.

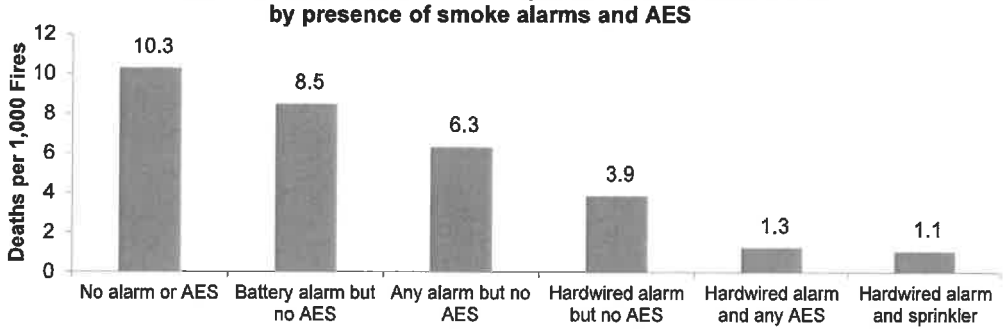
In three out of five (62%) of fires in which sprinklers failed to operate, the system was shut off.

Combined Impact of Smoke Alarms and Sprinklers

The lowest home fire death rate per 1,000 reported fires is found in homes with sprinkler systems and hardwired smoke alarms. Compared to reported home fires with no smoke alarms or AES, the death rate per 1,000 reported fires was as follows:

- 18% lower where battery-powered smoke alarms were present but AES were not
- 39% lower where smoke alarms with any power source were present but AES were not
- 62% lower where hardwired smoke alarms were present but AES were not
- 88% lower where hardwired smoke alarms and any AES were present
- 90% lower where sprinklers and hardwired smoke alarms were present

Average fire death rates per 1,000 reported home structure fires by presence of smoke alarms and AES



Source: *U.S. Experience with Sprinklers,* National Fire Protection Association report, 2017.

Source: NFPA Research: www.nfpa.org/research
Contact information: 617-984-7451 or research@nfpa.org

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

List of Figures and Tables

List of Figures and Tables (Continued)

U.S. Experience with Sprinklers

INTRODUCTION

Sprinklers play a critical role in fire protection. Information about sprinkler presence and performance in reported fires is essential to understanding the prevalence, impact, reliability and effectiveness of these systems, as well as avenues for performance improvement. This report provides a statistical overview of sprinkler presence and performance in reported fires. Because the majority of deaths are caused by home fires, additional details are provided on sprinklers in fires in homes.

METHODOLOGY

Estimates were derived from the details collected by the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey. NFIRS collects detailed incident-based information about causes and circumstances of fires from local fire departments. The coding structure is documented in the *National Fire Incident Reporting System Complete Reference Guide* [1]. Participation in NFIRS is voluntary at the federal level. Some states require fire departments to report all incidents or all fires, some have a loss threshold, and in other states, reporting is completely voluntary.

NFPA's annual Fire Experience Survey (FES) collects summary data from a sample of fire departments to calculate estimates of fires and associated losses by broad category. More details can be found in NFPA's report, *U.S. Fire Loss during 2015* and other reports in the series. [2]

To compensate for fires reported to local fire departments but not captured by NFIRS, fire and loss estimates from the FES are divided by comparable totals in NFIRS to develop multipliers. NFIRS data are scaled up by these multipliers. In most cases, unknown data are allocated proportionally. The basic approach was documented in a 1989 *Fire Technology* article by John Hall and Beatrice Harwood. [3]

Fires with one of the six NFIRS confined fire incident types are included in estimates of sprinkler presence, fire spread, and heads operating, but not of operation in general. NFIRS 5.0 includes six types of structure fires collectively referred to as "confined fires," identified by incident type codes 113-118. These include confined cooking fires, confined chimney or flue fires, confined trash fires, confined fuel burner or boiler fires, confined commercial compactor fires, and confined incinerator fires. Losses are generally minimal in these fires, which by definition, are assumed to have been limited to the object of origin. Although NFIRS rules do not require data about automatic extinguishing systems for these fires, local departments do sometimes provide it.

All estimates in this report exclude fires in properties under construction. Fires in which partial systems were present and fires in which sprinklers were present but failed to operate because they were not in the fire area were excluded from estimates related to presence and operation.

Casualty and loss estimates can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Property damage has not been adjusted for inflation. In most cases, fires are rounded to the nearest ten, civilian deaths and injuries are generally rounded to the nearest one, and direct property damage is rounded to the nearest million dollars. Less rounding is used when the numbers are smaller.

Appendix A has more details on how national estimates are calculated and Appendix B contains specific information about the NFIRS data elements.

Sprinklers in All Occupancies

SPRINKLER PRESENCE AND TYPE

Some type of sprinkler was present in an estimated average of 49,840 (10%) of reported structure fires during 2010-2014. Sprinkler presence varies widely by occupancy. Figure 1 shows the percentage of fires by occupancy in which any type of sprinkler was present. Sprinklers were most likely to be found in institutional occupancies, such as nursing homes, hospitals, and prisons or jails. Although the majority of structure fires, civilian fire deaths and injuries, and property damage occurred in residential properties, particularly homes, only 8% of the reported residential fires were in properties with sprinklers. Sprinklers in home fires are discussed in greater detail later in the report. High-rise buildings were much more likely to have sprinklers than were shorter structures. [4]

Figure 1. Presence of sprinklers in U.S. structure fires, by occupancy: 2010-2014

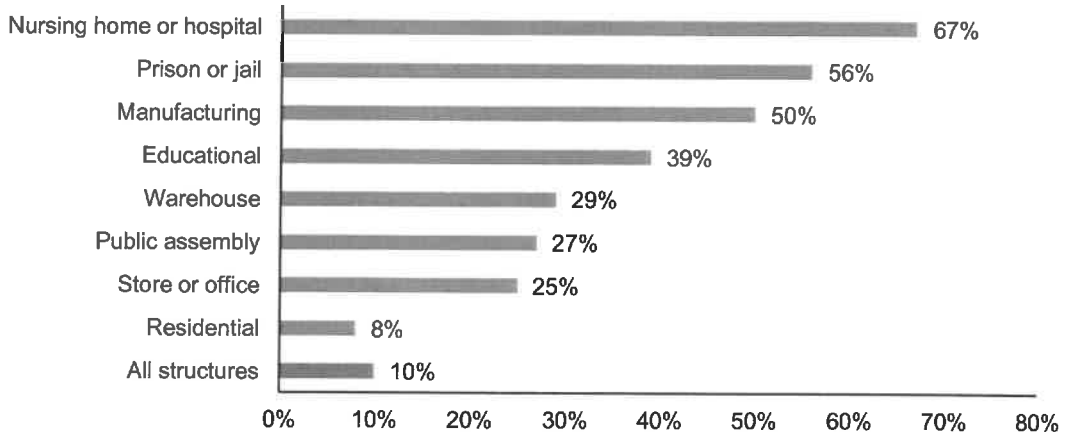


Table 1 provides information about more occupancies and shows estimates of automatic extinguishing system (AES) presence in 1980-1984 and 1994-1998 for historical context.[1] Table A summarizes information about AES in all reported structure fires *except those under construction.*

Table A.
Summary of AES presence and type in reported structure fires
2010-2014 annual averages

AES Presence of Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
AES present	**57,430**	**(12%)**	**45**	**(2%)**	**1,259**	**(9%)**	**$793**	**(8%)**
Sprinkler present	49,840	(10%)	42	(2%)	1,148	(8%)	$709	(7%)
Wet	*43,540*	*(9%)*	*39*	*(1%)*	*1,058*	*(7%)*	*$579*	*(6%)*
Dry	*4,770*	*(1%)*	*2*	*(0%)*	*69*	*(0%)*	*$120*	*(1%)*
Other	*1,530*	*(0%)*	*1*	*(0%)*	*21*	*(0%)*	*$10*	*(0%)*
Non-sprinkler AES present	7,590	(2%)	4	(0%)	110	(1%)	$84	(1%)
Partial system AES of any type	2,190	(0%)	5	(0%)	56	(0%)	$66	(1%)
AES of any type not in fire area and did not operate	1,630	(0%)	2	(0%)	47	(0%)	$75	(1%)
No AES present	**422,180**	**(87%)**	**2,659**	**(98%)**	**13,241**	**(91%)**	**$8,609**	**(90%)**
Total	**483,430**	**(100%)**	**2,711**	**(100%)**	**14,602**	**(100%)**	**$9,544**	**(100%)**

[1] Data about specific types of AES was first collected in NFIRS 5.0, introduced in 1999.

Wet pipe sprinklers accounted for 87% of the sprinklers in reported structure fires, dry pipe systems were in 10%, and other types of sprinklers were in 3%. See Figure 2.

Figure 2. Types of sprinklers found in U.S. structure fires: 2010-2014

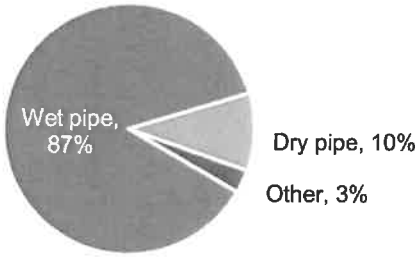
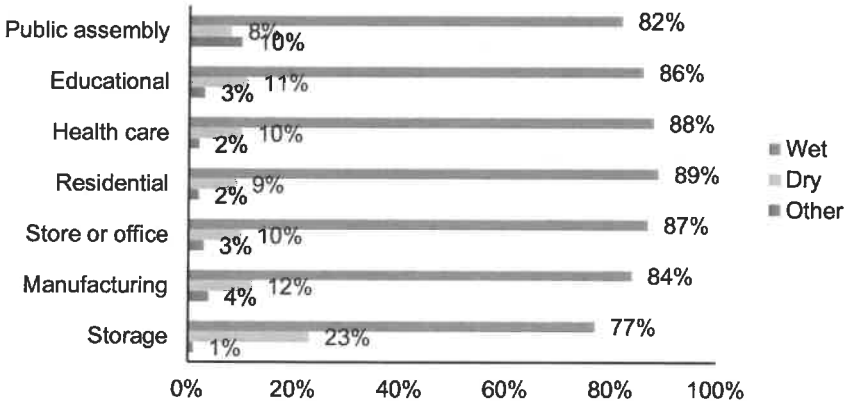


Figure 3 and Table 2 show that dry pipe sprinklers were more common in storage occupancies. "Other" sprinklers were seen most frequently in eating and drinking establishments. It is possible that some of these other sprinklers were actually miscodes of systems designed specifically for cooking equipment.

