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Access to Virginia-Specific Fire Data is Lacking:

All stakeholders should have equal access to data related to residential home fire incidents, deaths, injuries, causes, and other relevant information. Currently, the US Fire Administration dashboard contains informative, but surface level, data regarding the fire casualties by incident type, residential structure fire casualties, and a handful of other data points. However, there is a dearth of publicly available, substantive, and comprehensive data that would inform stakeholders about residential home fire trends in Virginia. According to their website, the US Fire Administration annually collects data from 24,112 fire departments across the country – however, that data is only available by 1) ordering a "CD or DVD" – free of charge. Some stakeholders have the option to download the data from the USFA website – however, the information is provided in countless raw data files that require a "…database management system and expertise in SQL and/or other database programming language" to access[1]. The USFA also has a disclaimer that the database is for "researchers and fire data analysts" and that users "should have considerable experience with fire data analysis and NFIRS data to properly use the PDR".

I understand that this is a complex data set with 24,000 fire departments inputting a lot of data set – but there is little-to-no ability for non-fire data analysts to dive into the numbers, aside from the relatively high-level reports published by the NFPA. Additionally, unless I'm missing something, the NFPA does not make publicly available any reports specific to Virginia – it's all national-level data.

I have also attempted to find more Virginia-specific data on the Virginia Department of Fire Programs (VDFP) website – my assumption being that USFA and NFPA focus on national data, leaving the state-level data to VDFP to analyze and publish. There are currently several pages on VDFP's website devoted to data:

> **Fire and Data Statistics:** https://www.vafire.com/fire-and-data-statistics-2/ - There is a high-level chart which summarizes incidents between 2013-2018. However, the summary data has not been updated since 2018 – and there is little information that would be relevant to the discussion of townhome fire sprinklers. There also appears to be more substantive reports re: residential structure fire causes, incident types, etc – but those reports stopped being published on the VDFP website in 2015. And currently, there are only reports for 2013, 2014, and 2015.
>
> **VFIRS Facts and Figures**: https://www.vafire.com/vfirs-facts-and-figures/ - Same as above – this page contains high-level information.
>
> **VFIRS Annual Reports**: https://www.vafire.com/vfirs-annual-reports/ - The annual reports are probably the most substantive data set on the VDFP website, but the annual reports stopped being published in 2014. To the VDFP's credit, they have uploaded the annual reports for every

[1] USFA Website – NFIRS Data Download: https://www.usfa.fema.gov/nfirs/order/

year between 2007 to 2014, but there is no ability to look at all of this data over time, unless someone is willing to aggregate every data point from each report into a single spreadsheet.

As stated on the USFA's website, the purpose of having fire departments contribute to NFIRS is to:

- Analyze the severity and reach of the nation's fire problem.
- Use NFIRS information to develop national public education campaigns.
- Make recommendations for national codes and standards.
- Determine consumer product failures.
- Identify the focus for research efforts.
- Support federal legislation.

I imagine that the purpose of the VFIRS data is similar, if not identical. However, in its current "lock box form" where very few people can actually access it, it is extremely difficult to see how fire services representatives, local governments, legislators, or stakeholders can actually utilize that data to accomplish any of the goals mentioned above.

Again – I understand that this is an incredibly complex data set that probably requires a significant investment of time and resources by VDFP staff to collect, analyze, and publish. I also understand that the VDFP may not have the staff or resources available to undertake that endeavor – if that is the case, there should be a concerted effort by the stakeholders to advocate for a significant increase in state financial resources so that the VDFP can publish the data that would benefit local and state elected officials, local and state government staff, fire departments, and others.

Virginia-Specific Data is Needed to Inform Discussion re: Fire Sprinklers

The decision to require residential fire sprinkler systems in townhomes or single-family structures is a significant public policy decision that would have a direct impact on the cost of housing in Virginia. Although some stakeholders will debate the actual cost of the proposal, the very low number of states that have adopted some form of the requirement reflects the substantial nature of the public policy decision to require or not require residential fire sprinklers.

Given the impact that this proposal would have on the cost of housing – at a time where the housing affordability crisis is a top priority for local and state officials – this code proposal should not be adopted without a thorough review of Virginia-specific fire data – that level of review would allow the stakeholders and the Board of Housing and Community Development the opportunity to weigh the costs of potentially exclusionary market requirements against the public health benefits of raising the baseline standard of all new townhomes – and furthermore, would allow the stakeholders to determine whether a similar public safety benefit could be accomplished through a more cost-effective means for consumers.

Phrased differently – The stakeholders and the Board deserve the opportunity to evaluate Virginia-specific data to determine if, as some stakeholders claim, new homes are actually more susceptible to fires – or if the predominant number of residential fires (and death/injury resulting from a residential fire) are actually occurring in older structures built to a lesser standard. If the data demonstrates that the majority of residential home fires are occurring in older existing structures - or structures where smoke alarms are not installed or outdated/removed - we should focus our efforts on reducing/mitigating that risk by increasing consumer education about the importance of smoke alarms, establishing more “touch points” between fire services and renters/homeowners in areas known to be at a greater risk of home fires, and ensuring that localities and local fire departments have the resources they need to test and install modern smoke alarm technology in those structures, free of cost to the resident or tenant.

There is a large body of evidence which demonstrates that the proliferation of smoke alarms in residential structures has saved lives with virtually zero impact to the cost of housing for consumers – reports from both NFPA, NAHB, and third parties substantiate this claim. Similarly, advancements in smoke alarm technology have virtually eliminated the possibility of the battery being removed to power other electronic devices or to “stop the beeping” when a battery is running low – and as a result, has further reduced the number of fatalities in residential home fires. However, according to data that has been released by the NFPA, 41% of the home fire deaths were caused by fires in properties ***with no smoke alarms***[2]***.*** Furthermore, an additional 16% of home fire deaths occurred in properties where the smoke alarm failed to operate. Smoke alarms are a proven, cost-effective means of increasing public safety in residential structures – and the national data from the NFPA shows that there are still a large number of homes that are under-protected or unprotected.

The purpose of the Virginia Uniform Statewide Building Code is to establish a baseline standard of safety, quality, and efficiency in new residential structures. All residents deserve to be safe and secure in their homes or apartments – and the data shows that advancements in building codes coupled with the homebuilding industry’s response to consumer expectations have contributed to safer structures. However, not all homebuyers or renters can afford the additional costs of a residential fire sprinkler system – and the proposal to require these systems in all new townhomes would disproportionately impact individuals and families in the lower to middle end of the income spectrum.

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[2] NFPA Smoke Alarm Report (2021): https://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/Detection-and-signaling/ossmokealarms.pdf

Overview from Home Builders Association of Virginia:

The purpose of the Virginia Uniform Statewide Building Code is to establish a baseline standard of safety, quality, and efficiency in new residential structures. Proposed building codes should not be rejected outright because there may be associated costs, however, the Board of Housing and Community Development must weigh the effects of potentially exclusionary market requirements on the supply and access to housing for households across the income spectrum; and furthermore, identify other code requirements that may accomplish an identical public safety benefit through less exclusionary means.

Proponents of the proposal to mandate fire sprinkler systems in new single-family homes and townhomes have discounted concerns raised by the housing industry and other stakeholders regarding the proposal's impact on housing affordability and housing accessibility in Virginia. The housing crisis, both nationally and in Virginia, is well documented and has been identified as a top policy priority for state and local elected officials.

The Home Builders Association of Virginia has compiled several reports/studies regarding the housing affordability challenges in the Commonwealth and ask that the study group and the Board of Housing and Community Development consider this information while discussing the code proposal.

- Joint Legislative Audit and Review Committee (JLARC) Report: Affordable Housing in Virginia (December 2021)
- Metropolitan Washington Council of Governments: The Future of Housing in Greater Washington
- Virginia Housing Policy Advisory Council: Addressing the Impact of Housing for Virginia's Economy (November 2017)
- National Low Income Housing Coalition – Out of Reach Report, Virginia (2021)
- National Association of Home Builders – Priced Out Report (2022)

Joint Legislative Audit and Review Committee Report: Affordable Housing in Virginia

The Joint Legislative Audit and Review Commission (JLARC) conducts program evaluation, policy analysis, and oversight of state agencies on behalf of the Virginia General Assembly. In 2020, the Joint Legislative Audit and Review Commission (JLARC) directed staff to "conduct a review of affordable housing in Virginia. JLARC staff were asked to report on the "number of Virginia households that are housing cost burdened; the supply of affordable quality housing statewide and by region; the state's efforts to increase the supply of affordable housing and make existing housing more affordable through direct financial assistance; and the effectiveness of the management of the state's housing assistance programs."[1]

The report, which was released in December 2021, is a comprehensive analysis of the housing market in Virginia and, over the course of it's 200 pages, refutes any claims that housing affordability is not a dire crisis and challenge for localities and regions across the Commonwealth.

Summary of Report's Findings:

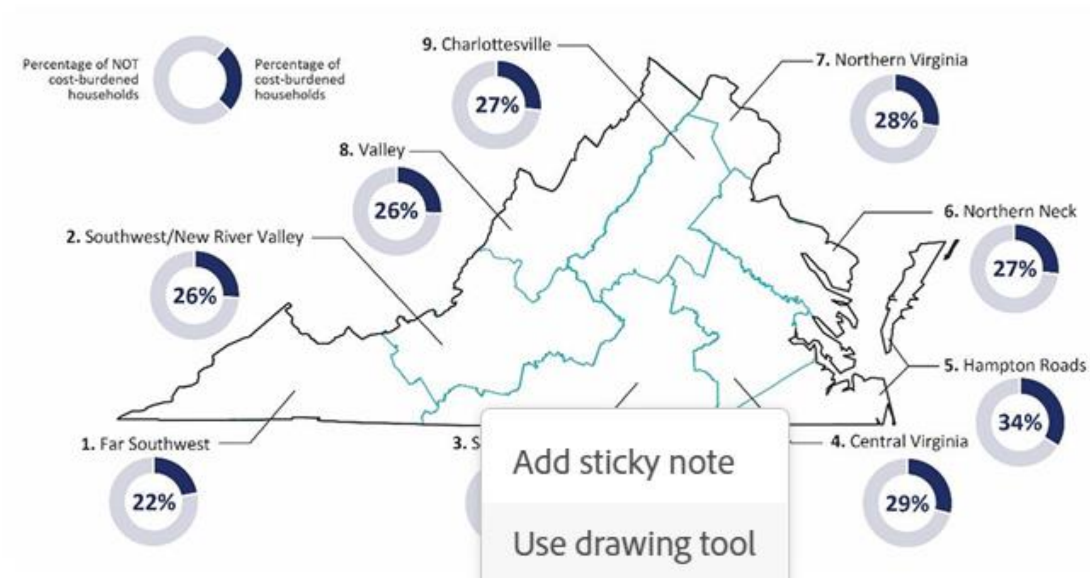
- "Approximately 29 percent of Virginia households (905,000) were housing cost burdened in 2019, and nearly half of these households spent more than 50 percent of their income on housing. Virginia

[1] JLARC Report: Affordable Housing in Virginia: http://jlarc.virginia.gov/landing-2021-affordable-housing-in-virginia.asp

ranks near the middle of states in terms of the percentage of households that are cost burdened." (JLARC Report: PDF Page 5)

  - "Households are considered housing cost burdened when they spend more than 30 percent of their income on housing expenses. Housing cost burden constrains households' budgets, making it difficult for households to afford other necessities and making eviction more likely." (JLARC Report: PDF Page 5)

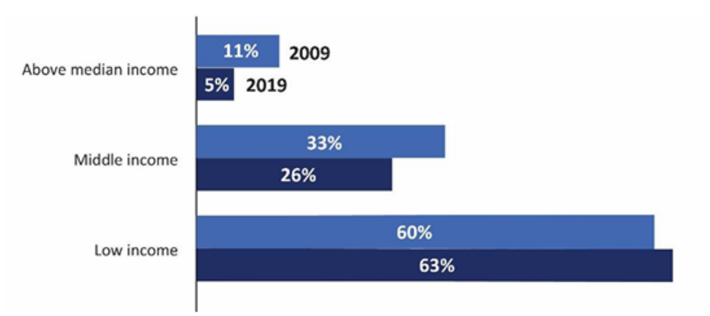
- Every region of the Commonwealth has a high percentage of households who are cost-burdened – see chart on next page



SOURCE: JLARC analysis of American Community Survey, 5 year data, 2015–2019.

- The Percentage of Cost Burdened Low-Income Households is Growing:
  - While the proportion and number of Virginia households that are cost burdened declined between 2009 and 2019, the prevalence of housing cost burden among low-income Virginians increased slightly from 60 percent to 63 percent over this period (Figure 2-6). This affects Virginians who work in common occupations that are essential to the state's economy and are paid low wages. For example, the median income for a home health aide in Virginia is approximately $22,000, which is considered very low income for a single person household (income between 31 and 50 percent AMI) (Figure 2-7). In another example, the median income for a bus driver is $45,000, which is considered low income for a single person household (income between 51 and 80 percent AMI). (JLARC Report: PDF Page 35)

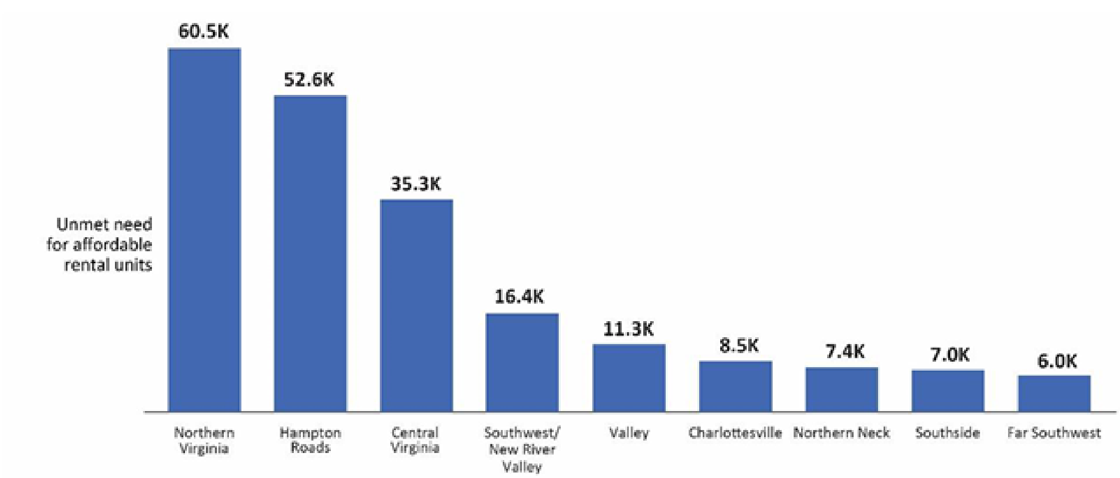
FIGURE 2-6
Percentage of cost burdened households grew among lower income households, 2009–2019



SOURCE: JLARC analysis of American Community Survey, 5 year data, 2005–2009 and 2015–2019.

- “Declining number of Virginians can afford to buy a home, and state has a shortage of at least 200,000 affordable rental units” (JLARC Report: PDF Page 5)
    - “Rising home prices have made it more difficult for Virginians to own their homes. The median home sales price in Virginia has risen 28 percent over the past four years to $270,000 in 2021. Virginia’s stock of homes that would be affordable to low- and middle-income households has declined substantially in the past few years.”
    - “Low- and middle-income households may have incomes that could support mortgage payments but lack the savings to cover the upfront costs of purchasing a home. Rising home prices mean that down payments and closing costs can be over $10,000 on even moderately priced homes.” (JLARC Report: PDF Page 6)
- Shortage of Affordable Units is Statewide – Every Region Needs AT LEAST 6,000 new affordable units
    - Virginia has a statewide shortage of at least 200,000 affordable rental units for extremely and very low income households. Only 42 out of every 100 extremely and very low income households can find affordable housing. The actual number of needed affordable rental units likely exceeds 200,000 because this figure is based on data from several years ago and assumptions about the most affordable units that can be created through programs like the federal Low Income Housing Tax Credit pro-gram (LIHTC) (JLARC Report: PDF Page 38)

FIGURE 2-8
Majority of affordable rental units are needed in Urban Crescent



SOURCE: JLARC analysis of American Community Survey, 5 year data, 2015–2019.
NOTE: All figures are rounded to the nearest 100. Figures may not add because of rounding.

- Median Home Sales Prices Have Risen Significantly between 2016-2021, 2020-2021

TABLE 2-4
Median home sales prices increased substantially, and especially rapidly in the past year

	Median home sales prices			Percentage change	
	2016	**2020**	**2021**	**2016 to 2021**	**2020 to 2021**
Northern Virginia	$508,000	$582,000	$650,000	28%	12%
Charlottesville	290,000	319,000	350,000	21	10
Hampton Roads	254,000	234,000	330,000	30	41
Northern Neck	267,000	270,000	325,000	22	20
Central Virginia	210,000	257,000	299,000	42	16
Valley	233,000	241,000	285,000	22	18
Southwest/New River Valley	192,000	196,000	217,000	13	11
Southside	125,000	134,000	177,000	42	32
Far Southwest	98,000	117,000	160,000	63	37
Statewide	$204,000	$234,000	$270,000	32%	15%

SOURCE: JLARC analysis of Monthly Median Sales Prices by County/Independent City, 2016 – present. Virginia REALTORS, updated July 15, 2021.
NOTE: Median cost home sales prices reflect the median prices in July of each year. Adjusted to 2021 dollars.

Metropolitan Washington Council of Governments – The Future of Housing in Greater Washington

Report can be found here: https://www.mwcog.org/documents/2019/09/10/the-future-of-housing-in-greater-washington/

The Metropolitan Washington Council of Governments (MWCOG) is an independent, nonprofit association, with a membership of 300 elected officials from 24 local governments, the Maryland and Virginia state legislatures, and U.S. Congress.

Key Findings:

- Continued growth and an increased demand to live here, "…the region now finds itself in a challenging situation. There is an imbalance between the number of jobs and the amount of housing available to the workforce. This gap is expected to widen without intervention; the region is forecast to add approximately 413,000 new jobs to its employment base between 2020 and 2030, but only approximately 245,000 new housing units over the same period."
- The Metropolitan Washington Council of Governments analysis "…showed the region needs, between 2020 and 2030, more than 75,000 additional households than what is currently anticipated (245,000 households). If the timeframe is stretched from 2020 to 2045, more than 100,000 additional households will be needed beyond the new households anticipated."
- "At least 75% of new housing should be affordable to low-and middle-income households."

Virginia Housing Policy Advisory Council – Addressing the Impact of Housing for Virginia's Economy (November 2017)

Report can be found here:
https://www.vchr.vt.edu/virginiahousingeconomiclinkages#:~:text=In%20October%202014%2C%20Governor%20McAuliffe,Council%20(HPAC)%20was%20thus%20established

Background:
In October 2014, Governor McAuliffe issued Executive Order (EO) 32, "Advancing Virginia's Housing Policy," to "identify and implement actions to enable quality, affordable housing, which will strengthen families and communities and foster economic growth." The Housing Policy Advisory Council (HPAC) was thus established under the leadership of the Secretary of Commerce and Trade to help guide the development and implementation of Virginia's housing policy.

A key directive of EO 32 was identifying the links between housing and economic and community development. To this end, the HPAC commissioned a study from a consortium of researchers at Virginia Tech, George Mason University, The College of William and Mary, and Virginia Commonwealth University, with the premise that successful housing policy must be based on independent analytic findings and best practices. The collaborative research of the four universities provides key information on the Commonwealth housing sector, focusing on the economic impact of housing, future scenarios impacting housing needs, and links between housing and other key policy sectors.

This report summarizes the research conducted by the four universities and the implications for Virginia's housing policy development. The report is designed to assist stakeholders and policymakers think more creatively and collaborate more intensely at the state, regional, and local levels as Virginia strives to build on the successes of the past and meet the pressing housing challenges facing the commonwealth. The entirety of the research is included in nine papers presented here.

Key Findings:

1. Virginia has a shortage of housing affordable to a substantial share of households. All regions of the state are experiencing significant shortages of affordable housing, as evidenced by the large share of households experiencing housing cost burdens across urban, suburban, and rural areas. Statewide, one in three households is cost burdened, spending more than 30 percent of their income for housing.

2. Failure to address affordable housing needs adequately has significantly affected key priorities of state policy, including economic and workforce development, transportation, education, and health.

3. Virginia needs to produce substantial new affordable housing to accommodate anticipated workforce growth. Virginia will need to house over 350,000 new workers in the next 10 years. The retirement of Baby Boomers and the entry of millennials into the workforce implies that a large share of new workers will be young with relatively low incomes and in need of affordable rental and homeownership units.

4. The homebuilding industry faces major challenges in meeting affordable housing needs. Nationally and in Virginia, the homebuilding industry faces challenges in affordable housing production for the following reasons:

   a. Developable residential site shortages and high land costs near major employment centers

   b. Construction labor supply constraints (especially in skilled trades)

   c. Limited means for reducing rapid increases in development costs

5. Regions with lower combined housing and transportation costs have experienced better economic performance.

6. Virginia can no longer rely on the federal government to address critical housing needs. Federal housing appropriations are severely constrained, and fiscal stress is expected to further reduce federal housing expenditures and increase the likelihood of devolution of housing assistance responsibilities to the states.

Appendix 2 of the report provides estimates of the amount, type (single-family and multi-family), tenure (owner and renter), price or rent, and location of housing that the Commonwealth of Virginia will need to accommodate new workers over the next decade. During this time Virginia will add 357,800 net new jobs, but to ensure that this employment growth can occur, a sufficient supply of housing must be available for these new workers—in the right locations, of the right types, and at affordable prices and rents. The analysis produced estimates for the Commonwealth and 11 Virginia regions.

Table 7. Net New Households by Home Price Affordable to Net New Households, Hampton Roads Region (2015 $s)

	2014-2024 Change		Share of Current Owner Households
	Households	Share of New Owner Households	
Less than $100,000	2,550	12.3%	9.3%
$100,000-199,999	7,250	35.2%	30.1%
$200,000-299,999	6,650	32.1%	29.2%
$300,000-399,999	2,850	13.8%	16.1%
$400,000+	1,350	6.6%	15.3%
Total	**20,600**	**100.0%**	**100.0%**

Numbers may not sum due to rounding.
Source: GMU Center for Regional Analysis

As shown in Table 8, the majority of new renters will earn over $25,000, and will be likely to find apartments that will suit their needs based on the current distribution of rents. A gap is likely to increase for homes renting for less than $625 per month, which would be affordable to households earning less than $25,000. Over a quarter (26.7 percent or 5,600 households) of the new renter households formed by the new workers

Table 3. Net New Households by Home Price Affordable to Net New Households, Charlottesville Region (2015 $s)

	2014-2024 Change		Share of Current Owner Households
	Households	Share of New Owner Households	
Less than $100,000	900	15.5%	9.7%
$100,000-199,999	1,800	31.7%	23.6%
$200,000-299,999	1,800	31.9%	23.6%
$300,000-399,999	850	15.0%	16.0%
$400,000+	350	5.9%	27.1%
Total	**5,650**	**100.0%**	**100.0%**

Numbers may not sum due to rounding.
Source: GMU Center for Regional Analysis

Similarly, some new renter households may have difficulty finding apartments at rents affordable to them. As shown in Table 4, about 1,200 new renter households will earn less than $25,000, and need rental units below $625 in order to spend less than 30 percent of their income on rent. An additional 1,500 renters will earn between $25,000 and $49,999, and can afford rents up to $1,249.

Table 11. Net New Households by Home Price Affordable to Net New Households, Lynchburg Region (2015 $s)

	2014-2024 Change		Share of Current Owner Households
	Households	Share of New Owner Households	
Less than $100,000	950	41.5%	25.5%
$100,000-199,999	650	28.0%	39.0%
$200,000-299,999	500	22.3%	19.9%
$300,000-399,999	150	6.4%	6.8%
$400,000+	50	1.9%	8.8%
Total	**2,300**	**100.0%**	**100.0%**

Numbers may not sum due to rounding.
Source: GMU Center for Regional Analysis

Likewise, the vast majority of new renter households will earn less than $25,000 (Table 12). These 1,150 new renter households will be able to afford rents under $625, and may have difficulty finding units. Currently, about 7,800 households rent for less than $625, and the nearly 15 percent increase in demand for this product may be difficult to meet through new construction.

Table 19. Net New Households by Home Price Affordable to Net New Households, Richmond Region (2015 $s)

	2014-2024 Change		Share of Current Owner Households
	Households	Share of New Owner Households	
Less than $100,000	2,150	9.0%	10.6%
$100,000-199,999	8,850	37.1%	35.7%
$200,000-299,999	6,700	28.1%	27.3%
$300,000-399,999	4,600	19.4%	13.4%
$400,000+	1,550	6.4%	13.0%
Total	**23,800**	**100.0%**	**100.0%**

Numbers may not sum due to rounding.
Source: GMU Center for Regional Analysis

As shown in Table 20, the new renter households will have more difficulty finding housing that is affordable to them. A quarter of new renters will be able to afford a maximum of $625 in rent, but only 12.2 percent of current units rent in that range. Similar to other markets, new product in this price range may be difficult to build, forcing many of the new households to pay more than 30 percent of their income on rent.

National Low Income Housing Coalition – Out of Reach Report (2021)

The National Low Income Housing Coalition's Out of Reach report documents the significant gap between renters' wages and the cost of rental housing across the United States. The report's central statistic, the Housing Wage, is an estimate of the hourly wage a full-time worker must earn to afford a modest rental home at HUD's fair market rent (FMR) without spending more than 30% of his or her income on housing costs, the accepted standard of affordability. The FMR is an estimate of what a family moving today can expect to pay for a modestly priced rental home in a given area.

Virginia Report Card can be found here:
https://reports.nlihc.org/sites/default/files/oor/files/reports/state/va-2021-oor.pdf

In Virginia, the Fair Market Rent (FMR) for a two-bedroom apartment is $1,269. In order to afford this level of rent and utilities — without paying more than 30% of income on housing — a household must earn $4,231 monthly or $50,767 annually. Assuming a 40-hour work week, 52 weeks per year, this level of income translates into an hourly Housing Wage of $24.41 per hour.

That translates into:

- 103 work hours per week at minimum wage to afford a two-bedroom rental home (at FMR)
- 88 work hours per week at minimum wage to afford a one-bedroom rental home (at FMR)
- 2.6 full time jobs at minimum wage to afford a two-bedroom rental home (at FMR)
- 2.2 full-time jobs at minimum wage to afford a one-bedroom rental home (at FMR)

National Association of Home Builders – "Priced Out" Report (2022)

This article presents the NAHB's "priced out estimates" for 2022, showing how higher prices and interest rates affect housing affordability. The 2022 US estimates indicate that a $1,000 increase in the median new home price ($412,5051) would price 117,932 households out of the market. As a benchmark, 87.5 million households (roughly 69 percent of all U.S. households) are not able to afford a new median priced new home. A $1,000 home price increase would make 117,932 more households disqualify for the new home mortgage. Home prices surged during the pandemic, creating affordability challenges, particularly for first-time buyers.

Other NAHB estimates in this paper show that for 2022, 25 basis points added to the mortgage rate at 30-year fixed rate of 3.5% would price out around 1.1 million households. In addition to the national numbers, NAHB once again is providing priced out estimates for individual states and more than 300 metropolitan areas. Other Key Findings:

- 87 million households in the US (and 1.7 million households in Virginia) are not able to afford a new median priced new home in 2022
- 36 Million Households Can't Afford a $150,000 Home:
    - Using the same standard underwriting criterion as the priced-out estimates to determine affordability (that the sum of mortgage payments, property taxes, home owners and private mortgage insurance premiums should be no more than 28% of the household income), the minimum income required to purchase a $150,000 home is $36,074. In 2022, about 36 million U.S. households are estimated to have incomes at or below that threshold. Another 24.4 million can only afford a home priced between $150,000 and $250,000 (the second step on the pyramid). Each step represents a maximum affordable price range for fewer and fewer households.
- In Virginia, a $1,000 increase in the median home price would price over 3,800 households out of the market

Report can be found here: https://www.nahb.org/-/media/05E9E223D0514B56B56F798CAA9EBB34.ashx?_ga=2.213243421.805995588.1647882212-336051620.1620423394

Richmond Region Builder

Direct/Tangible costs:

1. Cost to install system within each unit – $2.55-$2.75/sq. feet
    a. 2,015 sq. feet townhome would be $5,125.50 to $5,541.25
2. Infrastructure cost – 6" dedicated waterline for fire sprinkler distribution – very dependent on density and efficiency of layout - $2,100/townhome minimum. We are fairly dense and efficiently configured. This number could easily double or worse depending on the site constraints.

Intangible costs – these items add cost, but difficult to determine specific dollar amount.

1. Sitework prolonged: Fire line and domestic water line are not installed in the same trench. Increased exposure to weather, damage etc. due to added installation of materials and installation means and methods.
2. Vertical construction prolonged: Adds an additional trade to the construction process, adds firestopping complexity, insulation complexity and increases the number of inspections required to obtain a certificate of occupancy.
3. If static pressure of surrounding waterlines is insufficient booster pumps will be required to maintain minimum pressures on the upper levels of the home. Booster pump requires the construction of a heated, weather proof enclosure, power supply, and meter; **adding a minimum cost $20,000 if required.** This has happened in several of our projects in the Richmond Region.
4. Damage to system during construction creates catastrophic losses, usually passed on to insurance, raising premiums which then get passed on to future purchasers. This has also occurred at several of our properties.
5. Damages/failures after occupancy, creates catastrophic losses to homeowner and potentially neighboring homes and personal property. This has also happened at several properties.

Additional Notes:

- I've included sprinklers in several of our projects in the area – and can say that it certainly adds cost to the units – which is fine for us/the builder – but it does have the effect of shifting the price point of the units up, which means a different set a buyers are moving in. Units that may have been in line with "market rate" become above-market rate – and in some cases, they become "luxury units".
- We have noticed that several potential buyers have been uncomfortable about moving into a unit that has sprinklers in it – these have typically been consumers that have done some research and found stories about sprinklers going off when there isn't a fire, etc; in some of the larger townhome units, we've had some people concerned about their kids and their friends throwing toys at the sprinkler heads. The other frequent question that we get is if a homeowner has the ability to turn off the sprinkler after its been activated. We try to educate the potential buyer but are not always successful.
- Backflow Testing – we get questions about whether localities require annual inspection and if so, how expensive it is
- Longevity of the equipment – Most people live in their townhome for maybe 5-7 years; some go longer. But we have received questions about how long the infrastructure lasts and whether it will need to be replaced or updated after 5 years or so.