Figure 3. Sprinkler type by occupancy: 2010-2014

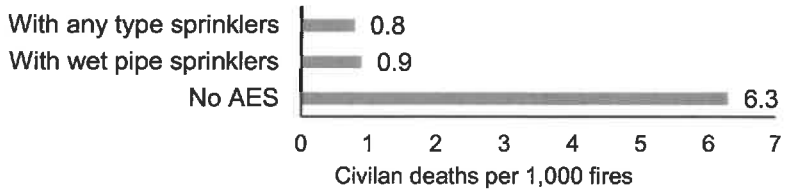


FIRES IN PROPERTIES WITH SPRINKLERS VS. NO AES

The death rate per 1,000 reported fires was 87% lower in properties with sprinklers than in properties with no AES. These rates are based strictly on reported presence or absence. Operation is not considered. Figure 4 shows that in reported structure fires with no automatic extinguishing systems (AES), the civilian death rate was 6.3 per 1,000 fires. When any type of sprinklers were present, the death rate was 0.8 per 1,000 fires. When wet pipe sprinklers were present, the death rate of 0.9 deaths per 1,000 fires was 86% lower than in home fires without AES. Table 3 shows these rates for all sprinklers and wet pipe sprinklers by occupancy. The smallest reduction (33%) was seen in manufacturing properties. Civilian deaths in sprinklered properties are discussed in greater detail later in this report.

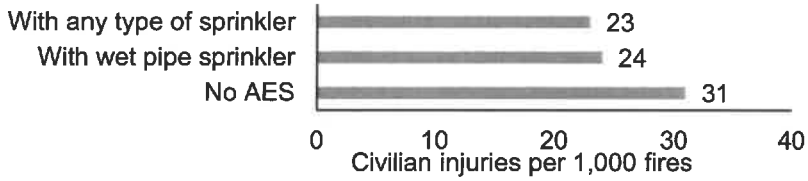
While the reduction in deaths was greater in some occupancies with wet pipe sprinklers than total sprinklers, the differences were small. With so few deaths in sprinklered properties, the differences are not meaningful.

Figure 4. Civilian death rates per 1,000 fires in properties with sprinklers and with no AES: 2010-2014



The civilian injury rate per 1,000 reported fires was 27% lower in properties with sprinklers than in properties with no AES. Figure 5 shows that when sprinklers of any type were present, reported civilian injuries averaged 23 per year, compared to 31 per year in which no AES was present. The injury rate in fires with wet pipe sprinklers was 24 per 1,000 fires or 22% lower than in fires with no AES. In more than half of these cases, the fire was too small to trigger the sprinkler. In others, someone was injured while trying to fight a fire in the initial moments before a sprinkler operated.

Figure 5. Civilian injury rates per 1,000 fires in properties with sprinklers and with no AES: 2010-2014



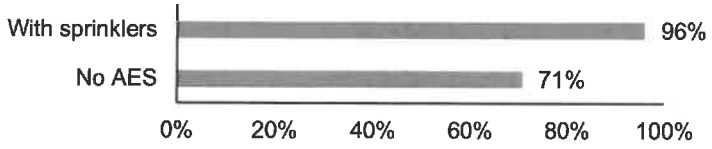
The average firefighter fireground injury rate per 1,000 reported fires was 67% lower when sprinklers were present than in fires with no AES. Figure 6 shows that when sprinklers of any type were present, 20 firefighters were injured per 1,000 fires, compared to 61 firefighter injuries per 1,000 fires in properties without AES protection. The 19 firefighter injuries per 1,000 fires in properties with wet pipe sprinklers was 68% lower than the rate in fires without AES.

Figure 6. Firefighter injury rates per 1,000 fires in properties with sprinklers and with no AES 2010-2014

Reductions in average dollar loss per fire varied greatly by occupancy. Table 4 shows that compared to properties with no AES, the average overall loss was 30% lower when sprinklers of any type were present and 35% lower when wet pipe sprinklers were present. The average loss was actually higher in sprinklered warehouses than in those with no AES. The reduction in property loss in manufacturing properties ranged from 23% to 34%. Average losses were higher in warehouses and manufacturing than in other properties. A very small fire can damage expensive equipment. Warehouse contents may be rendered valueless by smoke. The reduction in average losses for public assembly and various residential occupancies ranged from 55% to 86%.

When sprinklers were present, fire spread was confined to the room of origin in 96% of fires compared to 71% of fires without AES. See Figure 7. Table 5 shows these percentages in different occupancies. In a change from previous editions of this report, fires with NFIRS incident types indicating confined structure fires (NFIRS incident type codes 113-118) were all considered to have been confined to the room of origin.

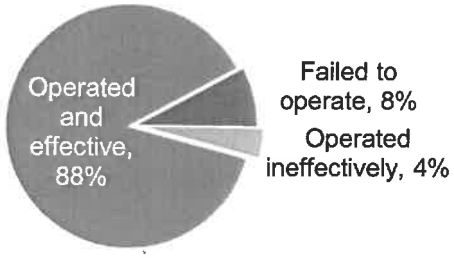
Figure 7. Percent of fires confined to room of origin in properties with sprinklers and with no AES 2010-2014



SPRINKLER OPERATION, EFFECTIVENESS AND PROBLEMS

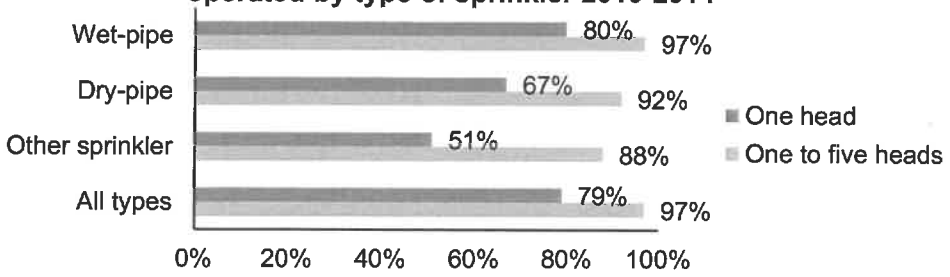
Sprinklers operated in 92% of the fires in which sprinklers were present and the fire was considered large enough to activate them.[2] They were effective at controlling the fire in 96% of fires in which they operated. Figure 8 shows that sprinklers operated effectively in 88% of the fires large enough to trigger them. Table 6 provides details on sprinkler operation and effectiveness in different occupancies and for different types of sprinklers.

Figure 8. Sprinkler operation and effectiveness: 2010-2014



Only one sprinkler activated in four out of five fires in which sprinklers of any type (79%) or wet pipe sprinklers (80%) operated. Figure 9 shows that in 97% of fires with operating sprinklers, five or fewer heads operated. The percentages were smaller for dry pipe and other sprinklers. Table 7 provides more details on number of sprinklers. The percentage of fires in which only one head operated is higher in this report than in previous editions because fires sprinklers operating in fires with the NFIRS confined fire incident types were included in the calculations.

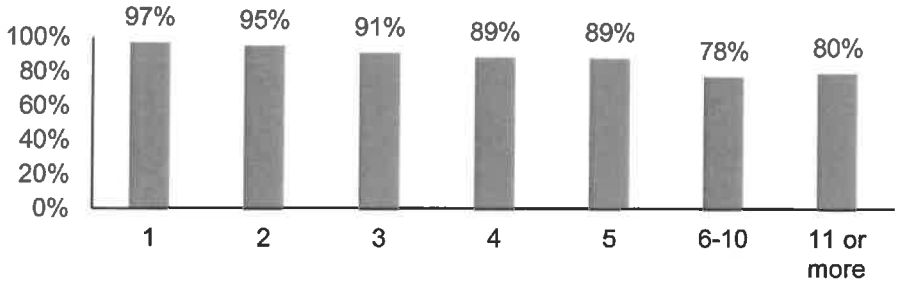
Figure 9. When sprinklers operated, percentage of fires in which one or one to five heads operated by type of sprinkler 2010-2014



In 97% of the fires in which one sprinkler operated, it was effective. Figure 10 shows that sprinklers were somewhat less likely to have operated effectively when more heads operated.

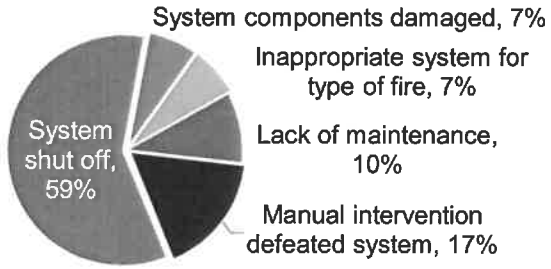
[2] These calculations exclude fires with confined structure fire incident types (NFIRS incident types 113-118). Among confined fires with sprinklers present, the fire was too small to operate 76% of the time, sprinklers operated and were effective 19% of the time and failed to operate 4% of the time. Since these fires are, by definition, confined, it is likely that a substantial share of fires in which the sprinklers were said to fail, were, in fact, too small to cause the sprinkler to operate. The 44% of non-confined (NFIRS incident types 110-123, excluding 113-118) that were too small to activate the sprinkler and 1% of non-confined structure fires with unclassified operation were also excluded.

Figure 10. Percentage of fires in which sprinklers were effective by number operating 2010-2014



In three of every five (59%) incidents in which sprinklers failed to operate, the system had been shut off. Figure 11 shows that manual intervention defeated the system in 17% of the incidents. In some cases, someone turned off the system prematurely.

Figure 11. Reasons for sprinkler failures: 2010-2014.