Stand Alone System - Public Water Supply

Item	Cost	Notes
Additional tap fees	$ 5,600.00	Cost of permit and tap of 1" non-metered water supply - per TOB Public Works Dept.
Exterior ditching and water pipe	$ 1,450.00	Secondary waterline install to the dwelling - established cost of water line install
Additional backflow preventer	$ 500.00	Backflow preventer and shutoff for sprinkler supply line
Sprinkler System Rough-In	$ 10,000.00	Piping, pressure testing, sprinkler heads, etc. - estimation by Fire Protection Services
Water flow alarm	$ 400.00	Reporting alarm system triggred by water flow - average from market research
Additional attic frost protection	$ 1,200.00	Water line encapsulation and crush protection in freezing area
Drain for water supply	$ 200.00	Cost for hub drain at point of supply
	$ 19,350.00	

Multi-Purpose System - Public Water Supply

Item	Cost	Notes
Additional tap fees	$ 6,960.00	Cost 1" water supply minus cost of standard 5/8" water meter - per TOB Public Works Dept.
Larger backflow preventer	$ 300.00	2" Backflow preventer and shutoff for multi-purpose system
Sprinkler System Rough-In	$ 10,000.00	Piping, pressure testing, sprinkler heads, etc.
Water flow alarm	$ 400.00	Reporting alarm system triggred by water flow
Additional attic frost protection	$ 1,200.00	Water line encapsulation and crush protection in freezing area
Drain for water supply	$ 200.00	Cost for hub drain at point of supply
	$ 19,060.00	

Private Water Supply - Costs are similar for both installation types

Item	Cost	Notes
Underground water storage	$ 4,200.00	Cost of cistern storage tank (1200 gallons), pump, and installation
Sprinkler System Rough-In	$ 10,000.00	Piping, pressure testing, sprinkler heads, etc.
Water flow alarm	$ 400.00	Reporting alarm system triggred by water flow
Additional attic frost protection	$ 1,200.00	Water line encapsulation and crush protection in freezing area
Back up power supply	$ 6,000.00	Power to pump
Drain for water supply	$ 200.00	Cost for hub drain at point of supply
	$ 22,000.00	

Home Fire Sprinkler® COALITION
Protect What You Value Most™

HFSC Fact Sheet

Formed in 1996, HFSC is a 501(c)(3) charitable organization and the leading resource for independent, noncommercial information about home fire sprinklers, their installation and operation, and their proven protection of people, pets and property. HFSC strives to improve and increase awareness of home fire dangers and the life safety benefits of sprinklers for residents and responding firefighters. HFSC creates original and effective educational content and advocacy resources and offers them at no cost. HFSC's BUILT FOR LIFE FIRE DEPARTMENT program (BFLFD) is a free resource that supports fire service public sprinkler education as a method to achieve local Community Risk Reduction goals. More than 3,200 BFLFD members routinely demonstrate how access to the right information and tools drives more and better home fire sprinkler education.

Home Fire Risk in One- and Two-Family Homes

Six people die in home fires every day. According to the National Fire Protection Association (NFPA) Fire Loss in the U.S. During 2020, home fires caused:

- 2,230 civilian fire deaths, 85% of all residential fire deaths.
- 8,600 injuries.
- $6.8 billion in direct property damage.

Today's one- and two-family homes are dangerous for residents and first responders (UL/NIST), burning faster and failing quicker (even collapsing). A home fire can become deadly in as little as two minutes. Homes burn faster due to modern home furnishings, more open spaces and unprotected lightweight wood construction.

Home Fire Mitigation

Fire sprinkler technology has been protecting a wide range of structures for more than a century, but their use has been slow to catch on in homes. The NFPA found that sprinklers were present in only 7% of 2021 home fires. Only California, Maryland and Washington, D.C. require statewide installation of sprinklers in new-home construction.

Broader installation of home fire sprinklers would save thousands of lives (USFA). Installing home fire sprinklers uniquely protects residents, property and the firefighters who respond to fires in these structures. According to the NFPA, the 2021 civilian fire death rate was 89% lower in structures with installed fire sprinklers. The rate of firefighter injuries was 60% lower in fires with sprinklers than in fires without sprinklers.

Home Fire Activation

If a fire occurs, the sprinkler closest to it activates automatically, in response to the high heat from a fire. That controls (often extinguishes) the flames, reduces the spread of toxic and damaging smoke, and provides time for occupants to escape. When sprinklers are present, fire is kept to the room of origin 96% of the time (NFPA). In most home fires, only one or two sprinklers will control the blaze. In fires in unsprinklered homes, the toxic smoke spreads widely and more area is exposed to heat, smoke and fire. This requires more water to be used for suppression with powerful fire department hoses. This greatly increases water and fire damages to the structure and contents.

First Responders

Installing home fire sprinklers helps communities in many ways, including protecting first responders from fire and exposure hazards. Today's home fires are dangerous for firefighters as well as occupants. Firefighters are 11 times more likely to be injured fighting structure fires; 87% of their injuries occur there (USFA 2019). The risk is not limited to fire exposure. Firefighters today face a 9% increase in cancer diagnoses and a 14% increase in cancer-related deaths, compared to the general population in the U.S. (National Institute for Occupational Safety and Health 2017)

Environment

Home fire sprinklers also protect property and the environment. In 2010, FM Global conducted a groundbreaking study of the environmental impact of fire sprinklers. Their research proved that sprinklers are green:

- Greenhouse gas emissions were cut by 97.8%
- Water usage was reduced between 50% and 91%
- Fewer persistent pollutants, such as heavy metals, were found in sprinkler wastewater versus fire hose water
- The high pH level and pollutant load of non-sprinkler wastewater are an environmental concern

In 2021, FM Global reaffirmed this important study, publishing *Environmental Impact of Residential Fires Review*, documenting that since 2010**:**

- 1.8 billion lbs. of greenhouse gases have been emitted into the atmosphere **due to the lack of home fire sprinklers**.
- **Installed home fire sprinklers would have reduced** greenhouse gas emissions by 97% to 54 million lbs.

Homebuyers

Today's homebuyers want smarter homes. In a recent national fire safety survey* of more than 2000 adults of all ages, 86% said fire safety was important as they look to buy a new home. After learning how home fire sprinklers work, 80 percent of millennials, the largest age group buying homes, said they would prefer to buy a home with fire sprinklers.

- HFSC Omnibus survey with Opinium, surveying a nationally representative sample of more than 2,000 US adults.

NFPA Reports:

US Experience with Sprinklers, Marty Ahrens October 2021: https://www.nfpa.org/News-and-Research/Data-research-and-tools/Suppression/US-Experience-with-Sprinklers

Fire Loss in the United States During 2020, Marty Ahrens and Ben Evarts September 2021: https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Fire-loss-in-the-United-States

NFPA RESEARCH

US Experience with Sprinklers

Marty Ahrens

October 2021

KEY FINDINGS

Sprinklers in Reported Structure Fires: All Occupancies

From 2015 to 2019, local fire departments responded to an estimated average of 51,000 structure fires per year (10 percent) in which sprinklers were present. These fires caused an average of 36 civilian deaths (1 percent) and $1 billion in direct property damage (9 percent) annually.

Sprinklers reduce the impact of fires. Compared to reported fires in properties with no automatic extinguishing systems (AES), when sprinklers were present, the civilian fire death and injury rates per fire were 89 percent and 27 percent lower, respectively. The rate of firefighter injuries per fire was 60 percent lower.

Fire spread was confined to the object or room of origin in 95 percent of reported structure fires in which sprinkler systems were present compared to 71 percent in properties with no AES.

Sprinklers have proven to be reliable in reported structure fires considered large enough to activate them. From 2015 to 2019, sprinklers operated in 92 percent of such fires and were effective at controlling the fire in 96 percent of the incidents in which they operated. Overall, sprinkler systems operated and were effective in 88 percent of the fires considered large enough to activate them.

The most common reason that sprinklers failed to operate was the system being shut off at some point before the fire.

One sprinkler is usually enough to control a fire. In 77 percent of the structure fires where sprinklers operated, only one operated. In 97 percent, five or fewer operated. In 99 percent, 10 or fewer operated.

Sprinklers in Reported Home Fires

Sprinklers were present in an estimated average of 23,600 of the reported home[i] structure fires per year in 2015–2019, resulting in an average of 23 civilian deaths, 555 civilian injuries, and $194 million in direct property damage annually.

The 7 percent of reported home structure fires that occurred in properties with sprinklers accounted for 1 percent of home fire deaths, 5 percent of home fire injuries, and 3 percent of home property loss.

Sprinklers operated in 95 percent of the home fires in which the systems were present and the fires were considered large enough to activate them. They were effective at controlling the fire in 97 percent of the fires in which they operated. Taken together, sprinklers operated effectively in 92 percent of the fires large enough to trigger them.

In 89 percent of the home fires with operating sprinklers, only one operated. In 99.5 percent, five or fewer operated.

Sprinklers save lives and reduce injuries and property loss. From 2015 to 2019, the civilian death and injury rates per reported home fire were 88 and 28 percent lower, respectively, and average property loss per home fire was 62 percent lower in reported home fires in which sprinklers were present compared to fires in homes with no AES.

The rate of firefighter injuries per home fire in which sprinklers were present was 78 percent lower than in homes with no AES.

In reported home fires in which sprinklers were present, the fire was confined to the object or room of origin 97 percent of the time compared to 74 percent in homes with no AES.

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[i] The term *home* includes one- and two-family homes, including manufactured housing and apartments or other multifamily homes.

INTRODUCTION

This report provides a statistical overview of sprinkler presence and performance in reported fires. This information is essential for understanding the prevalence, impact, reliability, and effectiveness of these systems and increasing their positive impact. Because the majority of fire deaths are caused by home fires, additional details are provided on sprinklers in fires in these properties.

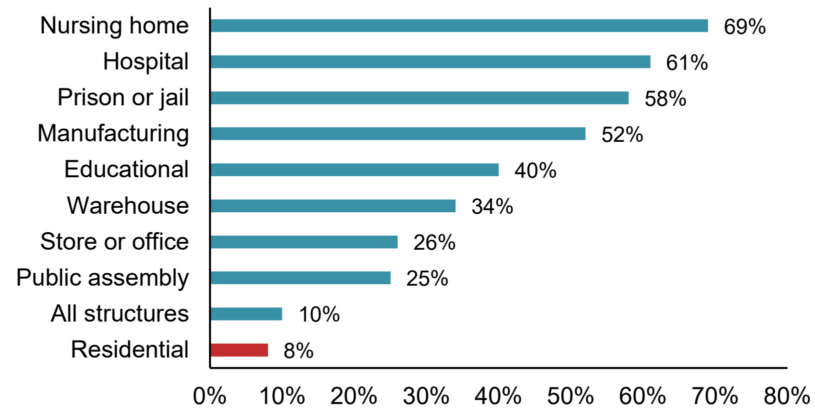
Estimates were derived from the details collected by the US Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey. Unless otherwise specified, estimates and rates in this report exclude fires in properties under construction. In addition, the casualty and loss estimates can be heavily influenced by the inclusion or exclusion of one unusually serious fire.

More detailed information is available in the supporting tables.

Sprinkler Presence and Type

Some type of sprinkler was present in an estimated average of 51,000 (10 percent) of the reported structure fires during 2015–2019. Sprinkler presence varied 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 the structure fires and associated civilian fire deaths, injuries, and direct property damage occurred in residential properties, particularly homes, only 8 percent of the reported residential fires occurred in properties with sprinklers. High-rise buildings are more tightly regulated and much more likely to have sprinklers than shorter structures.[1]

Figure 1. Presence of sprinklers in US structure fires by occupancy: 2015–2019



Some properties have both sprinkler and non-sprinkler AES. This is particularly likely in commercial kitchens. In such cases, only the AES type in the fire area would be recorded. This could result in underestimates of the presence of sprinklers in some occupancies.

Table A summarizes information about the various types of automatic extinguishing systems (AES) present in all the reported structure fires *except those in buildings under construction*. Figure 2 shows that wet pipe systems were in use at almost nine out of every 10 reported fires in which sprinklers were present.

Figure 2. Types of sprinklers present at US structure fires: 2015–2019

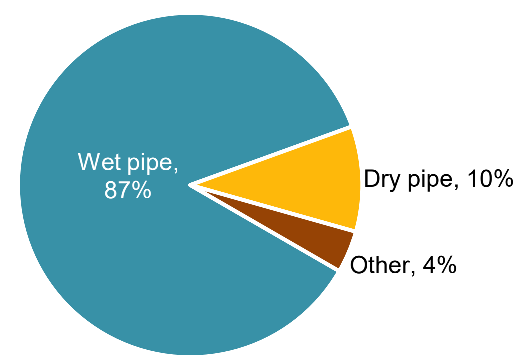
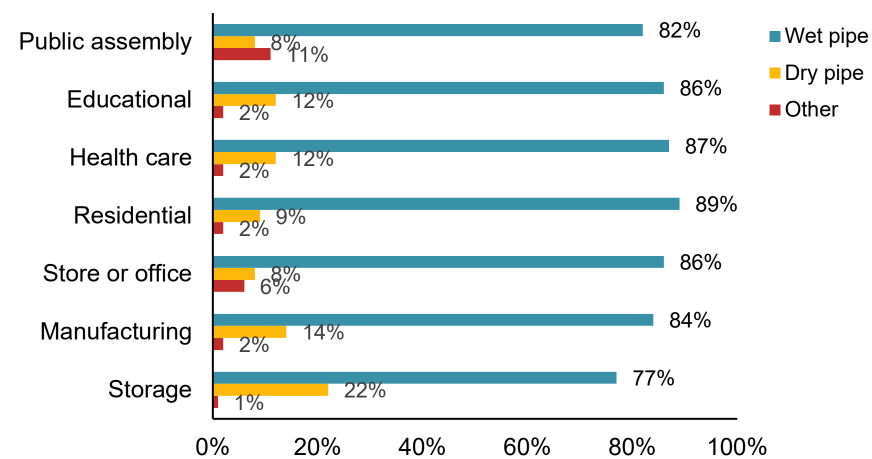


Table A. Summary of AES presence and type in reported structure fires: 2015–2019 annual averages

AES Presence and Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
AES present	**61,100**	**(13%)**	**37**	**(1%)**	**1,130**	**(9%)**	**$1,086**	**(10%)**
Sprinkler system present	51,000	(10%)	36	(1%)	1,020	(8%)	$1,008	(9%)
Wet pipe sprinkler system	*44,200*	*(9%)*	*33*	*(1%)*	*919*	*(7%)*	*$908*	*(9%)*
Dry pipe sprinkler system	*5,000*	*(1%)*	*2*	*(0%)*	*87*	*(1%)*	*$88*	*(1%)*
Other type of sprinkler system	*1,800*	*(0%)*	*1*	*(0%)*	*14*	*(0%)*	*$12*	*(0%)*
Non-sprinkler AES present	10,100	(2%)	1	(0%)	111	(1%)	$78	(1%)
Partial AES system of any type present	**2,500**	**(1%)**	**6**	**(0%)**	**54**	**(0%)**	**$109**	**(1%)**
AES of any type not in fire area and did not operate	**1,700**	**(0%)**	**2**	**(0%)**	**55**	**(0%)**	**$56**	**(1%)**
No AES present	**423,200**	**(87%)**	**2,816**	**(98%)**	**11,609**	**(90%)**	**$9,387**	**(88%)**
Total	**488,500**	**(100%)**	**2,862**	**(100%)**	**12,848**	**(100%)**	**$10,637**	**(100%)**

Figure 3 shows that dry pipe sprinkler systems were more common in storage occupancies. Table 2 in the supporting tables shows that other types of sprinkler systems were seen most frequently in eating and drinking establishments and grocery or convenience stores. It is possible that some of these other types were miscodes of systems designed specifically for cooking equipment.

Figure 3. Sprinkler system type by occupancy: 2015–2019



Fires in Properties with Sprinklers vs. with No AES

Figure 4 shows that the death rate per 1,000 reported fires was 89 percent lower in properties with sprinklers than in properties with no AES. These rates are based strictly on the reported presence or absence of this equipment; whether or not the system operated was not considered. Civilian deaths in sprinklered properties are discussed in greater detail later in this report.

Figure 4. Civilian death rates per 1,000 reported fires in properties with sprinklers and with no AES 2015–2019

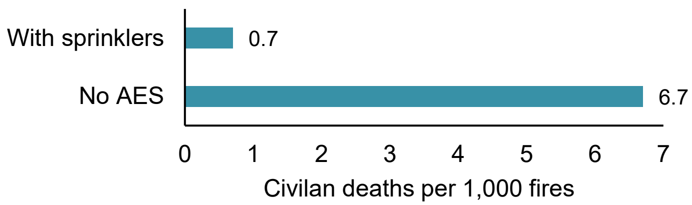


Figure 5 shows that the civilian injury rate per 1,000 reported fires was 27 percent lower in properties with sprinklers than in properties with no AES. Many of the injuries occurred in fires that were too small to activate the sprinklers. In others, someone was injured while trying to fight the fire in the initial moments before the sprinklers operated.

Figure 5. Civilian injury rates per 1,000 reported fires in properties with sprinklers vs. with no AES: 2015–2019

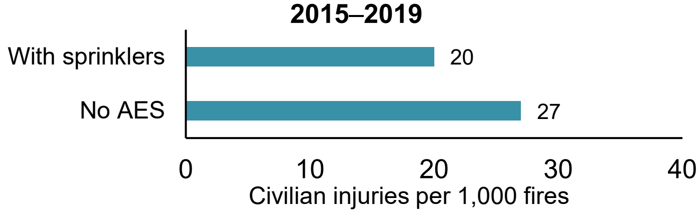
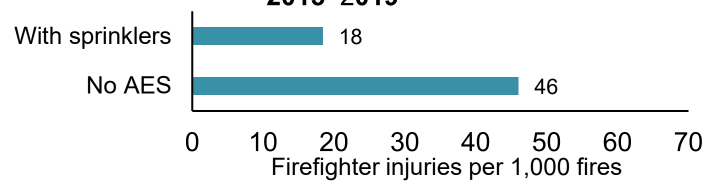


Figure 6 shows that the rate of firefighter injuries per 1,000 fires was 60 percent lower in structure fires with sprinklers compared to fires in properties without AES protection. Sprinklers begin to control a fire when they activate, making the situation less dangerous for responding firefighters.

Figure 6. Firefighter injury rates per 1,000 fires in properties with sprinklers vs. with no AES: 2015–2019

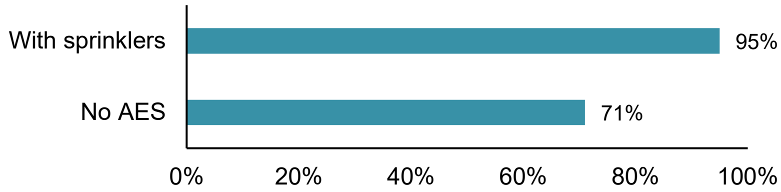


Reductions in the average dollar loss per fire when sprinklers were present varied greatly by occupancy. Table 4 in the supporting tables shows that compared to properties with no AES, the average overall loss was 11 percent lower in fires where sprinklers were present. The percentage reductions were highest in health care occupancies (73 percent), stores or offices (70 percent), public assembly occupancies (63 percent), and homes (62 percent).

The average loss per fire was higher in sprinklered warehouses and manufacturing properties than in those with no AES. Warehouse contents or expensive machinery may be rendered worthless by smoke alone. A very small fire can damage expensive manufacturing equipment. In the rare cases in which a sprinkler system fails to operate or operates ineffectively, the monetary loss can be exceedingly high, increasing the average loss for the occupancy type. For example, the average loss in sprinklered manufacturing properties was inflated by a $1.1 billion loss caused by a November 2019 Texas petrochemical plant explosion and the resulting multi-day fire and additional explosions.[2] The plant's wet pipe sprinkler system did not operate.

Sprinklers limit fire spread. Figure 7 shows a 24 percent increase in fires that were confined to the object or room of origin when sprinklers were present compared to fires with no AES.

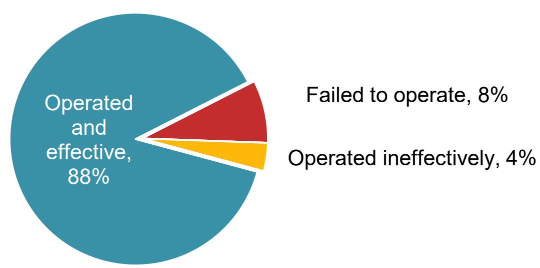
Figure 7. Percent of fires confined to object or room of origin in properties with sprinklers vs. with no AES: 2015–2019



Sprinkler Operation, Effectiveness, and Issues

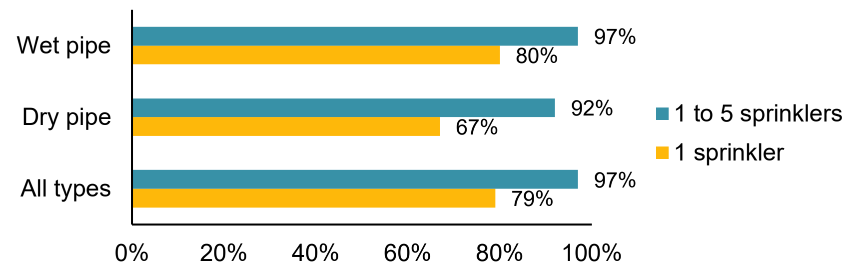
From 2015 to 2019, sprinklers operated in 92 percent of the fires in which they were present and the fire was considered large enough to activate them.[i] They were effective at controlling the fire in 96 percent of the fires in which they operated. Taken together, sprinklers operated effectively in 88 percent of the fires large enough to trigger them. (See Figure 8.) Details on sprinkler operation and effectiveness in different occupancies and for wet and dry pipe systems are provided in Table 6 of the supporting tables.

Figure 8. Sprinkler operation and effectiveness: 2015–2019



Sprinkler systems are designed to operate only where fire is present. Just one sprinkler activated in more than three-quarters (77 percent) of the fires in which sprinklers of any type operated and four out of five (80 percent) fires with operating wet pipe sprinkler systems. Figure 9 shows that in 97 percent of the fires in which sprinklers operated, five or fewer were activated. This was true for 92 percent of the dry pipe sprinkler systems.[ii] In 99 percent of the fires with operating sprinklers of any type, 10 or fewer sprinklers operated.

Figure 9. When sprinklers operated, percentage of fires in which one or one to five sprinklers operated by type of sprinkler system: 2015–2019



The following incident descriptions illustrate the effectiveness of sprinklers:

- Around 2:30 a.m., an alarm monitoring company alerted the local fire department to a system activation at a department store in a North Dakota mall. [3] Arriving firefighters initially saw no signs of fire or operating sprinklers. A store representative led them to a separate area where water was coming from under a closed office door. An electronic device left to charge overnight had overheated and started a small fire on the desk that spread to a chair. A single sprinkler extinguished the fire.

[i] These calculations exclude fires with confined structure fire incident types (NFIRS incident types 113–118). Among confined fires in which sprinklers were present, the fire was too small to activate the sprinklers 71 percent of the time, the sprinklers operated and were effective 14 percent of the time, and the sprinklers failed to operate 4 percent of the time. Since these fires are, by definition, confined, it is likely that a substantial share of the fires in which the sprinklers were said to fail, were, in fact, too small to cause the sprinkler to operate. The 41 percent of non-confined fires (NFIRS incident types 110–123, except for 113–118) that were too small to activate the sprinklers and the less than 1 percent of the non-confined structure fires in which sprinkler operation was unclassified were also excluded.

[ii] Fires with NFIRS confined fire incident types were included in these calculations.

- An intentional fire set along an exterior wall of a California nonprofit organization's storage facility spread inside.[4] The fire department was notified around 4:20 a.m. Two sprinklers controlled the inside fire and firefighters completed extinguishment. In the report, the investigator noted that the building would likely have been a total loss without the working sprinklers.
- A sprinkler at an Illinois fitness center controlled a dryer fire. [5] Responding firefighters used a pump can to extinguish the remaining fire inside the dryer. The maintenance worker who discovered the fire had attempted to put the fire out with an extinguisher. He was transported to the hospital for treatment of moderate smoke inhalation.

In 98 percent 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 sprinklers operated.

Figure 10. Percentage of fires in which sprinklers were effective by number that operated: 2015–2019

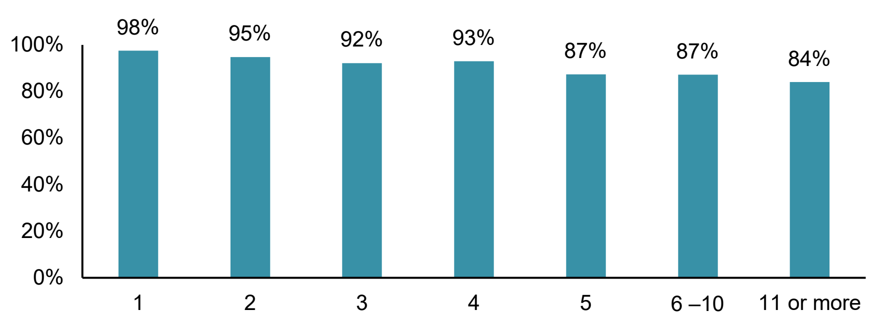


Figure 11 shows that in nearly three out of every five incidents in which sprinklers failed to operate, the system had been shut off.

- An October 2018 West Virginia warehouse fire in which the sprinklers had been shut off caused $10 million in property damage.[6] The warehouse contained plastic goods and recycled plastic.

Figure 11. Reasons for sprinkler failure: 2015–2019

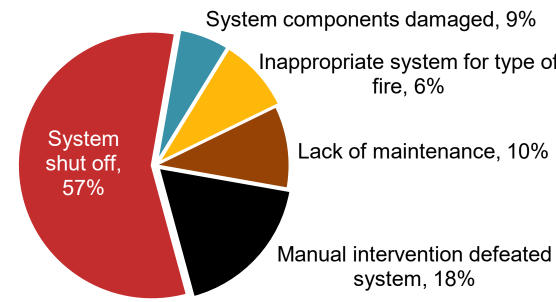
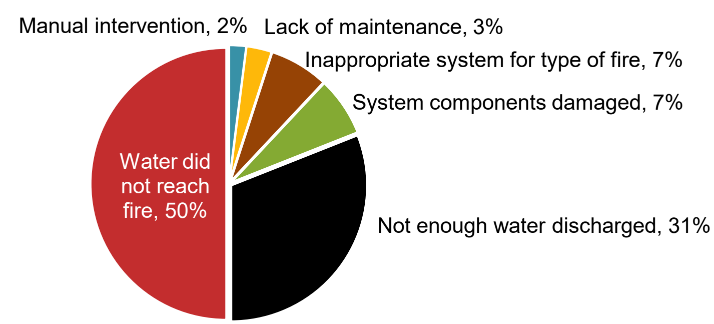


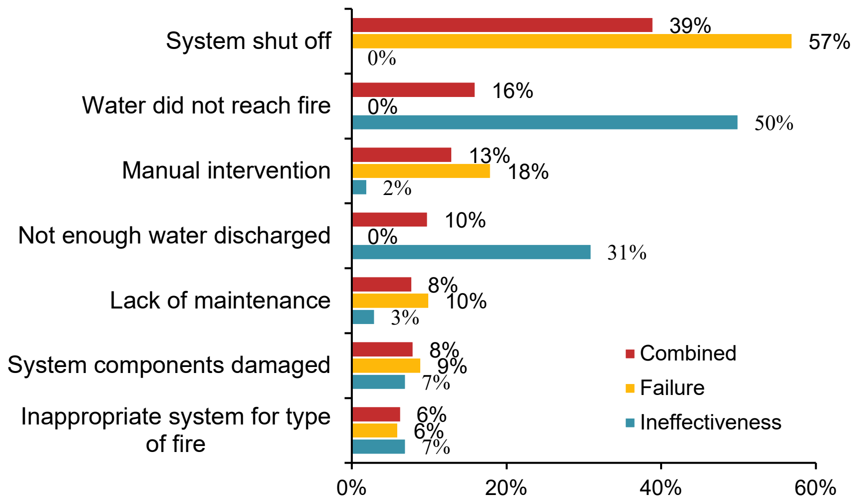
Figure 12 shows that in eight out of every 10 fires in which sprinkler systems operated ineffectively, the problem involved getting water to the fire. In half of the fires in which sprinklers were ineffective, the water did not reach the fire. In nearly one-third of the fires, not enough water was discharged.

Figure 12. Reasons for sprinkler ineffectiveness: 2015–2019



In 2015–2019, reported sprinkler failures (750 per year) were more than twice as common as reported fires in which sprinklers were ineffective (340 per year). Figure 13 shows the breakdown of each cause of failure or ineffectiveness individually and combined. For example, manual intervention was blamed for 13 percent of the total situations in which sprinklers were either ineffective or failed to operate at all. As noted earlier, manual intervention was blamed for 18 percent of the fires in which sprinklers failed to operate and 2 percent of the fires in which they were ineffective.

Figure 13. Reasons for combined sprinkler failure and ineffectiveness: 2015–2019



The categories in Figures 11–13 are based on NFIRS and sometimes overlap.

Long, Wu, and Blum explored the root causes of unsatisfactory sprinkler performance, dividing them into the following broad categories:[7]

- "Failure to maintain operational status of the system." Regular inspection, testing, and maintenance are essential to ensure sprinkler operability. Water being shut off before or during a fire is included in this category.
- "Failure to assure adequacy of the system and/or for the complete coverage of current hazard." Problems with the initial plans, installation errors, and changes to the structure or its contents could be captured here.
- "Defects affecting, but not involving, the sprinkler system." This includes water supply problems and building construction issues.
- "Inadequate performance by the sprinkler itself." Sprinkler systems have numerous components. A failure of one component can impact the larger system.
- All other situations, including fires that started on the structure's exterior, delays in notifying the fire department, etc.