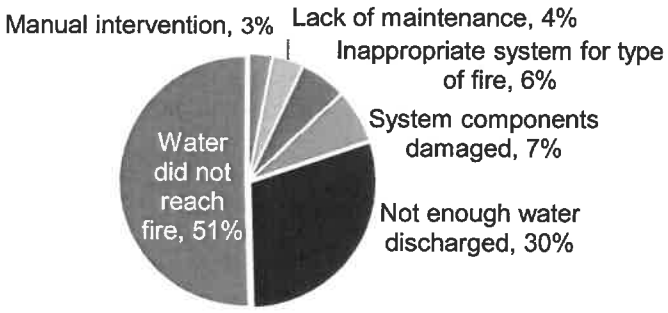


The system was inappropriate for the type of fire in 7% of the incidents in which sprinklers failed to operate. Throughout a building's life cycle, the use and occupancy type may change. A system that was designed for the original purpose may not be sufficient to meet the requirements of the changed building use. In another 7% of sprinkler failures, system components were damaged.

Table 8 shows the failure reasons for different occupancies and different types of sprinklers. In all cases, system shut-off was the leading reason.

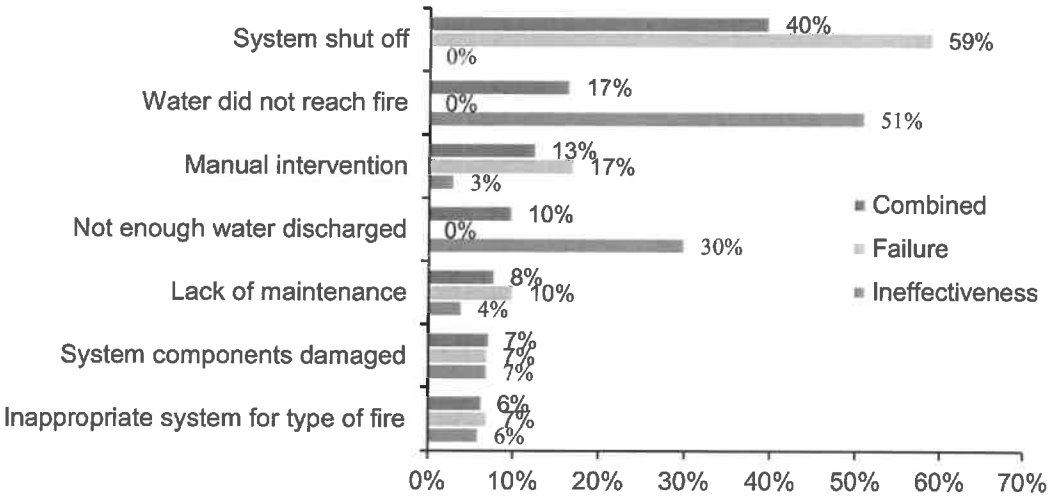
In half (51%) of the fires in which sprinklers were ineffective. the water did not reach the fire. Figure 12 shows that in 30% of the incidents, not enough water was discharged. In 7%, system components were damaged. The system was inappropriate for the type of fire in 6%. Lack of maintenance was identified as a factor in 4% of the incidents. Manual intervention was the cause of 3% of ineffective systems. Table 9 provides more details by occupancy and by type of sprinkler.

Figure 12. Reasons for sprinkler ineffectiveness: 2010-2014



In 2010-2014, reported sprinkler failures (660 per year) were twice as common as reported fires in which sprinklers were ineffective (320 per year). Figure 13 shows that 40% of the combined sprinkler problems were due to system shut-offs. In 17% of these incidents, water did not reach the fire. In 13%, manual intervention defeated the system. In 10%, not enough water was discharged. Lack of maintenance was a factor in 8%, system components were damaged in 7%, and in 6%, the system was inappropriate for the type of fire.

Figure 13. Reasons for combined sprinkler failure and ineffectiveness: 2010-2014

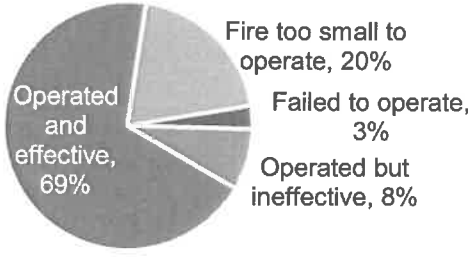


CIVILIAN DEATHS IN SPRINKLERED PROPERTIES

While sprinklers were present in 10% of all properties, only 2% of all fire deaths occurred in these properties. Fires in sprinklered properties killed an average of 42 people per year in 2010-02014. During the same period, fires in properties with no automatic extinguishing systems caused an average of 2,660 civilian deaths per year.

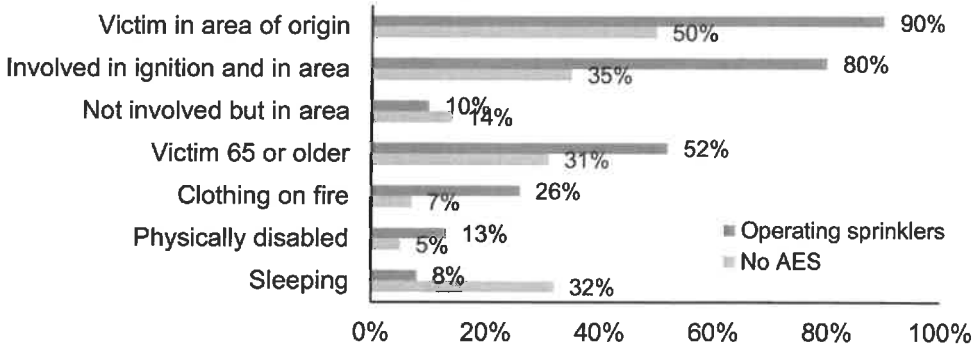
Figure 14 shows that 69% of the deaths in properties with sprinklers were caused by fires in which the sprinklers operated and were effective in controlling the fire. In some of these cases, the sprinklers actually extinguished the fire. The victims were typically fatally injured before the sprinklers activated. In one of every five (20%) such deaths, the fire never became large enough to activate the sprinkler. The sprinklers failed to operate in fires causing 3% of the deaths in sprinklered properties, and operated or were ineffective in controlling fires that caused 8% of the fatalities.

Figure 14. Civilian fire deaths by sprinkler performance: 2010-2014



Compared to victims of fires with no AES, people who died in fires in which sprinklers operated effectively were less likely to have been sleeping and more likely to have been in the area of origin, even more likely to have been involved in the ignition and in the area, to have been at least 65 or older, to have clothing on fire, or to have been physically disabled. Figure 15 shows this contrast; more details are provided in Table 10. Note that many of these differences are also seen in victims of fires with and without working smoke alarms. [5] There are limits to even the best fire protection. When someone is directly involved in the ignition or their clothing is burning, they may be fatally injured before the fire protection operates. If someone is physically incapable of getting themselves to safety, even a fire controlled by sprinklers may still cause harm.

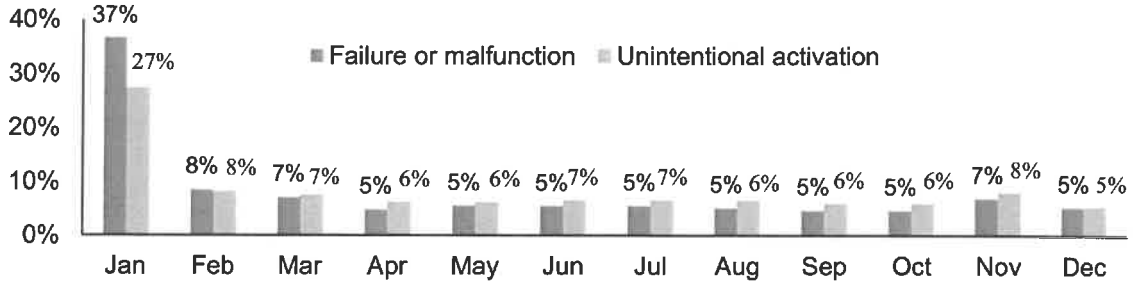
Figure 15. Victim characteristics in fires with effectively operating sprinklers and with no AES 2010-2014



UNWANTED ACTIVATIONS

Fire departments responded to an estimated 29,800 sprinkler activations caused by a system failure or malfunction and 33,600 unintentional sprinkler activations in 2014. According to the *NFIRS 5.0 Complete Reference Guide* [7], false alarms due to sprinkler failures or malfunctions include "any failure of sprinkler equipment that leads to sprinkler activation with no fire present." It "excludes unintentional operating caused by damage to the sprinkler system." Unintentional activations also include "testing the sprinkler system without fire department notification." Figure 16 shows that more than one-third (37%) of the system failures or malfunctions occurred in January, as did one-quarter (27%) of the unintentional activations. This suggests that cold weather may have played a role.

Figure 16. Unwanted sprinkler activations by type and month in 2014



Not all activations result in water flow outside the system. For example, water may flow in the pipes of a dry-pipe system. This could alert a monitoring company and trigger a fire department response.

Sprinklers in Home Fires

SPRINKLER PRESENCE AND TYPE

During 2010-2014, some type of fire sprinkler was present in an average 24,440 reported home structure fires per year. These fires caused an average of 35 civilian deaths, 616 civilian injuries, and $198 million in direct property damage per year. Properties under construction were excluded from these calculations.

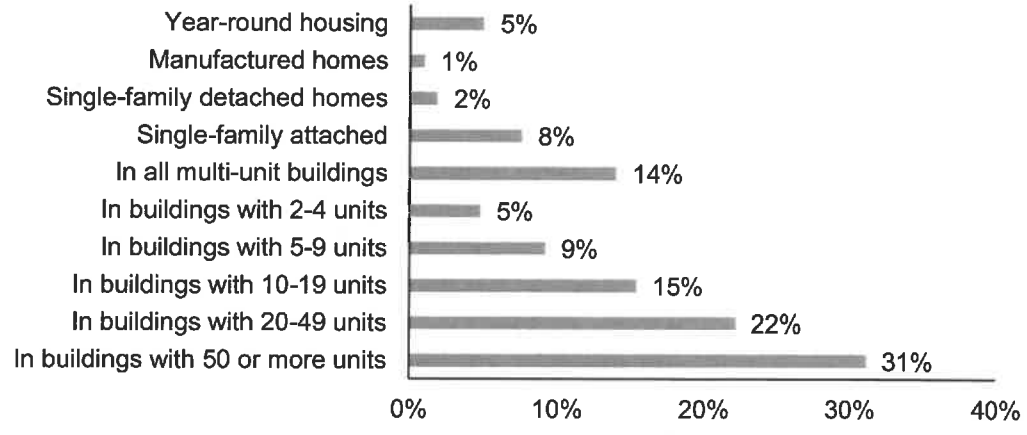
Table B summarizes information about AES in all reported home structure fires except those under construction.