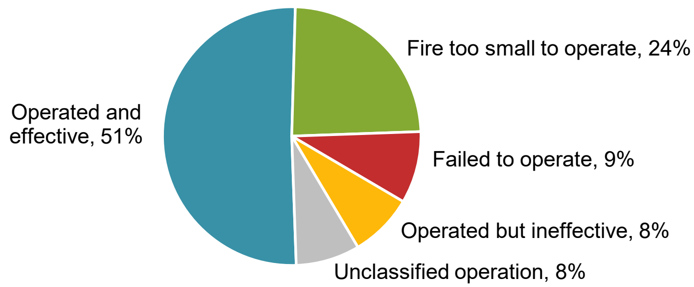
Civilian Deaths in Sprinklered Properties

While sprinklers were present in 10 percent of all the properties in which fires occurred in 2015–2019, only 1 percent of all the fire deaths occurred in these properties. Fires in sprinklered properties killed an average of 36 people per year in 2015–2019. Fires in properties that were not under construction and had no automatic extinguishing systems caused an average of 2,816 civilian deaths per year.

In fires that were large enough to activate sprinklers, 21, or 87 percent, of the fatalities per year resulted from fires in which the sprinklers operated. Of those who died in fires with operating sprinklers, 18, or 86 percent, died in fires in which the sprinklers operated effectively. Taken together, 18, or three-quarters (75 percent), of the 24 victims of fires large enough to activate sprinklers per year were fatally injured in fires in which the sprinklers operated and were effective.

Figure 14 shows that nine, or one-quarter, of the 36 victims per year of fires in sprinklered properties were fatally injured in fires that never became large enough to activate the sprinklers. In other cases, the sprinklers extinguished the fire. Victims in fires with sprinklers were typically fatally injured before the sprinklers activated. In both situations, the victims were usually intimate with the ignition. In some cases, the victim had been smoking in bed or while using medical oxygen. The victim's clothing may have caught fire while the victim was cooking or smoking.

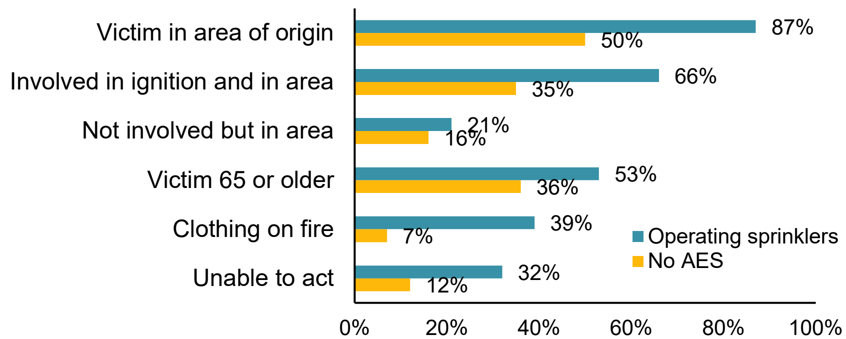
Figure 14. Civilian fire deaths by sprinkler performance: 2015–2019



- In 2015, a resident of a 7-story North Carolina apartment building was fatally injured when he lit a cigarette while using medical oxygen. The living room sprinkler extinguished his burning clothes and chair.[8]

Compared to victims of fires in which no AES was present, people who died in fires in which sprinklers operated were more likely to have been in the area of origin, been at least 65 or older, been wearing clothing that caught fire, or been unable to act, and even more likely to have been involved in the ignition and in the area. Figure 15 shows this contrast. Note that many of these differences are also evident among victims of fires with and without working smoke alarms.[9]

Figure 15. Victim characteristics in fires with operating sprinklers vs. with no AES: 2015–2019



There are limits to even the best fire protection. When someone is directly involved in the ignition of a fire or their clothing is burning, they may be fatally injured before the sprinkler system operates. If someone is physically incapable of getting themself to safety, even a fire controlled by sprinklers can still cause harm.

Three-quarters (76 percent) of the fire deaths in sprinklered properties resulted from fires that were confined to the object or room of origin. This was true for only 18 percent of the deaths from fires in which no AES was present. When present, sprinklers keep the fire from spreading and threatening those in other areas. A fire that is confined to the room of origin is much less dangerous to those outside the room.

Multiple death fires are rare when sprinklers are present. However, as mentioned earlier, exterior fires can challenge sprinkler protection. In addition, explosions can damage a sprinkler system, rendering it ineffective or non-functional.

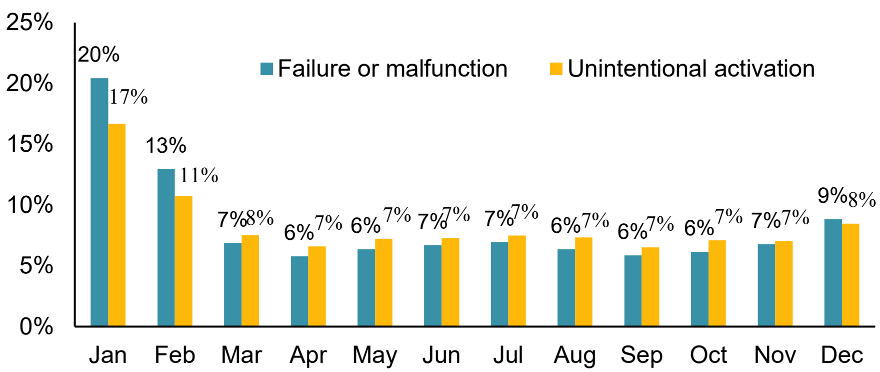
Two fires in 2015–2019 in which sprinklers were present resulted in four deaths each.

- Around 2:00 a.m. one morning in March 2017, a fire department was alerted to a fire at a Maryland assisted living facility of unprotected wood-frame construction.[10] One employee and six adult residents were in the structure at the time of the fire. All the residents required assistance to evacuate. A discarded cigarette had ignited leaves and grass outside the building. The flames spread to the exterior wall, porch, and into the confined ceiling space. Both detection and activation of the residential wet pipe sprinkler system were delayed because the fire was in the concealed space. Once activated, the sprinkler system controlled the fire. In addition to the four fatalities, three civilians were also injured.
- Around 9:30 p.m. on a May 2019 evening, an Illinois fire department was notified of an explosion and fire at a silicone manufacturing plant.[11] The plant was operating at the time. The explosion damaged both the detection and sprinkler systems, so they did not operate.

Unwanted Activations

Fire departments responded to an estimated average of 26,000 sprinkler activations caused by a system failure or malfunction per year and 29,700 unintentional sprinkler activations per year in 2015–2019. According to the *NFIRS 5.0 Complete Reference Guide,*[12] false alarms due to sprinkler failures or malfunctions include "any failure of sprinkler equipment that leads to sprinkler activation with no fire present." This category "excludes unintentional operating caused by damage to the sprinkler system." Unintentional activations also include "testing the sprinkler system without fire department notification." The winter months of December, January, and February account for only one-quarter of the year yet Figure 16 shows that 42 percent of the sprinkler system failures or malfunctions occurred in these three months, as did 36 percent of the unintentional activations. This suggests that cold weather and frozen pipes played a role.

Figure 16. Unwanted sprinkler activations by type and month: 2015–2019



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.

In their 2012 article on investigating inadvertent fire sprinkler discharges,[13] Blum, Long, and Dillon referred to Russ Fleming's 2000 description of the six primary reasons for non-fire discharges from sprinklers: overheating, freezing, mechanical damage, corrosion, deliberate sabotage, and mechanical defects.

Overheating can be caused by nearby equipment that may have been added after a sprinkler system was installed. While overheating typically affects the sprinkler and not the piping, freezing can impact the pipes. Mechanical damage can occur when a sprinkler is bumped by something such as a ladder, forklift, or tossed objects. Deliberate sabotage includes vandalism and disabling sprinklers to increase fire damage. While rare, manufacturing defects can also occur.

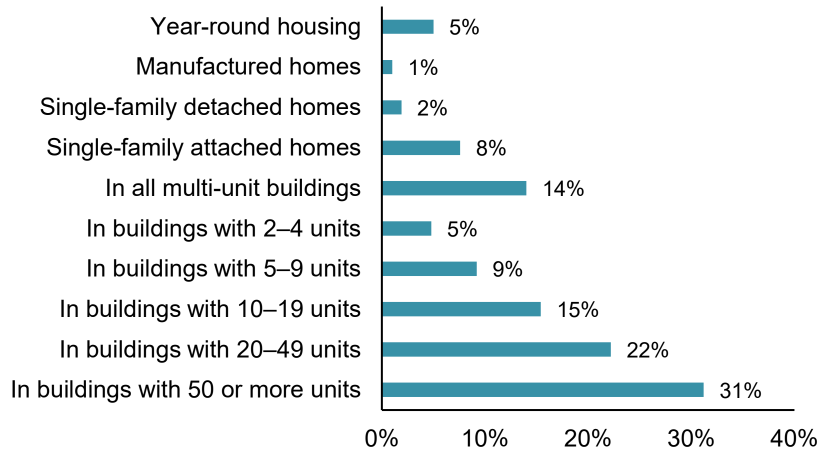
In a 2017 article, Huet, Martorano, and Ames described experiments involving intentional damage simulating random microscopic flaws to more than 100 glass bulb sprinklers. These were then exposed to a constant load in a test frame.[14] Forty-four of the sprinklers failed within 36 days, while the remaining 58 lasted more than two years. They concluded that unwanted activations due to damaged sprinkler bulbs tended to occur within days or weeks of the damage. Such damage, if undetected, could explain unwanted activations with no identifiable cause.

Sprinklers in Home Fires

Sprinkler Presence and Type

During 2015–2019, some type of fire sprinkler was present in an estimated average of 23,600 reported home structure fires (7 percent) per year. Properties under construction were excluded from these estimates. Table B summarizes information about automatic extinguishing systems (AES), including sprinklers, in all reported home structure fires except those under construction. According to the 2011 American Housing Survey, buildings with more housing units were more likely to have sprinklers. Figure 17 shows that 5 percent of housing units that are occupied year-round had sprinklers, ranging from a low of 1 percent in manufactured homes to a high of 31 percent in buildings with at least 50 units.[15]

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



Source: American Housing Survey

Figure 18 shows that wet pipe sprinkler systems were present in nine out of every 10 reported home fires with sprinklers.

Figure 18. Types of sprinkler systems present at home structure fires: 2015–2019

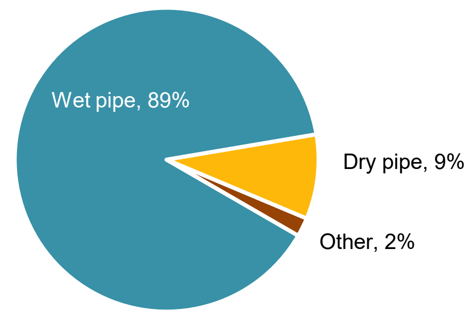


Table B. Summary of AES presence and type in reported home structure fires, excluding properties under construction: 2015–2019 annual averages

AES Presence and Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
AES present	**25,000**	**(7%)**	**24**	**(1%)**	**593**	**(5%)**	**$197**	**(3%)**
Sprinklers present	23,600	(7%)	23	(1%)	555	(5%)	$194	(3%)
Wet pipe sprinkler system	*21,000*	*(6%)*	*22*	*(1%)*	*477*	*(4%)*	*$185*	*(3%)*
Dry pipe sprinkler system	*2,100*	*(1%)*	*1*	*(0%)*	*69*	*(1%)*	*$8*	*(0%)*
Other type of sprinkler system	*500*	*(0%)*	*0*	*(0%)*	*9*	*(0%)*	*$1*	*(0%)*
Non-sprinkler AES present	1,400	(0%)	1	(0%)	38	(0%)	$3	(0%)
Partial system AES present	900	(0%)	5	(0%)	40	(0%)	$25	(0%)
AES not in fire area and did not operate	500	(0%)	0	(0%)	28	(0%)	$24	(0%)
None present	**318,500**	**(92%)**	**2,587**	**(99%)**	**10,408**	**(94%)**	**$6,907**	**(97%)**
Total	**344,900**	**(100%)**	**2,616**	**(100%)**	**11,036**	**(100%)**	**$7,153**	**(100%)**

Fires in Homes with Sprinklers vs. with No AES

Figure 19 shows that the civilian death rate per 1,000 reported fires was 88 percent lower in homes with sprinklers than in homes with no AES during 2015–2019. These rates are based only on the reported presence or absence of an AES; operation was not considered.

Figure 19. Civilian death rates per 1,000 fires in homes with sprinklers vs. with no AES: 2015–2019

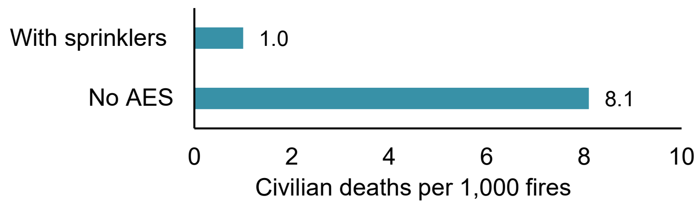


Figure 20 shows that the civilian injury rate per 1,000 reported fires was 28 percent lower in homes with sprinklers than in homes with no AES. In many cases, the injuries occurred in fires that were too small to activate the sprinkler system. In others, someone was injured while trying to fight the fire in the initial moments before the sprinklers operated. A 2012 Fire Protection Research Foundation study found that sprinkler presence was associated with a 53 percent reduction in the medical cost of civilian injuries per 100 home fires.[16]

Figure 20. Civilian injury rates per 1,000 fires in homes with sprinklers vs. with no AES: 2015–2019

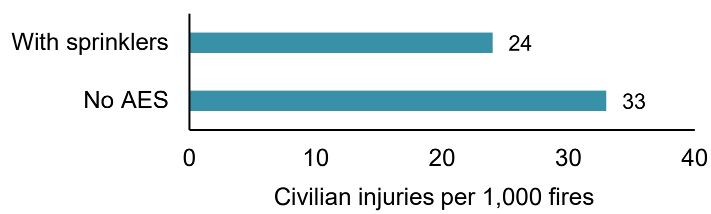
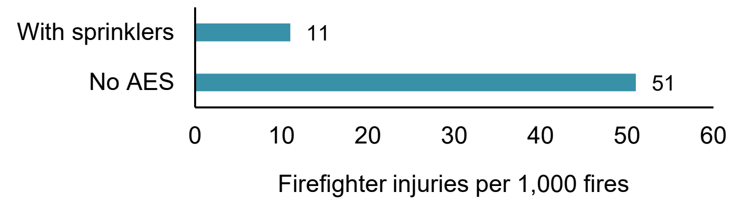


Figure 21 shows that the average firefighter fireground injury rate per 1,000 reported home fires was 78 percent lower when sprinklers were present than in fires with no AES.

Figure 21. Firefighter injury rates per 1,000 fires in homes with sprinklers vs. with no AES: 2015–2019



When sprinklers were present in reported home fires, the average property loss per fire was 62 percent lower than the average in homes with no AES. See Figure 22.

Figure 22. Average loss per fire in homes with sprinklers vs. with no AES: 2015–2019

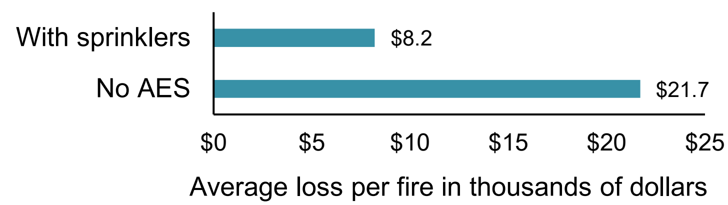
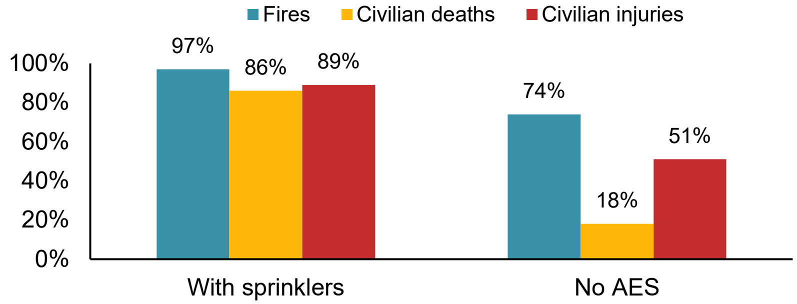


Figure 23 shows that when sprinklers were present, almost all of the fires were confined to the object or room of origin. The majority of civilian deaths and injuries resulting from fires in homes with sprinklers were caused by these fires. In home fires that lacked AES, only three-quarters of the fires were confined to the object or room of origin. Only one in five deaths and half of the injuries in home fires with no AES present resulted from such fires.

Figure 23. Percent of home fires, injuries, and casualties resulting from fires confined to object or room of origin: 2015–2019



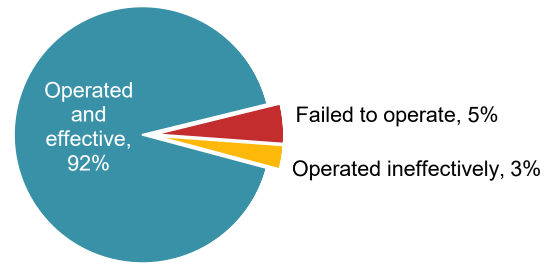
In rare cases, sprinklers may contain or even extinguish fires that cause fatal injuries. These injuries can occur *before* the fire's heat reaches a sprinkler. In some situations, the victim might be unable to move out of harm's way.

- An alarm monitoring company notified a fire department of a fire in a 12-story New York apartment building. By the time firefighters arrived, a wet pipe sprinkler system had operated and extinguished most of the fire in a third-floor apartment. A bed in the living room had been ignited by smoking materials. A male resident with a mobility impairment was severely burned and died at the hospital.[17]

Sprinkler Operation, Effectiveness, and Issues in Home Fires

Figure 24 shows that sprinklers operated in 95 percent of the home fires in which sprinklers were present and the fires were considered large enough to activate them.[i] They were effective at controlling the fire in 97 percent of the fires in which they operated. Taken together, sprinklers operated effectively in 92 percent of the fires large enough to trigger them.

Figure 24. Sprinkler operation and effectiveness in home fires: 2015–2019



Sprinklers protect occupants and property in many circumstances. Sometimes, no one is home or everyone has safely evacuated. Operating sprinklers can also protect a building and its occupants from incendiary fires. Fires that start on the exterior of a building can be particularly challenging, as they can enter into concealed spaces and spread before smoke alarms sound to alert occupants. Sprinkler protection for balconies can limit the damage from these fires. The following are several examples of such scenarios:

- One sprinkler operated to extinguish a grease fire that spread to the overhead cabinets in the kitchen of a second-floor Arizona apartment. The resident had gone outside while cooking and learned of the fire when an outdoor sprinkler alarm sounded. Another building resident called 911 to report the sprinkler activation and burning odor.[18]
- A dry pipe sprinkler system extinguished a fire in a second-floor unit in a three-story university apartment building in Colorado. A candle had been left burning unattended when the occupant left the unit. A

[i] These calculations exclude fires with confined structure fire incident types (NFIRS incident types 113–118). Among confined fires in which sprinklers were present, the fire was too small to activate the sprinklers 69 percent of the time, the sprinklers operated and were effective in 27 percent of total fires with sprinklers (and in 99 percent of the fires in which sprinklers operated), and the sprinklers failed to operate 3 percent of the time. Since these fires are, by definition, confined, it is likely that a substantial share of the fires in which the sprinklers were said to fail, were, in fact, too small to cause the sprinkler to operate. The 34 percent of non-confined fires (NFIRS incident types 110–123, except for 113–118) that were too small to activate the sprinklers and the 1 percent of non-confined structure fires in which sprinkler operation was unclassified were also excluded.

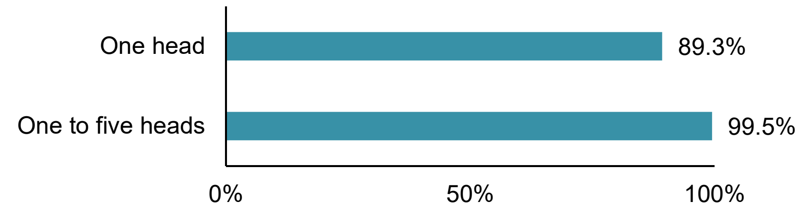
drape on an open window ignited when it was blown over the candle. The fire spread to the window blinds and papers on the desk before it was extinguished.[19]

- While firefighters were responding to a late afternoon fire alarm with smoke reported on the second floor of a four-story Oregon apartment building, they were informed that residents on the second and fourth floors had mobility impairments and would need help to evacuate. After they arrived, they found that the sprinkler system had extinguished an incendiary fire in a second-floor laundry room.[20]
- A 24-unit Texas apartment building was protected by a wet pipe sprinkler system installed under the provisions of NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*. Discarded smoking materials ignited a plastic container on a third-floor balcony. The fire spread to an outdoor couch and upward and sideways on the balcony until a sidewall sprinkler activated and contained the fire. Firefighters completed extinguishment when they arrived. The exterior fire did not activate smoke alarms inside the building.[21]

As in structure fires overall, when home sprinklers failed to operate, it was usually because the system had been shut off. This was true in a 2015 California single-family home fire that killed a young woman. The property's sprinkler system, installed to the requirements of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, had been shut off at some point before the fire.[22]

Figure 25 shows that in nearly all the home fires in which operating sprinklers were present, five or fewer individual sprinklers operated.

Figure 25. Percent of home fires with operating sprinklers in which one or one to five operated: 2015–2019



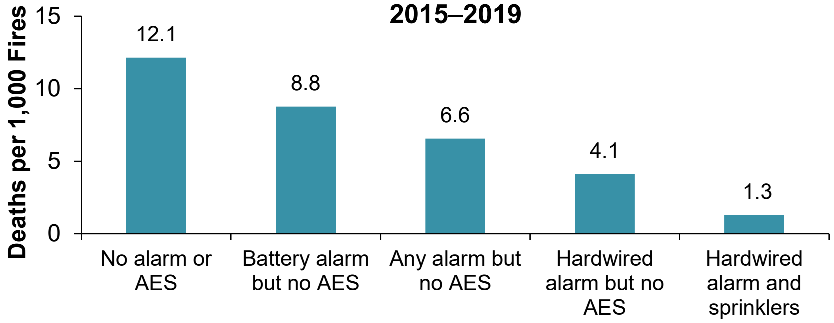
Impact of Smoke Alarm and Sprinkler Presence on Death Rates per 1,000 Home Fires

The lowest home fire death rate per 1,000 reported fires was found in homes with sprinkler systems and hardwired smoke alarms.[i] Figure 26 shows that compared to reported home fires (*including* properties under construction) in which no smoke alarms or AES was present, the death rate per 1,000 reported fires was:

- 28 percent lower when battery-powered smoke alarms were present, but AES protection was not
- 46 percent lower when smoke alarms with any power source were present but AES protection was not
- 66 percent lower when hardwired smoke alarms were present but AES protection was not
- 89 percent lower when sprinklers and hardwired smoke alarms were present

[i] In this analysis, the term *smoke alarm* also includes smoke detectors that are part of a system.

Figure 26. Average fire death rate per 1,000 reported home structure fires by presence of smoke alarms and AES: 2015–2019



Note that these rates are based on the *presence* of various types of fire protection; operation was not considered. Minor fires in homes with monitored smoke alarms are more likely to result in a fire department response than comparable fires in homes with unmonitored smoke alarms. Smoke alarms in monitored systems are generally hardwired.

Unwanted Activations

Fire departments responded to an estimated average of 4,700 non-fire activations of home fire sprinklers per year caused by a system failure or malfunction and 5,400 unintentional sprinkler activations per year in 2015–2019. According to the *NFIRS 5.0 Complete Reference Guide*[23], sprinkler failures or malfunctions include "any failure of sprinkler equipment that leads to sprinkler activation with no fire present." The category "excludes unintentional operating caused by damage to the sprinkler system," which should be considered unintentional activations. Unintentional activations include "testing the sprinkler system without fire department notification."

Forty-eight percent of the home sprinkler activations resulting from system failures or malfunctions and 38 percent of the unintentional home sprinkler activations occurred in the winter months of December, January, and February.

Conclusions and Further Reading

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

NFPA standards provide essential guidance on the installation, inspection, testing, maintenance, and integration of sprinklers with other systems, as well as for evaluating needs when an occupancy changes use or contents. See the following standards for more information:

- 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*. 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*. See NFPA 4 for test protocols to ensure that the fire protection and life safety systems will function correctly together.
- NFPA 1, *Fire Code*. NFPA 1 includes evaluation requirements for assessing the adequacy of existing sprinkler systems if the use or contents of a space have changed.

Resources to help reduce the home fire death toll by increasing the number of new one- and two-family homes protected by sprinklers are available from the NFPA Fire Sprinkler Initiative.

Methodology

The statistics in this analysis are estimates derived from the US Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association (NFPA) annual survey of US fire departments. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates. Unless otherwise specified, properties under construction were excluded from the analysis.

The NFPA fire department experience survey provides estimates of the big picture. NFIRS is a voluntary system through which participating fire departments report detailed factors about the fires to which they respond.

To compensate for fires reported to local fire departments but not captured in NFIRS, scaling ratios are calculated and then applied to the NFIRS database using the formula below:

$$\frac{\text{NFPA's fire experience survey projections}}{\text{NFIRS totals}}$$

NFPA also allocates unknown data proportionally to compensate for fires for which information was undetermined or not reported.

Fires in which partial sprinkler 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 the estimates of presence and operation. Fires with one of the six NFIRS confined fire incident types were included in estimates of sprinkler presence, fire spread, and sprinklers operating, but not of operation or effectiveness in general. Information on methodology is provided in more detail at the end of this report.

Confined structure fires in NFIRS 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 (NFIRS incident types 113–118). Losses are generally minimal in these fires, which, by definition, are assumed to have been limited to the object of origin. Although detailed data about detection is not required for these fires, it is sometimes available.

Raw NFIRS data for 2015–2019, excluding properties under construction, contained a total of 7,737 confined structure fires (1 percent of total confined fires) in which some type of AES was present and 34,919 confined structure fires (4 percent of total confined fires) in which none was present. AES presence was undetermined or left blank for 95 percent of the confined structure fires. A total of 4,355 confined fires with AES present indicated wet pipe, dry pipe, or other sprinklers were present. The AES type was undermined or not reported in 2,338 confined fires with AES present. Sprinkler operation when present was known in a total of 92 percent (3,793) of the confined fires in which sprinklers were present . Sprinkler operation for confined fires was used to calculate the number of sprinklers that operated in fires in which sprinklers operated but not for overall estimates of operation or effectiveness.

The raw NFIRS data for 2015–2019 contained a total of 53,859 non-confined structure fires (NFIRS incident type 110–123, excluding incident types 113–118) in which AES presence was known. A total of 103 civilian deaths; 2,137 civilian injuries; and $3.8 billion in direct property damage were associated with these fires. AES presence was known for 97 percent of the non-confined fires, 90 percent of the deaths, 95 percent of the injuries, and 99 percent of the direct property damage. The AES type was known in 67 percent of the non-confined fires, 80 percent of the deaths, 81 percent of the injuries, and 84 percent of the associated property loss when AES was present.

When sprinklers were present in non-confined structure fires, sprinkler operation was known for a five-year raw total of 27,151 fires associated with 57 deaths; 1,426 injuries; and $2.6 billion in direct property damage. When present, sprinkler operation was known for 84 percent of the non-confined fires, 72 percent of the deaths, 89 percent of the injuries, and 89 percent of the direct property damage. ("Operation of AES, other" was considered unknown.).

When AES was coded as present, but failed to operate, and the reason given was "fire not in the area protected," NFPA recoded the AES presence to

"Not in fire area; did not operate." These incidents and incidents coded to indicate the presence of partial systems were excluded from further analysis.

Property damage has not been adjusted for inflation. In most cases, fires are rounded to the nearest ten, civilian deaths and injuries are 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.

For more information on the methodology used for this report see, *How NFPA's National Estimates Are Calculated for Home Structure Fires.*

Acknowledgments

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 makes this analysis possible. Their contributions allow us to estimate the size of the fire problem.

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

Thanks also to Ben Evarts for providing the estimates of unwanted activations.

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RESEARCH

US Experience with Sprinklers

Supporting Tables

October 2021

Marty Ahrens

US Experience with Sprinklers: Supporting Tables

The tables in this document are a companion to the report of the same name. The table topics are listed below.

Most of the national estimates of fires and losses in this analysis are presented as 2015–2019 annual averages. Estimates were derived from the US Fire Administration's National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey and include proportional shares of unknown or missing data. Fires are rounded to the nearest 10, deaths and injuries to the nearest one, and property loss to the nearest million dollars. Property loss was not adjusted for inflation. Percentages were calculated on unrounded estimates. Sums may not equal totals due to rounding errors. Estimates include proportional shares of fires with unknown data. For more information on how these estimates were calculated, please see the full report and *How NFPA's National Estimates Are Calculated for Fires.*

Acknowledgments

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 makes this analysis possible. Their contributions allow us to estimate the size of the fire problem.

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

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NFPA No. USS14-ST

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 by Property Use — Any Automatic Extinguishing System (AES) 1980–1984		1994–1998		2015–2019		Any Sprinkler 2015–2019	
All public assembly	4,280	(13%)	4,380	(26%)	7,900	(49%)	4,120	(25%)
Variable-use amusement place	120	(8%)	140	(16%)	240	(21%)	210	(19%)
Place of worship or funeral property	50	(2%)	90	(5%)	330	(19%)	290	(16%)
Library or museum	80	(14%)	110	(28%)	190	(30%)	180	(28%)
Eating or drinking establishment	3,310	(16%)	3,240	(29%)	5,740	(62%)	2,300	(25%)
Passenger terminal	70	(20%)	60	(35%)	300	(40%)	250	(33%)
Educational property	1,620	(13%)	1,820	(24%)	2,000	(43%)	1,860	(40%)
Health care property*	6,920	(47%)	4,400	(68%)	3,820	(65%)	3,420	(58%)
Nursing home	2,250	(61%)	2,060	(76%)	2,170	(76%)	1,980	(69%)
Hospital	3,370	(47%)	1,650	(74%)	830	(80%)	640	(61%)
Prison or jail	370	(10%)	430	(19%)	300	(61%)	280	(58%)
All residential	7,090	(1%)	11,110	(3%)	32,370	(9%)	30,390	(8%)
Home (including apartment)	5,120	(1%)	8,440	(2%)	24,970	(7%)	23,570	(7%)
Hotel or motel	1,590	(15%)	1,690	(35%)	2,190	(56%)	2,090	(54%)
Dormitory or barracks	430	(16%)	620	(29%)	2,300	(60%)	2,130	(56%)
Rooming or boarding home	70	(4%)	230	(17%)	900	(31%)	860	(29%)
Residential board and care home or assisted living facility	Not available		Not available		860	(46%)	820	(43%)
Store or office	5,510	(13%)	5,230	(21%)	6,500	(34%)	4,940	(26%)
Grocery or convenience store	1,160	(15%)	1,190	(27%)	2,360	(53%)	1,250	(28%)
Laundry, dry cleaning, or other professional service	330	(8%)	310	(13%)	330	(19%)	330	(18%)
Department store	1,340	(44%)	1,100	(52%)	580	(51%)	520	(47%)
Office	1,240	(12%)	1,470	(25%)	1,000	(32%)	940	(30%)
Manufacturing facility	11,910	(44%)	6,400	(50%)	3,050	(58%)	2,720	(52%)
All storage	1,430	(2%)	1,090	(3%)	830	(4%)	810	(4%)
Warehouse (excluding cold storage)	1,060	(13%)	740	(22%)	500	(35%)	500	(34%)
All structures**	38,620	(4%)	37,100	(7%)	61,40	(13%)	51,000	(10%)

* Health care property includes other facilities not listed separately. In 1980–1984 and 1994–1998, this category excludes doctors' offices and elder care facilities without nursing staff (which are assumed to be residential board and care facilities). In 2015–2019, health care property includes nursing homes, hospitals, clinics, doctor's offices, substance abuse recovery centers or developmental disability facilities.
** Includes properties not listed separately above.