Table B.
Summary of AES presence and type in reported home structure fires
2010-2014 annual averages

AES Presence of Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
AES present	**25,700**	**(7%)**	**36**	**(1%)**	**650**	**(5%)**	**$203**	**(3%)**
Sprinklers present	24,440	(7%)	35	(1%)	616	(5%)	$198	(3%)
Wet	*21,760*	*(6%)*	*34*	*(1%)*	*581*	*(5%)*	*$184*	*(3%)*
Dry	*2,140*	*(1%)*	*0*	*(0%)*	*26*	*(0%)*	*$10*	*(0%)*
Other	*540*	*(0%)*	*1*	*(0%)*	*9*	*(0%)*	*$4*	*(0%)*
Non-sprinkler AES present	1,260	(0%)	1	(0%)	34	(0%)	$5	(0%)
Partial system AES	970	(0%)	5	(0%)	31	(0%)	$17	(0%)
AES Not in fire area and did not operate	600	(0%)	2	(0%)	24	(0%)	$19	(0%)
None present	**329,460**	**(92%)**	**2,471**	**(98%)**	**11,979**	**(94%)**	**$6,359**	**(96%)**
Total	**356,740**	**(100%)**	**2,514**	**(100%)**	**12,684**	**(100%)**	**$6,599**	**(100%)**

According to the 2011 American Housing Survey, buildings with more housing units were more likely to have sprinklers. Figure 17 shows that 5% of occupied year-round housing units had sprinklers, ranging from a low of 1% in manufactured homes to a high of 31% in buildings with at least 50 units. [7]

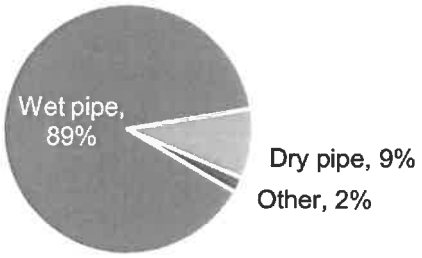
Figure 17. Percentage of occupied units with sprinklers in 2011 American Housing Survey



Source: American Housing Survey

Wet pipe sprinklers accounted for 89% of the sprinklers in reported home fires, dry pipe systems were in 9%, and other types of sprinklers were in 2%. See Figure 18.

Figure 18. Types of sprinklers found in home structure fires: 2010-2014



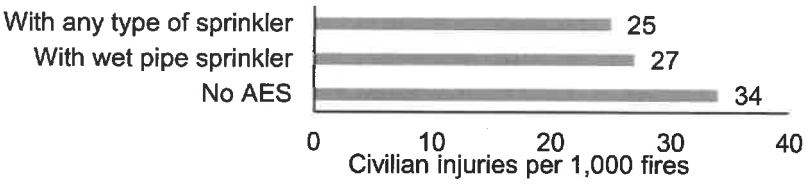
FIRES IN HOMES WITH SPRINKLERS VS. NO AES

The death rate per 1,000 reported fires was 81% lower in homes with sprinklers than in homes with no AES. These rates are based strictly on reported presence or absence. Operation is not considered. Figure 19 shows that in reported structure fires with no automatic extinguishing systems (AES) present, the death rate was 7.5 per 1,000 fires. When any type of sprinkler was present, the death rate was 1.4 per 1,000 fires, a reduction of 81%. When wet pipe sprinklers were present, the death rate of 1.4 deaths was 79% lower. With so few deaths in sprinklered properties, the differences are not meaningful.

Figure 19. Civilian death rates per 1,000 fires in homes with sprinklers and with no AES 2010-2014

The civilian injury rate per 1,000 reported fires was 31% lower in homes with sprinklers than in homes with no AES. Figure 20 shows that when any type of sprinklers were present, reported civilian injuries averaged 25 per year, compared to 34 per year in which no AES was present. The injury rate for wet pipe sprinklers of 27 per 1,000 fires was 27% lower than in fires with no AES. In many cases, the fire was too small to operate. In others, someone was injured while trying to fight a fire in the initial moments before a sprinkler operated.

Figure 20. Civilian injury rates per 1,000 fires in homes with sprinklers and with no AES 2010-2014



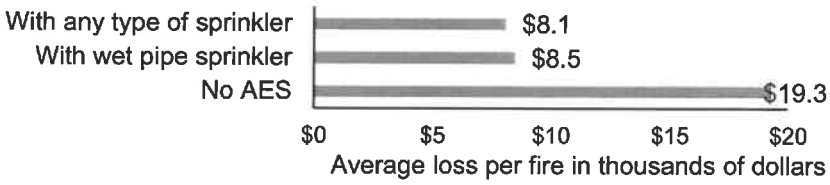
2012 Fire Protection Research Foundation study found that sprinkler presence was associated with a 53% reduction in the medical cost of civilian injuries per 100 home fires. In addition, larger percentages of injuries in sprinklered homes resulted from fires that were limited to the object or room of origin than in home fires without sprinklers. [8]

The average firefighter fireground injury rate per 1000 reported home fires was 79% lower when sprinklers were present than in fires with no AES. Figure 21 shows that when sprinklers were present, 13 firefighters were injured per 1000 fires, compared to 62 firefighter injuries per 1,000 fires in properties without AES protection.

Figure 21. Firefighter injury rates per 1,000 fires in homes with sprinklers and with no AES 2010-2014

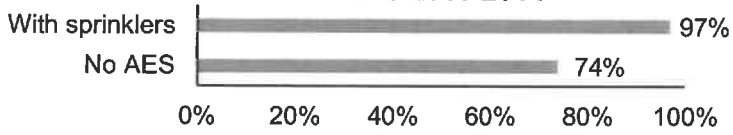
When sprinklers were present in reported home fires, the average property loss per fire was less than half the average in homes with no AES. Figure 22 shows that when any type of fire sprinkler was present in reported fires, the average loss was $8,100 per fire. This was 58% lower than the $19,300 average in home fires in which no AES was present. When wet pipe sprinklers were present, the average loss of $8,500 was 56% lower than in homes with no AES.

Figure 22. Average loss per fire in homes with sprinklers and with no AES 2010-2014



When sprinklers were present, flame damage was confined to the room of origin in 97% of fires compared to 74% of fires without AES. See Figure 23. In a change from previous editions of this report, fires with NFIRS incident types indicating confined structure fires (NFIRS incident type codes 113-118) were all considered to have been confined to the room of origin.

Figure 23. Percent of fires confined to room of origin in homes with sprinklers and with no AES 2010-2014

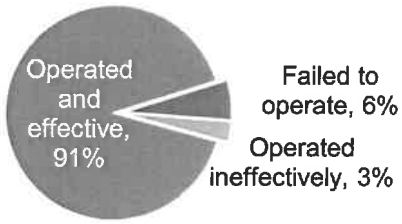


SPRINKLER OPERATION, EFFECTIVENESS AND PROBLEMS IN HOME FIRES

Sprinklers operated in 94% of home fires in which sprinklers were present and fires were considered large enough to activate them.[3] They were effective at controlling the fire in 96% of fires in which they operated. Figure 24 shows that, taken together, sprinklers operated effectively in 91% of the fires large enough to trigger them.

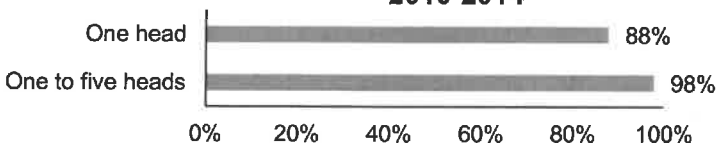
[3] These calculation exclude fires with confined structure fire incident types (NFIRS incident types 113-118). Among confined fires with sprinklers present, the fire was too small to operate 74% of the time, sprinklers operated and were effective 22% of the time and failed to operate 4% of the time. Since these fires are, by definition, confined, it is likely that a substantial share of fires in which the sprinklers were said to fail, were, in fact, too small to cause the sprinkler to operate. The 34% of non-confined (NFIRS incident types 110-123, excluding 113-118) that were too small to activate the sprinkler and 1% of non-confined structure fires with unclassified operation were also excluded.

Figure 24. Sprinkler operation and effectiveness in home fires: 2010-2014



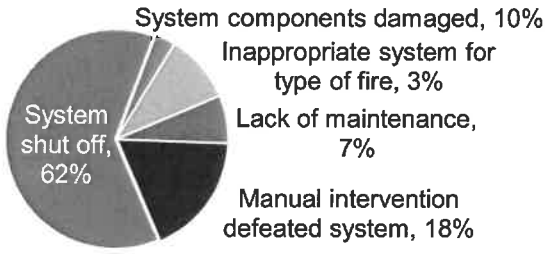
In 98% of home fires with operating sprinklers, five or fewer heads operated. Figure 25 shows that only one sprinkler operated in 88% of fires with operating sprinklers of all types. The percentage of fires in which only one head operated is higher in this report than in previous editions because fires sprinklers operating in fires with the NFIRS confined fire incident types were included in the calculations.

Figure 25. When sprinklers operated, percentage of home fires in which one or one to five heads operated 2010-2014



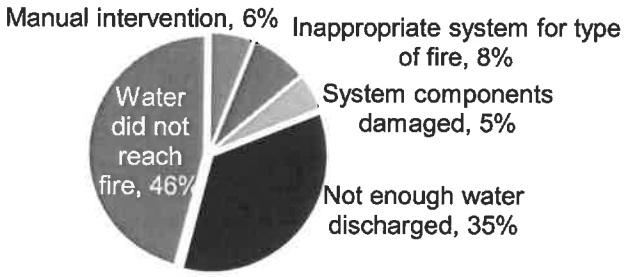
In three of every five (62%) home fires in which sprinklers failed to operate, the system had been shut off. Figure 26 shows that manual intervention defeated the system in 18% of the incidents. System components were damaged in 10% of these fires, lack of maintenance caused 7% of the failures, and 3% occurred because the system was inappropriate for the type of fire that occurred.

Figure 26. Reasons for sprinkler failures in home fires: 2010-2014



In almost half (46%) of home fires in which sprinklers were ineffective, the water did not reach the fire. Figure 27 shows that in one-third (35%) of the incidents, not enough water was discharged. The system was inappropriate for the type of fire in 8% of the incidents. In 5%, system components were damaged. Manual intervention was the cause of 6% of ineffective systems. Table 8 provides more details by occupancy and by type of sprinkler.

Figure 27. Reasons for sprinkler ineffectiveness in home fires: 2010-2014

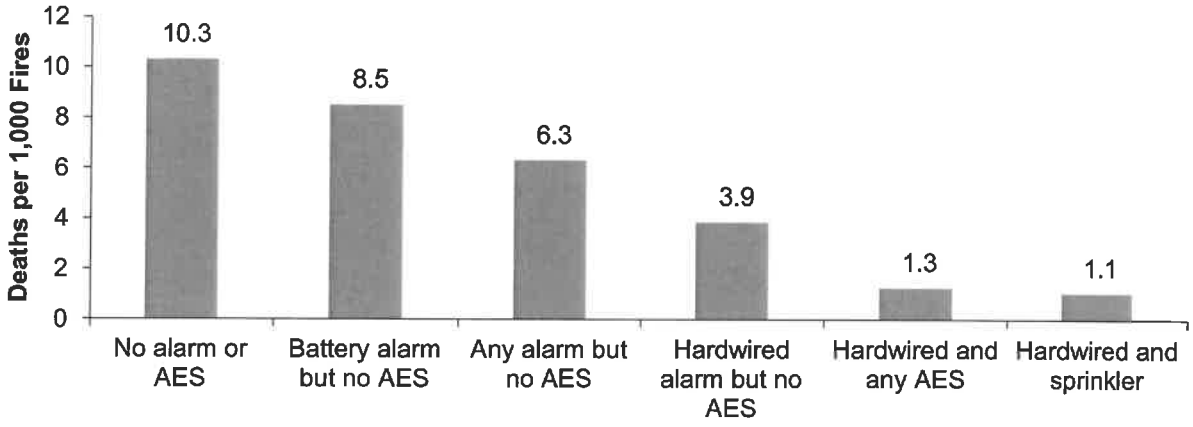


IMPACT OF SMOKE ALARMS AND SPRINKLERS IN DEATHS PER 1,000 HOME FIRES

The lowest home fire death rate per 1,000 reported fires is found in homes with sprinkler systems and hardwired smoke alarms. Figure 28 shows that compared to reported home fires (excluding manufactured home fires) with no smoke alarms or automatic extinguishing systems/equipment (AES) at all, the death rate per 1,000 reported fires was:

- 18% lower when battery-powered smoke alarms were present but AES were not;
- 39% lower when smoke alarms with any power source were present but AES were not;
- 62% lower when hardwired smoke alarms were present but AES were not;
- 88% lower when hardwired smoke alarms and any AES were present; and
- 90% lower when sprinklers and hard-wired smoke alarms were present.

Figure 28. Average Fire Death Rate per 1,000 Reported Home Structure Fires by Presence of Smoke Alarms and AES 2010-2014



UNWANTED ACTIVATIONS

Fire departments responded to an estimated 5,600 non-fire activations of home fire sprinklers caused by a system failure or malfunction and 6,800 unintentional sprinkler activations in 2014. Note that activations in manufactured homes could not be identified or screened out. According to the NFIRS Complete Reference Guide, [9] sprinkler failures or malfunctions include "any failure of sprinkler equipment that leads to sprinkler activation with no fire present." It. "excludes unintentional operating caused by damage to the sprinkler system." The latter should be considered unintentional activations. Unintentional activations also include "testing the sprinkler system without fire department notification.

20 Years of Home fire Sprinklers in Scottsdale, Arizona

Survey in Scottsdale, Arizona found that home fire sprinklers were still operational after 20 years. In his 2008 Executive Fire Officer Program Applied Research Project, Residential fire sprinkler reliability in homes older than 20 years old in Scottsdale, AZ, Richard Upham described the results of a survey he conducted of owners of single-family homes built in 1986-1988 after requirements for residential sprinklers systems took effect. [10] Respondents could check yes, no or unsure to four questions. They could also request a free inspection of their system.

Excluding blanks and responses of unsure, all of the respondents answered "Yes" when asked "To the best of your knowledge, is your fire sprinkler system still in operation?"

With the same exclusions, 89% said "No" when asked "Has your sprinkler system ever had a leak or maintenance problem?" The author noted that leaks or maintenance issues on Scottsdale were usually due to either relief valves that had developed a leak or sprinkler heads that were unintentionally damaged. He also noted that more than 300,000 Omega sprinkler heads manufactured between 1983 and 1998 were replaced in Scottsdale after a recall. Some of these may have been considered maintenance issues.

Again, with the same exclusions, slightly more than half (54%) said "Yes" to "Has your fire sprinkler system ever been inspected?" Two (1%) of the respondents said "Yes" to "Has your fire sprinkler system ever been activated as a result of fire?"

Two-thirds provided contact information to request a free fire department inspection of their sprinkler system. No issues were found that would have prevented the systems from working in the 60 inspections completed when his paper was written.

Conclusions and Further Reading

Sprinklers are a very reliable and effective part of fire protection. Their impact is seen most strongly in the reduction of civilian fire deaths per 1,000 reported fires when sprinklers are present compared to fires without AES. Notable reductions are also seen in injury rates, and in most occupancies, average loss per fire. Increasing the usage of sprinklers will the reduce loss of life and property from fire.

NFPA standards provide essential guidance in installation, inspection, testing, maintenance, integration of sprinklers with other systems, and in evaluating needs when an occupancy changes use or contents. See

- NFPA 13: *Standard for the Installation of Sprinkler Systems*,
- NFPA, 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*,
- NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*,
- *NFPA 25:, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2017 edition, Quincy, MA, U.S.: NFPA, 2016. See NFPA 25 for minimum inspection, testing, and maintenance requirements for sprinkler systems.
- NFPA 4: *Standard for the Integrated Fire Protection and Life Safety Systems Testing*, 2015 Edition, Quincy, MA, U.S.: NFPA, 2014. See NFPA 4 for test protocols to ensure that the fire protection and life safety systems will function correctly together.
- NFPA 1, *Fire Code*, 2015 Edition, Quincy, MA, U.S.: NFPA, 2014. NFPA 1 has evaluation requirements to assess the adequacy of existing sprinkler systems if the use or contents in the space have changed.

Because sprinklers control fires in the early stages, far less water is needed than if the fire extinguished by traditional methods. See FM Global's 2010 report, *The Environmental Impact of Automatic Fire Sprinklers*.

See www.firesprinklerinitiave.org for resources to help increase the number of new one- and two-family homes built protected by sprinklers and to reduce this death toll. Three out of every five fire deaths were caused by fires in one- or two-family homes, excluding manufactured housing. Sprinklers were present in only 1.5% of the fires in these properties.

The Fire Protection Research Foundation has produced a number of reports to inform home fire sprinkler codes and standards. See:

- Stakeholder Perceptions of Home Fire Sprinklers (2016)
- Home Fire Sprinkler Cost Assessment (2013)
- Sprinkler Impact on Fire Injury (2012)
- Residential Fire Sprinklers - Water Usage and Water Meter Performance Study (2011)
- Sprinkler Insulation: A Literature Review (2011)
- Incentives for the Use of Residential Fire Sprinkler Systems in U.S. Communities (2010)
- Analysis of the Performance of Residential Sprinkler Systems with Sloped or Sloped and Beamed Ceilings (2010)
- Antifreeze Solutions in Home Fire Sprinkler Systems - Phase II Interim Report (2010)
- Antifreeze Solutions in Home Fire Sprinkler Systems - Literature Review and Research Plan

Table 1.
Presence of Sprinklers in Structure Fires by Property Use, Excluding Properties under Construction

Property Use	Number of Structure Fires With Equipment Present and Percentage of Total Structure Fires in Property Use							
	Any Automatic Extinguishing Equipment						Any Sprinkler	
	1980-1984		1994-1998		2010-2014		2010-2014	
All public assembly	4,280	(13%)	4,380	(26%)	6,610	(47%)	3,760	(27%)
Variable-use amusement place	120	(8%)	140	(16%)	240	(21%)	190	(17%)
Religious property	50	(2%)	90	(5%)	230	(14%)	180	(10%)
Library or museum	80	(14%)	110	(28%)	260	(44%)	230	(39%)
Eating or drinking establishment	3,310	(16%)	3,240	(29%)	4,360	(59%)	1,860	(25%)
Passenger terminal	70	(20%)	60	(35%)	400	(54%)	390	(53%)
Educational property	1,620	(13%)	1,820	(24%)	2,130	(43%)	1,950	(39%)
Health care property*	6,920	(47%)	4,400	(68%)	3,350	(53%)	3,100	(49%)
Nursing home	2,250	(61%)	2,060	(76%)	1,870	(70%)	1,780	(67%)
Hospital	3,370	(47%)	1,650	(74%)	900	(79%)	770	(67%)
Prison or jail	370	(10%)	430	(19%)	260	(59%)	250	(56%)
All residential	7,090	(1%)	11,110	(3%)	33,880	(9%)	31,500	(8%)
Home (including apartment)	5,120	(1%)	8,440	(2%)	26,390	(7%)	24,440	(7%)
Hotel or motel	1,590	(15%)	1,690	(35%)	2,130	(58%)	2,020	(55%)
Dormitory or barracks	430	(16%)	620	(29%)	2,210	(56%)	2,100	(53%)
Rooming or boarding home	70	(4%)	230	(17%)	1,120	(40%)	1,100	(39%)
Residential board and care home or assisted living	Not available		Not available		990	(52%)	950	(50%)
Store or office	5,510	(13%)	5,230	(21%)	5,380	(32%)	4,270	(25%)
Grocery or convenience store	1,160	(15%)	1,190	(27%)	1,820	(47%)	1,000	(26%)
Laundry or dry cleaning or other professional service	330	(8%)	310	(13%)	320	(21%)	310	(20%)
Department store	1,340	(44%)	1,100	(52%)	460	(46%)	440	(44%)
Office	1,240	(12%)	1,470	(25%)	1,150	(37%)	1,100	(36%)
Manufacturing facility	11,910	(44%)	6,400	(50%)	2,660	(55%)	2,390	(50%)
All storage	1,430	(2%)	1,090	(3%)	680	(3%)	660	(3%)
Warehouse excluding cold storage*	1,060	(13%)	740	(22%)	370	(30%)	360	(29%)
All structures	38,620	(4%)	37,100	(7%)	57,430	(12%)	49,840	(10%)

* "Health care property" includes other facilities not listed separately. In 1980-84 and 1994-98, this category excludes doctors' offices and care of aged facilities without nursing staff (which are assumed to be residential board and care facilities).