Note: 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 the fire area.

Table 2. Type of Sprinkler System Reported in Structure Fires Where Equipment Was Present in Fire Area by Property Use (Excluding Properties Under Construction): 2015–2019 Annual Averages

Property Use	Fires per year with any type of sprinkler	Wet pipe sprinklers		Dry pipe sprinklers		Other sprinklers*	
All public assembly	4,120	3,330	(82%)	330	(8%)	470	(11%)
Variable-use amusement place	210	180	(85%)	30	(14%)	0	(1%)
Place of worship or funeral property	290	220	(75%)	50	(16%)	20	(9%)
Library or museum	180	170	(97%)	0	(2%)	0	(1%)
Eating or drinking establishment	2,300	1,740	(76%)	160	(7%)	400	(17%)
Passenger terminal	250	240	(98%)	0	(1%)	0	(0%)
Educational property	1,860	1,590	(86%)	230	(12%)	30	(2%)
Health care property**	3,420	2,960	(87%)	390	(12%)	70	(2%)
Nursing home	1,980	1,730	(88%)	210	(11%)	40	(2%)
Hospital	640	570	(89%)	60	(9%)	10	(1%)
Prison or jail	280	250	(91%)	20	(8%)	0	(1%)
All residential	30,390	27,030	(89%)	2,770	(9%)	590	(2%)
Home (including apartment)	23,570	20,960	(89%)	2,130	(9%)	480	(2%)
Dormitory or barracks	2,130	1,830	(86%)	260	(12%)	30	(2%)
Hotel or motel	2,090	1,850	(88%)	190	(9%)	50	(2%)
Rooming or boarding house	860	800	(94%)	50	(6%)	0	(0%)
Residential board and care or assisted living facility	820	730	(89%)	70	(9%)	20	(2%)
Store or office	4,940	4,270	(86%)	380	(8%)	290	(6%)
Grocery or convenience store	1,250	980	(78%)	100	(8%)	180	(14%)
Laundry, dry cleaning, or other professional service	330	300	(91%)	20	(5%)	10	(4%)
Department store	520	460	(88%)	50	(10%)	10	(2%)
Office	940	820	(87%)	80	(8%)	40	(5%)
Manufacturing facility	2,720	2,290	(84%)	370	(14%)	60	(2%)
All storage	810	620	(77%)	180	(22%)	10	(1%)
Warehouse (excluding cold storage)	500	410	(81%)	90	(18%)	0	(1%)
All structures ***	51,000	44,160	(87%)	5,040	(10%)	1,810	(4%)

* Includes deluge and pre-action sprinkler systems and may include sprinklers of an unknown or unreported type.
** Nursing homes, hospitals, clinics, doctor's offices, substance abuse recovery centers or developmental disability facilities.
*** Includes properties not listed separately above.

Note: Row totals are shown in the left-most column of percentages and sums may not equal totals due to rounding errors. In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the location where the fire started. This field was not required if the fire did not begin within the designed range of the system. Buildings under construction and partial systems were excluded.

Source: NFIRS and NFPA fire experience survey.

Table 3. Estimated Reduction in Civilian Deaths per Thousand Fires Associated with All Types of and Wet Pipe Sprinklers by Property Use (Excluding Properties Under Construction): 2015–2019 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	1.9	0.1	97%	0.1	96%
Health care*	1.2	0.8	33%	0.5	58%
Residential	8.0	0.9	89%	1.0	88%
Home (including apartment)	8.1	1.0	88%	1.0	87%
Dormitory or barracks	1.0	0.2	84%	0.2	81%
Hotel or motel	8.6	0.2	98%	0.2	98%
Rooming or boarding house	6.5	3.3	49%	3.5	46%
Residential board and care or assisted living facility	3.2	1.4	57%	1.5	52%
Store or office	1.2	0.5	57%	0.4	64%
Manufacturing facility	1.0	0.6	34%	0.7	22%
Warehouse (excluding cold storage)	2.1	0.0	100%	0.0	100%
All structures**	6.7	0.7	89%	0.7	89%

* Includes nursing homes, hospitals, clinics, doctor’s offices, substance abuse recovery centers or developmental disability facilities.
** Includes properties not listed separately above.

Note: These are national estimates of structure fires reported to US municipal fire departments based on fires reported in NFIRS 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 Any Type of and Wet Pipe Sprinklers by Property Use (Excluding Properties Under Construction): 2015–2019 Annual Averages

Property Use	Loss without AES	Loss with sprinklers of any type	Percent reduction	Loss with wet pipe sprinkler system	Percent reduction from no AES
All public assembly	$31,500	$11,600	63%	$12,000	62%
Health care*	$13,900	$3,800	73%	$4,000	71%
Residential	$21,200	$8,500	60%	$9,000	57%
Home (including apartment)	$21,700	$8,200	62%	$8,800	59%
Dormitory or barracks	$3,700	$1,500	58%	$1,700	53%
Hotel or motel	$29,800	$22,400	28%	$22,700	24%
Rooming or boarding house	$7,700	$3,600	52%	$3,700	51%
Residential board and care or assisted living facility	$4,600	$6,700	-44%	$7,300	-58%
Store or office	$59,400	$17,600	70%	$17,900	70%
Manufacturing facility	$141,000	$170,300	No reduction	$192,100	No reduction
Warehouse (excluding cold storage)	$112,300	$144,000	No reduction	$149,400	No reduction
All structures	$22,200	$19,800	11%	$20,600	7%

* Includes nursing homes, hospitals, clinics, doctor's offices, substance abuse recovery centers or developmental disability facilities.
** Includes properties not listed separately above.

Note: These are national estimates of structure fires reported to US municipal fire departments based on fires reported in NFIRS 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: 2015–2019 Annual Averages

	Percentage of fires confined to room of origin excluding structures under construction and sprinklers not in fire area		
Property Use	**With no AES**	**With sprinklers of any type**	**Difference (in percentage points)**
Public assembly	77%	93%	16%
Religious property	73%	94%	22%
Library or museum	83%	96%	13%
Eating or drinking establishment	72%	91%	19%
Educational	89%	97%	8%
Health care property*	92%	98%	6%
Residential	74%	97%	23%
Home (including apartment)	74%	97%	23%
Dormitory or barracks	97%	99%	3%
Hotel or motel	84%	96%	13%
Store or office	67%	92%	24%
Grocery or convenience store	72%	94%	22%
Department store	65%	90%	25%
Office building	75%	93%	19%
Manufacturing facility	64%	84%	21%
Storage	25%	80%	55%
Warehouse (excluding cold storage)	52%	79%	27%
All structures**	71%	95%	24%

* Includes nursing homes, hospitals, clinics, doctor's offices, substance abuse recovery centers or developmental disability facilities.
** Includes properties not listed separately above.

Note: 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 location 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, Was Large Enough to Activate Sprinkler, and Sprinkler Was Present in Area of Fire by Property Use: 2015–2019 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	4,120	720	2,580	820	89%	92%	82%
Eating or drinking establishment	2,300	410	1,360	530	88%	91%	80%
Educational property	1,860	420	1,220	220	84%	97%	82%
Health care property*	3,420	650	2,390	380	86%	98%	84%
All residential	30,390	2,600	23,310	4,480	94%	97%	91%
Home (including apartment)	23,570	1,890	18,030	3,650	95%	97%	92%
Hotel or motel	2,090	400	1,280	410	91%	97%	88%
Store or office	4,940	1,150	2,450	1,340	90%	96%	86%
Grocery or convenience store	1,250	280	730	240	85%	94%	80%
Department store	520	180	220	120	89%	97%	86%
Office	940	210	510	220	88%	97%	85%
Manufacturing facility	2,720	650	900	1,170	91%	94%	86%
All storage	810	140	280	380	86%	95%	84%
Warehouse (excluding cold storage)	500	90	160	250	88%	95%	84%
All structures**	51,000	6,780	34,830	9,390	92%	96%	88%

* Includes nursing homes, hospitals, clinics, doctor's offices, substance abuse recovery centers or developmental disability facilities.
** Includes properties not listed separately above.

Note: In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the location 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, Was Large Enough to Activate Sprinkler, and Sprinkler Was Present in Area of Fire by Property Use: 2015–2019 Annual Averages, (Continued)

B. Wet Pipe Sprinkler Systems 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	3,330	600	2,030	700	90%	94%	85%
Eating or drinking establishment	1,740	330	980	430	90%	93%	84%
Educational property	1,590	370	1,020	200	85%	97%	83%
Health care property*	2,960	570	2,050	330	88%	97%	85%
All residential	27,030	2,330	20,560	4,150	95%	97%	92%
Home (including apartment)	20,960	1,690	15,870	3,390	95%	97%	92%
Hotel or motel	1,850	350	1,130	370	92%	97%	90%
Store or office	4,270	1,030	2,030	1,210	91%	97%	88%
Grocery or convenience store	980	250	520	210	87%	95%	83%
Department store	460	160	190	110	88%	98%	86%
Office	820	190	440	180	89%	97%	86%
Manufacturing facility	2,290	540	770	980	92%	94%	87%
All storage	620	110	220	300	91%	95%	87%
Warehouse (excluding cold storage)	410	80	120	210	90%	96%	86%
All Structures**	44,160	5,920	29,870	8,370	92%	96%	89%

* Includes nursing homes, hospitals, clinics, doctor's offices, substance abuse recovery centers or developmental disability facilities.
** Includes properties not listed separately above.

Note: In NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the location 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, Was Large Enough to Activate Sprinkler, and Sprinkler Was Present in Area of Fire by Property Use: 2015–2019 Annual Averages, (Continued)

C. Dry Pipe Sprinkler Systems 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	2,770	230	2,280	260	91%	97%	89%
Homes	2,130	160	1,770	190	92%	98%	90%
Store or office	380	100	190	90	83%	94%	78%
Manufacturing facility	370	100	110	160	89%	93%	83%
All storage	180	30	70	80	79%	94%	74%
All structures*	5,040	690	3,540	800	87%	94%	82%

* Includes properties not listed separately above.

Note: These are percentages of fires reported to US municipal fire departments and so exclude fires 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 location 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 were excluded. Percentages are based on estimated total fires reported in NFIRS with the indicated type of automatic extinguishing system and system performance not coded as fire too small to activate systems. Fires were excluded if the reason for failure or ineffectiveness was “system not present in area of fire.” Fires were recoded from “operated but ineffective” to “failed to operate” if the reason for failure or ineffectiveness was “system shut off.” Fires were 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 That Operated in Structure Fires by Type of Sprinkler System (Excluding Properties Under Construction): 2015–2019 Annual Averages

Number of Sprinklers Operating	Percentage of structure fires where that many sprinklers operated		
	Wet Pipe	Dry Pipe	All Sprinklers (Including "other")
1	80%	47%	77%
1 or 2	91%	63%	89%
1 to 3	94%	71%	92%
1 to 4	96%	83%	95%
1 to 5	97%	90%	97%
1 to 10	99%	99%	99%

Note: Percentages are based on structure fires reported in NFIRS to US 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 as present and operating and there was reported information on the number of sprinklers that operated. Fires were excluded if the reason for failure or ineffectiveness was coded as "system not present in area of fire." Fires were recoded from "operated but ineffective" to "failed to operate" if the reason for failure or ineffectiveness was "system shut off." Fires were 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 location where the fire started. Buildings under construction were excluded, as were partial systems and fires reported as confined fires.

Source: NFIRS and NFPA fire experience survey.

Table 8. Reasons for Sprinkler Failure or Ineffectiveness in Structure Fires Large Enough to Activate Sprinkler Present in Fire Area (Excluding Fires with Confined Structure Fire Incident Types and Fires in Properties Under Construction): 2015–2019 Annual Averages

A. Reason Sprinkler Failed to Operate

Reason	All sprinklers		Wet pipe		Dry pipe	
System shut off	430	(57%)	340	(56%)	70	(64%)
Manual intervention defeated system	130	(18%)	120	(20%)	10	(8%)
Lack of maintenance	70	(10%)	60	(9%)	10	(12%)
System components damaged	70	(9%)	50	(9%)	10	(12%)
Inappropriate system for type of fire	40	(6%)	40	(6%)	0	(4%)
Total	750	(100%)	610	(100%)	100	(100%)

B. Reason Operating Sprinkler Was Ineffective

Reason	All sprinklers		Wet pipe		Dry pipe	
Water did not reach the fire	170	(50%)	140	(53%)	10	(36%)
Not enough water released	100	(31%)	70	(27%)	20	(50%)
Inappropriate system for type of fire	20	(7%)	20	(8%)	0	(3%)
System components damaged	20	(7%)	20	(8%)	0	(3%)
Lack of maintenance	10	(3%)	0	(1%)	0	(7%)
Manual intervention defeated system	10	(2%)	10	(3%)	0	(0%)
Total	340	(100%)	270	(100%)	40	(100%)

C. Reasons for Sprinkler Failure or Ineffectiveness Combined

Reason	All sprinklers		Wet pipe		Dry pipe	
System shut off	430	(39%)	340	(39%)	70	(47%)
Water did not reach the fire	170	(16%)	140	(16%)	10	(10%)
Manual intervention defeated system	140	(13%)	130	(15%)	10	(6%)
Not enough water released	100	(10%)	70	(8%)	20	(14%)
System components damaged	90	(8%)	80	(9%)	10	(10%)
Lack of maintenance	80	(8%)	60	(7%)	20	(11%)
Inappropriate system for type of fire	70	(6%)	60	(7%)	10	(4%)
Total	1,080	(100%)	880	(100%)	140	(100%)

Note: Buildings under construction were excluded, as were partial systems and fires reported as confined fires. Fires reported with unclassified reasons for failure were treated as cases of unknown reasons for failure.

Source: NFIRS and NFPA fire experience survey.