Notes: These are structure fires reported to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. Post-1998 estimates are based only on fires reported in Version 5.0 of NFIRS and include fires reported as confined fires. After 1998, buildings under construction are excluded. Sprinkler statistics exclude partial systems and installations with no sprinklers in fire area.

Table 2.
Type of Sprinkler Reported in Structure Fires
Where Equipment Was Present in Fire Area, Excluding Properties under Construction
by Property Use: 2010-2014 Annual Averages

Property Use	Fires per year with any type of sprinkler	Wet pipe sprinklers		Dry pipe sprinklers		Other sprinklers*	
All public assembly	3,760	3,080	(82%)	300	(8%)	380	(10%)
Variable-use amusement place	190	170	(91%)	20	(8%)	0	(1%)
Religious property	180	160	(88%)	10	(3%)	10	(6%)
Library or museum	230	210	(91%)	20	(9%)	0	(1%)
Eating or drinking establishment	1,860	1,450	(78%)	130	(7%)	280	(15%)
Passenger terminal	390	280	(73%)	50	(13%)	50	(13%)
Educational property	1,950	1,670	(86%)	220	(11%)	60	(3%)
Health care property**	3,100	2,740	(88%)	300	(10%)	60	(2%)
Nursing home	1,780	1,550	(87%)	180	(10%)	40	(2%)
Hospital	770	690	(89%)	80	(10%)	0	(0%)
Prison or jail	250	210	(85%)	30	(11%)	10	(4%)
All residential	31,500	28,050	(89%)	2,700	(9%)	660	(2%)
Home (including apartment)	24,440	21,760	(89%)	2,140	(9%)	540	(2%)
Dormitory or barracks	2,100	1,910	(91%)	160	(8%)	20	(1%)
Hotel or motel	2,020	1,850	(92%)	130	(7%)	40	(2%)
Rooming or boarding house	1,100	970	(88%)	130	(12%)	0	(0%)
Residential board and care or assisted living	950	840	(89%)	90	(9%)	20	(2%)
Store or office	4,270	3,710	(87%)	430	(10%)	140	(3%)
Grocery or convenience store	1,000	830	(83%)	90	(9%)	80	(8%)
Laundry or dry cleaning or other professional service	310	270	(87%)	40	(13%)	0	(1%)
Department store	440	380	(86%)	60	(13%)	10	(1%)
Office	1,100	980	(89%)	100	(9%)	20	(2%)
Manufacturing facility	2,390	2,010	(84%)	290	(12%)	90	(4%)
All storage	660	510	(77%)	150	(23%)	0	(1%)
Warehouse excluding cold storage	360	300	(82%)	60	(17%)	0	(1%)
All structures ***	49,840	43,540	(87%)	4,770	(10%)	1,530	(3%)

* Includes deluge and pre-action sprinkler systems and may include sprinklers of unknown or unreported type.
** Nursing home, hospital, clinic, doctor's office, or development disability facility
*** Includes some property uses that are not shown separately.

Note: These are based on structure fires reported to U.S. municipal fire departments in NFIRS Version 5.0 and so exclude fires reported only to federal or state agencies or industrial fire brigades. Row totals are shown in the leftmost column of percentages, and sums may not equal totals because of rounding error. In Version 5.0 of NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system. Buildings under construction and partial systems are excluded.
Source: NFIRS and NFPA fire experience survey.

Table 3.
Estimated Reduction in Civilian Deaths per Thousand Fires
Associated With All Types of Sprinklers,
by Property Use (Excluding Properties under Construction): 2010-2014 Annual Averages

Property Use	Without AES	With sprinklers of any type	Percent reduction from no AES	With wet pipe sprinklers	Percent reduction from no AES
All public assembly	0.7	0.0	100%	0.0	100%
Health care	0.9	0.3	71%	0.1	83%
Residential	7.5	1.1	85%	1.2	84%
Home (including apartment)	7.5	1.4	81%	1.6	79%
Dormitory or barracks	0.4	0.0	100%	0.0	100%
Hotel or motel	7.0	0.3	95%	0.0	100%
Rooming or boarding house	8.4	0.3	96%	0.4	96%
Residential board and care or assisted living	7.2	1.3	82%	1.5	80%
Store or office	0.9	0.3	68%	0.3	63%
Manufacturing facility	1.6	1.0	33%	1.2	21%
Warehouse excluding cold storage	2.7	0.6	79%	0.7	74%
All structures	6.3	0.8	87%	0.9	86%

Note: These are national estimates of structure fires reported to U.S. municipal fire departments, based on fires reported in NFIRS Version 5.0, and so exclude fires reported only to federal or state agencies or industrial fire brigades.

Source: NFIRS and NFPA fire experience survey.

Table 4.
Estimated Reduction in Average Direct Property Loss per Fire
Associated With All Types of Sprinklers
by Property Use (Excluding Properties under Construction): 2010-2014 Annual Averages

Property Use	Loss without AES	Loss with sprinklers of any type	Percent reduction	Loss with wet pipe sprinklers	Percent reduction from no AES
All public assembly	$37,900	$9,100	76%	$8,900	77%
Health care*	$14,900	$4,000	73%	$3,700	75%
Residential	$19,200	$7,100	63%	$7,300	62%
Home (including apartment)	$19,300	$8,100	58%	$8,500	56%
Dormitory or barracks	$3,900	$1,300	67%	$1,400	65%
Hotel or motel	$35,200	$10,900	69%	$10,700	70%
Rooming or boarding house	$12,200	$1,700	86%	$1,800	85%
Residential board and care or assisted living	$5,500	$2,300	58%	$2,400	55%
Store or office	$52,400	$26,100	50%	$26,300	50%
Manufacturing facility	$107,200	$82,500	23%	$70,900	34%
Warehouse excluding cold storage	$90,700	$138,300	no reduction	$120,800	no reduction
All structures	$20,400	$14,200	30%	$13,300	35%

*Nursing home, hospital, clinic, doctor's office, or other medical facility.

Note: These are national estimates of structure fires reported to U.S. municipal fire departments, based on fires reported in NFIRS Version 5.0, and so exclude fires reported only to federal or state agencies or industrial fire brigades.

Source: NFIRS and NFPA fire experience survey.

Table 5.
Percentage of Fires with Fire Spread Confined to Room of Origin in Fires with Sprinklers Present vs. No Automatic Extinguishing System
2010-2014 Annual Averages

Property Use	Percentage of fires confined to room of origin excluding structures under construction and sprinklers not in fire area		
	With no AES	With sprinklers of any type	Difference (in percentage points)
Public assembly	75%	93%	18%
Religious property	72%	90%	18%
Library or museum	83%	97%	14%
Eating or drinking establishment	70%	92%	22%
Educational	88%	97%	9%
Health care property*	92%	98%	6%
Residential	73%	97%	24%
Home (including apartment)	74%	97%	23%
Dormitory or barracks	96%	99%	3%
Hotel or motel	82%	97%	15%
Store or office	65%	92%	26%
Grocery or convenience store	69%	93%	24%
Department store	65%	72%	7%
Office building	72%	94%	22%
Manufacturing facility	62%	85%	22%
Storage	26%	87%	61%
Warehouse excluding cold storage	53%	77%	24%
All structures**	71%	96%	25%

* Nursing home, hospital, clinic, doctor's office, or other medical facility.

** Includes some properties not listed separately above.

Note: Percentages are based on structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. All fires with one of the six NFIRS confined structure fire incident types were considered confined to the object of origin by definition. Fires that were confined to the room of origin include fires confined to the object of origin. In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system.

Source: NFIRS and NFPA fire experience survey.

Table 6.
Sprinkler Reliability and Effectiveness When Fire Was Coded as Not Confined and Large Enough to Activate Sprinkler and Sprinkler Was Present in Area of Fire, by Property Use: 2010-2014 Annual Averages

A. All Sprinklers

Property Use	Number of fires per year where sprinklers were present	Non-confined fires too small to activate or unclassified operation	Fires coded as confined fires	Number of qualifying fires per year	Percent where equipment operated (A)	Percent effective of those that operated (B)	Percent where equipment operated effectively (A x B)
All public assembly	3,760	590	2,540	640	90%	94%	85%
Eating or drinking establishment	1,860	300	1,150	410	90%	92%	83%
Educational property	1,950	420	1,360	180	87%	96%	84%
Health care property*	3,100	600	2,200	310	85%	97%	82%
All residential	31,500	2,490	24,870	4,140	93%	96%	89%
Home (including apartment	24,440	1,900	18,970	3,570	94%	96%	91%
Hotel or motel	2,020	350	1,340	330	90%	98%	89%
Store or office	4,270	1,030	2,200	1,040	91%	96%	87%
Grocery or convenience store	1,000	240	570	190	89%	93%	83%
Department store	440	160	170	120	90%	98%	88%
Office	1,100	230	700	180	91%	96%	87%
Manufacturing facility	2,390	610	760	1,030	91%	94%	85%
All storage	660	140	220	300	86%	96%	82%
Warehouse excluding cold storage	360	80	90	180	84%	97%	81%
All structures**	49,840	6,350	35,460	8,040	92%	96%	88%

* Nursing home, hospital, clinic, doctor's office, or other medical facility.
** Includes some properties not listed separately above.

Note: These are percentages of fires reported to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. In Version 5.0 of NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system. Buildings under construction are excluded. Percentages are based on estimated total fires reported in NFIRS Version 5.0 with the indicated type of automatic extinguishing system and system performance not coded as fire too small to activate systems. Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire."

Source: NFIRS and NFPA fire experience survey.

Table 6. (Continued)
Sprinkler Reliability and Effectiveness When Fire Was Coded as Not Confined and Large Enough to Activate Sprinkler and Sprinkler Was Present in Area of Fire, by Property Use: 2010-2014 Annual Averages

B. Wet Pipe Sprinklers Only

Property Use	Number of fires per year where sprinklers were present	Non-confined fires too small to activate or unclassified operation	Fires coded as confined fires	Number of qualifying fires per year	Percent where equipment operated (A)	Percent effective of those that operated (B)	Percent where equipment operated effectively (A x B)
All public assembly	3,080	490	2,030	560	90%	96%	86%
Eating or drinking establishment	1,450	250	860	340	93%	95%	89%
Educational property	1,670	370	1,140	160	90%	96%	86%
Health care property*	2,740	530	1,940	270	88%	97%	85%
All residential	28,050	2,320	21,970	3,770	96%	96%	93%
Home (including apartment)	21,760	1,680	16,730	3,350	95%	96%	91.2%
Hotel or motel	1,850	320	1,240	300	91%	99%	89.8%
Store or office	3,710	890	1,860	950	90%	96%	87%
Grocery or convenience store	830	210	460	170	89%	95%	85%
Department store	380	140	140	110	89%	99%	88%
Office	980	200	620	160	91%	98%	89%
Manufacturing facility	2,010	520	650	850	91%	94%	86%
All storage	510	100	150	250	82%	96%	79%
Warehouse excluding cold storage	290	60	80	160	84%	97%	82%
All Structures**	43,540	5,540	30,790	7,210	89%	96%	86%

* Nursing home, hospital, clinic, doctor's office, or other medical facility.
** Includes some properties not listed separately above.

Note: These are percentages of fires reported to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. In Version 5.0 of NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system. Buildings under construction are excluded. Percentages are based on estimated total fires reported in NFIRS Version 5.0 with the indicated type of automatic extinguishing system and system performance not coded as fire too small to activate systems. Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire."

Source: NFIRS and NFPA fire experience survey.

Table 6. (Continued)
Sprinkler Reliability and Effectiveness When Fire Was Coded as Not Confined and Large Enough to Activate Sprinkler and Sprinkler Was Present in Area of Fire, by Property Use: 2010-2014 Annual Averages

C. Dry Pipe Sprinklers Only

Property Use	Number of fires per year where sprinklers were present	Non-confined fires too small to activate or unclassified operation	Fires coded as confined fires	Number of qualifying fires per year	Percent where equipment operated (A)	Percent effective of those that operated (B)	Percent where equipment operated effectively (A x B)
All residential	2,700	240	2,230	230	79%	95%	76%
Homes	2,140	180	1,800	160	91%	95%	88%
Store or office	450	110	260	80	77%	89%	68%
Manufacturing facility	290	70	80	150	82%	93%	77%
All storage	150	40	70	50	73%	93%	68%
All structures*	4,770	660	3,480	630	79%	94%	74%

* Includes some properties not listed separately above.

Note: These are percentages of fires reported to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. In Version 5.0 of NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system. Buildings under construction are excluded. Percentages are based on estimated total fires reported in NFIRS Version 5.0 with the indicated type of automatic extinguishing system and system performance not coded as fire too small to activate systems. Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire."

Source: NFIRS and NFPA fire experience survey.

Table 7.
Number of Sprinklers Operating, by Type of Sprinkler
2010-2014 Structure Fires Excluding Properties under Construction

Number of Sprinklers Operating	Percentage of structure fires where that many sprinklers operated			
	Wet pipe	Dry pipe	Other type sprinkler	All sprinklers
1	80%	67%	51%	79%
1 or 2	93%	82%	66%	91%
1 to 3	95%	87%	77%	94%
1 to 4	97%	89%	86%	96%
1 to 5	97%	92%	88%	97%
1 to 10	99%	97%	99%	99%

Note: Percentages are based on structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. Percentages are based on fires where sprinklers were reported present and operating and there was reported information on number of sprinklers operating. Figures reflect recodings explained in Introduction: Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire." In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. Buildings under construction are excluded, as are partial systems and fires reported as confined fires.

Source: NFIRS and NFPA fire experience survey.

Table 8.
Reasons for Failure to Operate in Fires with Non-Confined Structure Fire Incident Types Large Enough to Activate Sprinkler that Was Present in Area of Fire, by Property Use Based on Estimated Number of 2010-2014 Structure Fires per Year

A. All Sprinklers

Property Use	System shut off	Manual intervention defeated system	System component damaged	Lack of maintenance	Inappropriate system for type of fire	Total fires per year
All public assembly	45%	17%	4%	22%	12%	63
Eating or drinking establishment	43%	12%	3%	27%	15%	39
All residential	59%	21%	9%	7%	4%	257
Home (including apartment)	62%	18%	10%	7%	3%	203
Store or office	62%	16%	7%	5%	9%	97
Manufacturing facility	59%	14%	5%	12%	9%	89
All structures*	59%	17%	7%	10%	7%	657

* Includes some properties not listed separately above.

Note: Percentages are based on structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. Percentages are based on fires where sprinklers were reported present and operating and there was reported information on number of sprinklers operating. Figures reflect recodings explained in Introduction: Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire." In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. Buildings under construction are excluded, as are partial systems and fires reported as confined fires. Fires reported with unclassified reason for failure are treated as cases of unknown reasons for failure.

Source: NFIRS and NFPA fire experience survey.

Table 8. (Continued)
Reasons for Failure to Operate in Fires with Non-Confined Structure Fire Incident Types Large Enough to Activate Sprinkler that Was Present in Area of Fire, by Property Use Based on Estimated Number of 2010-2014 Structure Fires per Year

B. Wet Pipe Sprinklers Only

Property Use	System shut off	Manual intervention defeated system	System component damaged	Lack of maintenance	Inappropriate system for type of fire	Total fires per year
All public assembly	50%	24%	3%	13%	10%	44.00
Eating or drinking establishment	47%	16%	5%	21%	11%	25.00
All residential	60%	21%	9%	6%	4%	225.00
Home (including apartment)	63%	19%	9%	6%	3%	181.00
Store or office	60%	19%	8%	4%	10%	81.00
Manufacturing facility	58%	18%	2%	8%	14%	64.00
All structures*	59%	20%	7%	7%	7%	530.00

C. Dry Pipe Sprinklers Only

Property Use	System shut off	Manual intervention defeated system	System component damaged	Lack of maintenance	Inappropriate system for type of fire	Total fires per year
All structures	61%	9%	8%	16%	5%	98.00

* Includes some properties not listed separately above.

Note: Percentages are based on structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. Percentages are based on fires where sprinklers were reported present and operating and there was reported information on number of sprinklers operating. Figures reflect recodings explained in Introduction: Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire." In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. Buildings under construction are excluded, as are partial systems and fires reported as confined fires. Fires reported with unclassified reason for failure are treated as cases of unknown reasons for failure.

Source: NFIRS and NFPA fire experience survey.

Table 9.
Reasons for Ineffectiveness in Fires with Non-Confined Structure Fire Incident Types Large Enough to Activate Sprinkler that Was Present in Area of Fire, by Property Use Based on Estimated Number of 2010-2014 Structure Fires per Year

A. All Sprinklers

Property Use	Water did not reach fire	Not enough water released	System Component damaged	Manual intervention defeated system	Lack of maintenance	Inappropriate system for type of fire	Fires per year
All public assembly	69%	21%	0%	0%	5%	5%	41
Eating or drinking establishment	69%	25%	0%	0%	6%	0%	33
All residential	39%	40%	7%	3%	5%	7%	119
Home (including apartment)	40%	35%	8%	3%	6%	9%	102
Store or office	39%	32%	8%	13%	4%	4%	34
Manufacturing facility	39%	26%	9%	9%	13%	6%	62
All structures*	44%	30%	8%	7%	7%	5%	300

* Includes some properties not listed separately above.

Note: Percentages are based on structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. Percentages are based on fires where sprinklers were reported present and operating and there was reported information on number of sprinklers operating. Figures reflect recodings explained in Introduction: Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire." In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. Buildings under construction are excluded, as are partial systems and fires reported as confined fires. Fires reported with unclassified reason for failure are treated as cases of unknown reasons for failure.

Source: NFIRS and NFPA fire experience survey.

Table 9. (Continued)
Reasons for Ineffectiveness When Fire Was Coded as Not Confined and Large Enough to Activate Sprinkler and Equipment that Was Present in Area of Fire, by Property Use
Based on Estimated Number of 2010-2014 Structure Fires per Year

B. Wet Pipe Sprinklers Only

Property Use	Water did not reach fire	Not enough water released	System component damaged	Manual intervention defeated system	Lack of maintenance	Inappropriate system for type of fire	Total fires per year
All public assembly	66%	26%	0%	0%	0%	8%	25
Eating or drinking establishment	66%	34%	0%	0%	0%	0%	17
All residential	42%	37%	8%	3%	3%	6%	108
Home (including apartment)	43%	33%	10%	4%	3%	7%	93
Store or office	34%	35%	6%	19%	0%	5%	29
Manufacturing facility	36%	31%	3%	12%	12%	6%	46
All structures*	43%	32%	6%	10%	5%	5%	240

C. Dry Pipe Sprinklers Only

Property Use	Water did not reach fire	Not enough water released	System component damaged	Manual intervention defeated system	Lack of maintenance	Inappropriate system for type of fire	Total fires per year
All structures	**42%**	**27%**	**11%**	**0%**	**12%**	**8%**	**33**

* Includes some properties not listed above.

Note: Percentages are based on structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. Percentages are based on fires where sprinklers were reported present and operating and there was reported information on number of sprinklers operating. Figures reflect recodings explained in Introduction: Fires are excluded if the reason for failure or ineffectiveness is "system not present in area of fire." Fires are recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires are recoded from "failed to operate" to "operated but ineffective" if the reason for failure or ineffectiveness was "not enough agent" or "agent did not reach fire." In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. Buildings under construction are excluded, as are partial systems and fires reported as confined fires. Fires reported with unclassified reason for failure are treated as cases of unknown reasons for failure.

Source: NFIRS and NFPA fire experience survey.

Table 10.
Characteristics of Fatal Victims
In Fires with Sprinklers vs. No Automatic Extinguishing Equipment
2010-2014 Annual Averages

A. Fire or Victims by Sprinkler Presence and Performance

Sprinkler/AES Status	Deaths when sprinklers present		Deaths when no AES present	
Total civilian deaths	42	(100%)	2,659	(100%)
Operated and effective	*29*	*(69%)*		
Fire too small to operate	*8*	*(20%)*		
Failed to operate	*1*	*(3%)*		
Operated but ineffective	*3*	*(8%)*		

B. Characteristics in Fires with Operating Sprinklers vs. No AES

Fire or Victim Characteristic	Deaths when sprinklers present		Deaths when no AES present	
With operating Sprinklers	29	(100%)	2,659	(100%)
Victim in area of origin	26	(90%)	1,319	(50%)
Involved in ignition	*23*	*(80%)*	*940*	*(35%)*
Not involved in ignition	*3*	*(10%)*	*379*	*(14%)*
Victim 65 or older	15	(52%)	833	(31%)
Clothing on fire	7	(26%)	192	(7%)
Physically disabled	4	(13%)	139	(5%)
Victim returned to fire, unable to act, or acted irrationally	7	(25%)	535	(20%)
Intentional fire	5	(16%)	368	(14%)
Sleeping	8	(8%)	854	(32%)

Note: Statistics are based on structure fires reported in NFIRS by U.S. municipal fire departments and so exclude fire reported only to federal or state agencies or industrial fire brigades. In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system. Buildings under construction are excluded.

Here is an example of how to read this table: Nearly all (90%) the people who died in fires despite the presence of operating sprinklers were located in the area of fire origin, hence closer to the fire and probably less able to escape than victims located farther from the fire, compared to only 50% of fatal victims in fires with no automatic extinguishing equipment present who were located in the area of fire origin.

Source: NFIRS and NFPA fire experience survey.

Appendix A.
How National Estimates Are Calculated

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit http://www.nfirs.fema.gov/. Copies of the paper forms may be downloaded from http://www.nfirs.fema.gov/documentation/design/NFIRS_Paper_Forms_2008.pdf.

NFIRS has a wide variety of data elements and code choices. The NFIRS database contains coded information. Many code choices describe several conditions. These cannot be broken down further. For example, area of origin code 83 captures fires starting in vehicle engine areas, running gear areas or wheel areas. It is impossible to tell the portion of each from the coded data.

Methodology may change slightly from year to year.
NFPA is continually examining its methodology to provide the best possible answers to specific questions, methodological and definitional changes can occur. *Earlier editions of the same report may have used different methodologies to produce the same analysis, meaning that the estimates are not directly comparable from year to year.*

NFPA's fire department experience survey provides estimates of the big picture.
Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are currently sent to all municipal departments protecting populations of 5,000 or more and a random sample, stratified by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

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

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; 3) the number and nature of non-fire incidents; and (4) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results. The results of the survey are published in the annual report *Fire Loss in the United States*. To download a free copy of the report, visit http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.

Projecting NFIRS to National Estimates

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

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

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission developed the specific basic analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates.

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

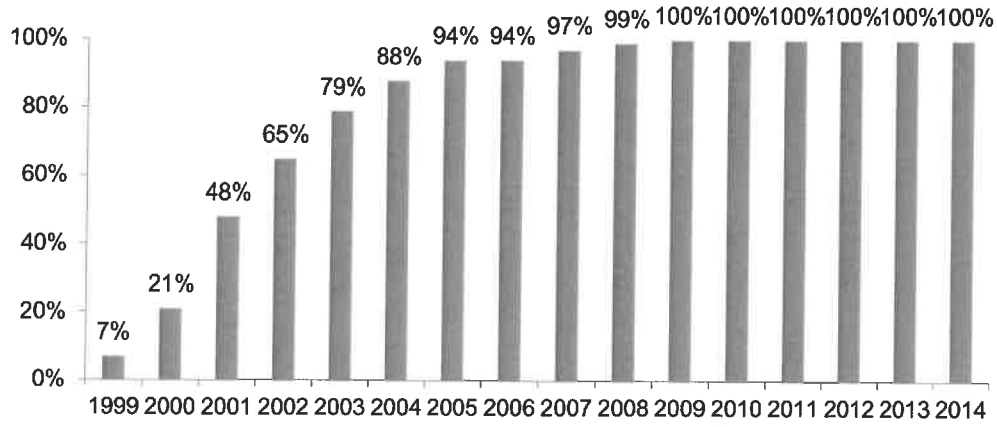
Figure A.1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

From 1999 data on, analyses are based on scaling ratios using only data originally collected in NFIRS 5.0:

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

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.

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



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

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

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases. 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.

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

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

Appendix B
Data Elements in NFIRS 5.0 Related to Automatic Extinguishing Systems

M1. Presence of Automatic Extinguishment System (AES)
This is to be coded based on whether a system was or was not present in the area of fire and is designed to extinguish the fire that developed. (The latter condition might exclude, for example, a range hood dry chemical extinguishing system from being considered if the fire began in a toaster.)

Codes:

N	None Present
1	Present
2	Partial system present (Added in 2005 for use beginning in 2006)
8	NFPA recode when M1AES Presence was coded as 1- Present, M3 AES Operation was coded as 4- Failed to operate and M5 AES Failure Reason was coded as 5- Fire not in area protected
U	Undetermined (restored to coding in 2003 for use beginning in 2004)

M2. Type of Automatic Extinguishment System
If multiple systems are present, this is to be coded in terms of the (presumably) one system designed to protect the hazard where the fire started. This is a required field if the fire began within the designed range of the system. It is not clear whether questions might arise over a system that is not located in the area of fire origin but has the area of fire origin within its designed range; this has to do with the interpretation of the "area" of fire origin.

Codes:

1	Wet pipe sprinkler
2	Dry pipe sprinkler
3	Other sprinkler system
4	Dry chemical system
5	Foam system
6	Halogen type system
7	Carbon dioxide system
0	Other special hazard system
U	Undetermined

M3. Automatic Extinguishment System Operation
This is designed to capture the "operation and effectiveness" of the system relative to area of fire origin. It is also said to provide information on the "reliability" of the system. The instructions say that "effective" does not necessarily mean complete extinguishment but does mean containment and control until the fire department can complete extinguishment.

Codes:

1	System operated and was effective
2	System operated and was not effective
3	Fire too small to activate the system
4	Failed to operate
0	Other
U	Undetermined

M4. Number of Sprinklers Operating
The instructions say this is not an indication of the effectiveness of the sprinkler system. The instructions do not explicitly indicate whether this data element is relevant if the automatic extinguishment system is not a sprinkler system (as indicated in M2). The actual number is recorded in the blank provided; there are no codes.

M5. Automatic Extinguishment System Failure Reason
This is designed to capture the (one) reason why the system "failed to operate or did not operate properly." The instructions also say that this data element provides information on the "effectiveness" of the equipment. It is not clear whether this is to be completed if the system operated properly but was not effective.

Text shown in brackets is text shown in the instructions but not on the form. Note that for code 4, the phrase "wrong" is replaced by "inappropriate" in the instructions; the latter term is more precise and appropriate, although it is possible for the type of fire to be unexpected in a given occupancy.

Codes:

1	System shut off
2	Not enough agent discharged [to control the fire]
3	Agent discharged but did not reach [the] fire
4	Wrong type of system [Inappropriate system for the type of fire]
5	Fire not in area protected [by the system]
6	System components damaged
7	Lack of maintenance [including corrosion or heads painted]
8	Manual intervention [defeated the system]
0	Other _____ [Other reason system not effective]
U	Undetermined

References

[1] U.S. Fire Administration, National Fire Data Center, *National Fire Incident Reporting System Complete Reference Guide* (U.S. Fire Administration, 2015), https://www.usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf.

[2.] H.J. Haynes, *U.S. Fire Loss during 2015* (FLX10), (Quincy, MA, U.S.: National Fire Protection Association, 2016), 2-3, http://www.nfpa.org//~/media/files/news-and-research/fire-statistics/overall-fire-statistics/osfireloss.pdf.

[3] J. R. Hall, Jr. and B. Harwood, B. "The National Estimates Approach to U.S. Fire Statistics," *Fire Technology* 25 no. 2 (1989): 99-113, http://www.nfpa.org/~/media/files/news-and-**research**/fire-statistics/latest-estimates/nationalestimatesapproach.pdf?la=en

[4.] M. Ahrens, *High-Rise Building Fires* (USS30) (Quincy, MA: National Fire Protection Association, 2016), 8. http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fires-by-property-type/high-rise-building-fires.

[5] M Ahrens, *Smoke Alarms in U.S. Home Fires* (USS04) (Quincy, MA: National Fire Protection Association, 2015), 47, http://www.nfpa.org/~/media/files/news-and-research/fire-statistics/fire-protection-systems/ossmokealarms.pdf?la=en.

[6] U.S. Fire Administration, National Fire Data Center, *National Fire Incident Reporting System Complete Reference Guide* (U.S. Fire Administration, 2015) 3-27- 3-28. https://www.usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf.

[7] U.S. Census Bureau, American Housing Survey, "2011 National - Health and Safety Characteristics - All Occupied Units, Variable 1, Units by Structure Type." American Housing Survey Table Creator, accessed March 23, 2017 , https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html#?s_areas=a00000&s_year=n2011&s_tableName=TableS01&s_byGroup1=a3&s_byGroup2=a1&s_filterGroup1=t1&s_filterGroup2=g1

[8] J. Hall, Jr., M. Ahrens, and B. Evarts, *Sprinkler Impact on Fire Injury*, (Quincy, MA: Fire Protection Research Association, 2012), 6, 19.

[9] U.S. Fire Administration, National Fire Data Center, *National Fire Incident Reporting System Complete Reference Guide* (U.S. Fire Administration, 2015): 3-27- 3-28. https://www.usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf

[10] Richard Upham, *Residential fire sprinkler reliability in homes older than 20 years old in Scottsdale, AZ* (Emmitsburg, MD: National Fire Academy, 2008), 17-19, 28-29. https://nfa.usfa.fema.gov/pdf/efop/efo42677.pdf