Table 9. Characteristics of Fatal Victims in Fires with Sprinklers vs. No Automatic Extinguishing Equipment: 2015–2019 Annual Averages

A. Number of Victims by Sprinkler Presence and Performance

Sprinkler/AES Status	Deaths when sprinklers present		Deaths when no AES present	
Total civilian deaths	36	(100%)	2,816	(100%)
Operated and effective	*18*	*(51%)*		
Operated but ineffective	*3*	*(8%)*		
Fire too small to operate	*9*	*(24%)*		
Failed to operate	*3*	*(9%)*		
Unclassified operation	*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	21	(100%)	2,816	(100%)
Victim in area of origin	18	(87%)	1,319	(50%)
Involved in ignition	*14*	*(66%)*	*976*	*(35%)*
Not involved in ignition	*4*	*(21%)*	*446*	*(16%)*
Victim 65 or older	11	(53%)	1,001	(36%)
Clothing on fire	8	(39%)	193	(7%)
Unable to act	7	(32%)	331	(12%)

Note: Here is an example of how to read this table: Almost nine out of every 10 people (87 percent) who died in fires despite the presence of operating sprinklers were located in the area of fire origin. Being closer to the fire makes it harder to escape. In comparison, only half of the fatal victims (50 percent) in fires in which no automatic extinguishing equipment was present were located in the area of fire origin.

Source: NFIRS and NFPA fire experience survey.

NFPA RESEARCH

Fire Loss in the United States During 2020

Marty Ahrens and Ben Evarts

September 2021

Key Findings

In 2020, local fire departments responded to an estimated 1.4 million fires in the United States. These fires caused 3,500 civilian fire deaths and 15,200 reported civilian fire injuries. Property damage was estimated at $21.9 billion.

On average, a fire department responded to a fire somewhere in the US every 23 seconds in 2020. A home structure fire was reported every 89 seconds, a home fire death occurred every three hours and 24 minutes, and a home fire injury occurred every 46 minutes.

More than one-third of the fires (490,500 — or 35 percent) occurred in or on structures. Most fire losses were caused by these fires, including 2,730 civilian fire deaths (78 percent); 13,000 civilian fire injuries (86 percent); and $12.1 billion in direct property damage (55 percent). Major fires in the California wildland/urban interface (WUI) caused $4.2 billion in direct property damage (19 percent). Unfortunately, losses from these fires were not broken out by incident type. A substantial portion of the loss was undoubtedly due to structure fires.

Only one-quarter of the fires (26 percent) occurred in home properties, including one- or two-family homes and apartments or other multifamily housing, yet these fires caused three-quarters of the civilian fire deaths (74 percent) and injuries (76 percent).

One of every five fires (19 percent) occurred in one- or two-family homes, yet these fires caused nearly two-thirds of the civilian fire deaths (64 percent) and nearly three-fifths of the civilian fire injuries (57 percent). The 6 percent of fires that occurred in apartments caused 10 percent of the civilian fire deaths and 19 percent of the injuries.

Vehicle fires accounted for 15 percent of the fires, 18 percent of the civilian deaths, and 11 percent of the civilian injuries.

Neither structures nor vehicles were involved in half of the fires reported in 2020. These fires included brush, grass, or wildland fires — excluding crops, timber, and other properties of value (20 percent); outside rubbish fires (16 percent); outside fires involving property of value (6 percent); and other fires (7 percent).

The 2020 estimates of the number of fires were 40–64 percent lower than in 1980 for most of the major incident type categories. However, property loss, adjusted for inflation, was 10 percent higher in 2020 than in 1980. This was partially due to the previously mentioned California WUI fires and a $3 billion Navy ship fire.

The 2020 estimate of total fire deaths was 46 percent lower than in 1980, home fire deaths were 50 percent lower, deaths in one- or two-family home fires were 47 percent lower, and apartment fire deaths were 66 percent lower.

Because the US population has grown since 1980, population-based rates have dropped even more than the estimates have.

Less progress has been made in preventing deaths and injuries associated with reported fires. For overall home fires, the 2020 rate of 7.2 deaths per 1,000 reported home fires was almost identical to the rate of 7.1 in 1980. The rate for one- or two-family home fires was 16 percent higher than in 1980, while the rate for apartment fires was 43 percent lower.

Most of the reduction in reported fires and fire losses occurred more than a decade ago. There is still more work to do, particularly around home fires.

Introduction

In many ways, 2020 was an anomaly. With the COVID-19 pandemic, many businesses were shuttered. Some people worked remotely, some continued normal work, and still others lost their jobs. Overall, people spent more time at home.

An Acosta report released in September 2020 noted that 55 percent of shoppers were eating at home more often during the pandemic than before it began.[1] The Outdoor Foundation reported that 53 percent of Americans at least six years of age engaged in outdoor recreation at least once during 2020.[2] This was the highest outdoor recreational participation rate ever recorded. These are examples of how people's behaviors and routines changed during the pandemic. While we do not yet have national data on the causes of fires in 2020, increases and decreases in various activities were likely associated with the corresponding changes in related fires.

In 2020, local fire departments, including departments protecting towns, townships, cities, and counties, responded to an estimated 1,388,500 fires in the US. These fires caused an estimated 3,500 civilian deaths; 15,200 civilian injuries; and $21.9 billion in direct property damage. This report provides a breakdown of these fires. Firefighter fatalities and injuries are discussed in separate NFPA reports and are not included here.

On average, a fire department responded to a fire somewhere in the US every 23 seconds in 2020. A civilian was fatally injured in a fire every two hours and 31 minutes. Every 35 minutes, a civilian suffered a non-fatal fire injury.

The fire and fire loss estimates in this analysis are derived from NFPA's 2020 fire department experience survey (FES). Only fires reported to local fire departments are included. State fire agencies were also surveyed about large loss and catastrophic multiple-death fires. Such major incidents were added to the results from the FES. For more information on how these estimates were calculated, see *Methodology Used in Calculating National Estimates from NFPA's Fire Experience Survey*.

Trends

While some year-to-year fluctuation is normal, from 2019 to 2020, the total number of fires rose 8 percent, civilian deaths fell 6 percent, and civilian injuries fell 8 percent. The increase in total fires was statistically significant. Meanwhile, direct property damage was 1.5 times as high in 2020 as it was in 2019. The 2020 fire property damage included losses of $4.2 billion from California fires in the WUI and a California blaze that destroyed a naval ship ($3 billion). The WUI fires included a wide variety of incidents and property types; these could not be broken down further.

The estimate of total fires was 54 percent lower in 2020 than in 1980, while fire death and injury estimates were 46 percent and 50 percent lower, respectively, over the same period. Property loss, adjusted for inflation, was 10 percent higher than in 1980. See Figures 1–3.

US Census data shows that the resident population of the US grew 46 percent from 1980 to 2020. The resulting rate of 4.2 fires per 1,000 population in 2020 was 68 percent lower than the 13.1 rate in 1980 and 7 percent higher than the 2019 rate of 3.9.

The 10.6 civilian fire deaths per million population in 2020 was 63 percent lower than the 28.6 rate in 1980 and 6 percent lower than the rate of 11.3 in 2019. (See Figures 4 and 5.)

Figure 1. Reported fires by year

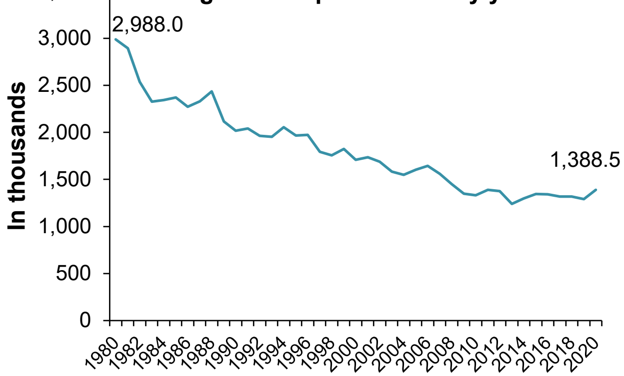


Figure 2. Civilian fire deaths by year

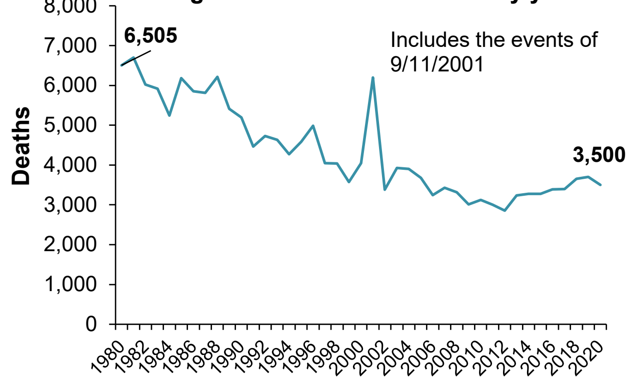


Figure 3. Estimated fire property loss by year*

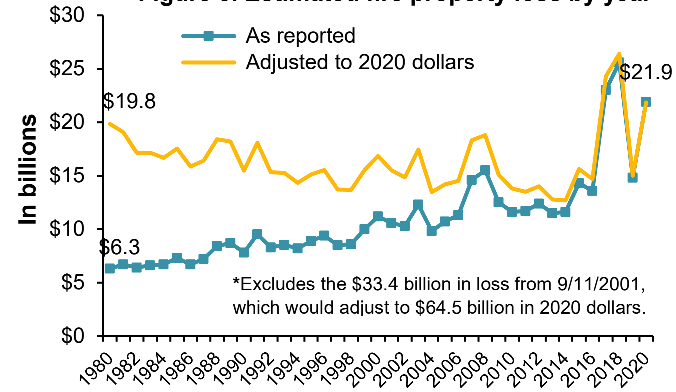
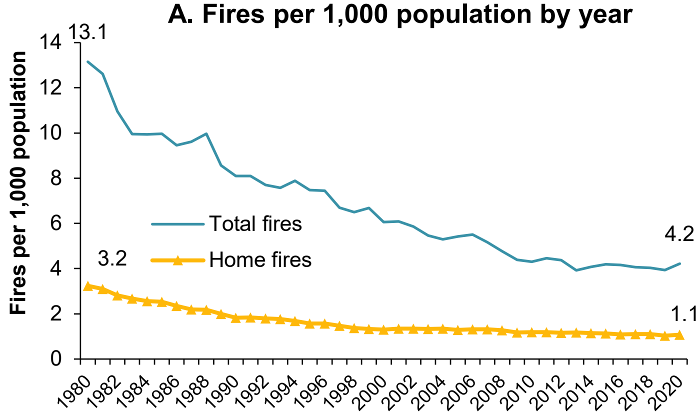
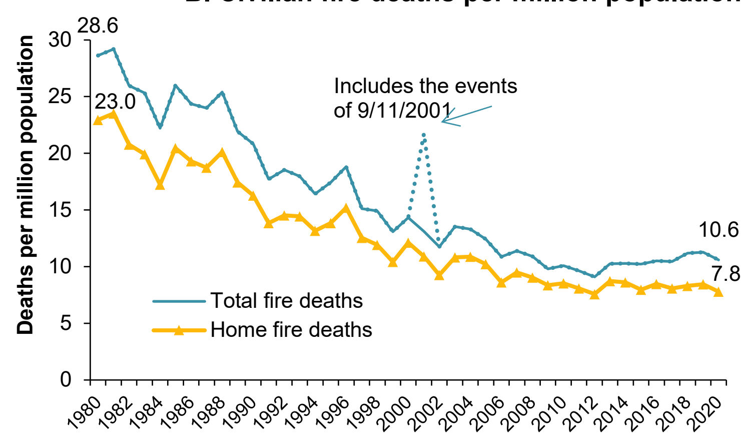


Figure 4. Population-based fire and civilian fire death rates: 1980–2020

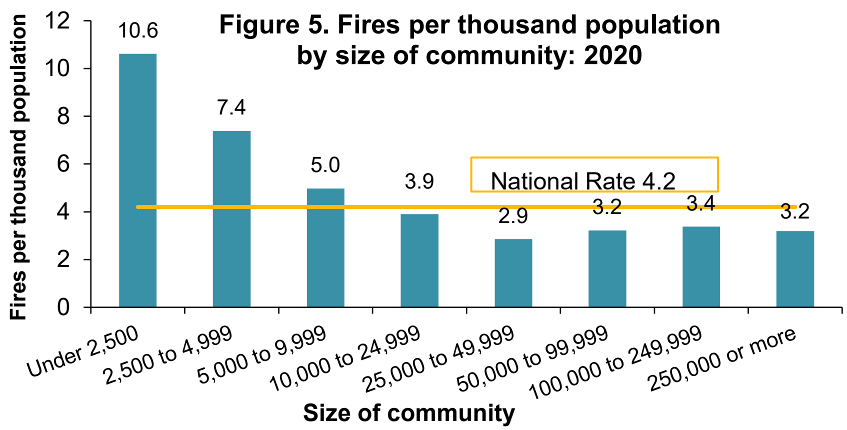
A. Fires per 1,000 population by year



B. Civilian fire deaths per million population



While smaller communities have fewer fires than larger communities, the 10.6 fires per 1,000 population for fire departments protecting communities with fewer than 2,500 people is 2.5 times the overall national rate. Fire departments in smaller communities are less likely to conduct fire prevention or code enforcement activities.[3] Open burning to get rid of debris might also be more common in these communities. Figure 5 shows that the rate of fires generally decreases as the population protected increases from very small to midsize, with the lowest population-based rate of fires found in departments protecting populations of at least 25,000.



The fire rates tell only part of the story. To really understand the US fire problem, the areas of progress, and the remaining challenges, we need to know more about where fires occur, the causes of these fires, and whether fires and casualties are increasing or decreasing in actual number and population-based rates. For information about specific fire causes or fires in specific occupancies, see nfpa.org/News-and-Research.

Table 1 provides a summary of fires, civilian casualties, and direct property loss by type of fire for 2020.

Definitions

Civilian: Anyone other than a firefighter.

Structure fire: In general, any fire in or on a structure is considered a structure fire, even if the structure itself is not damaged.

Homes: One- or two-family homes, including manufactured homes, and apartments, or other multifamily housing.

Non-home or other residential: Hotels, motels, dormitories, rooming houses, residential board and care, and unclassified residential.

Residential: Homes plus non-home or other residential.

Non-residential: Public assembly, educational (excluding dorms), institutional, stores or offices, industrial, utility, manufacturing or processing, storage, and bridges, tents, poles, and other special properties.

Highway vehicle: Vehicle intended for use on roadways, such as cars, trucks, motorcycles, buses, recreational vehicles in transit, etc. A vehicle burning inside a garage is considered a vehicle fire if the fire did not spread to the structure or other items.

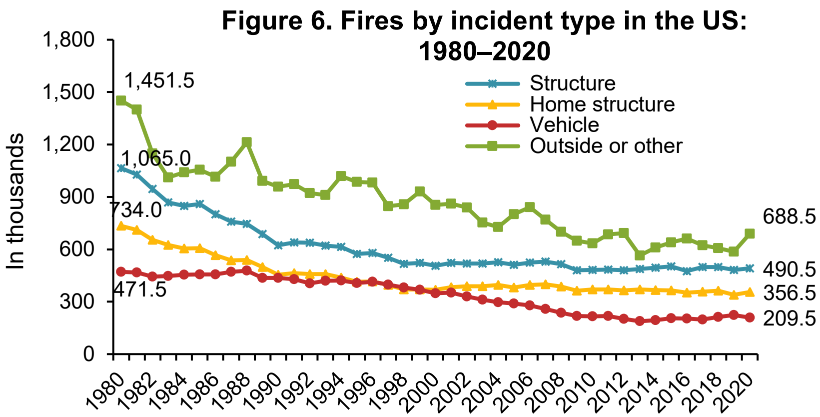
Structure Fires

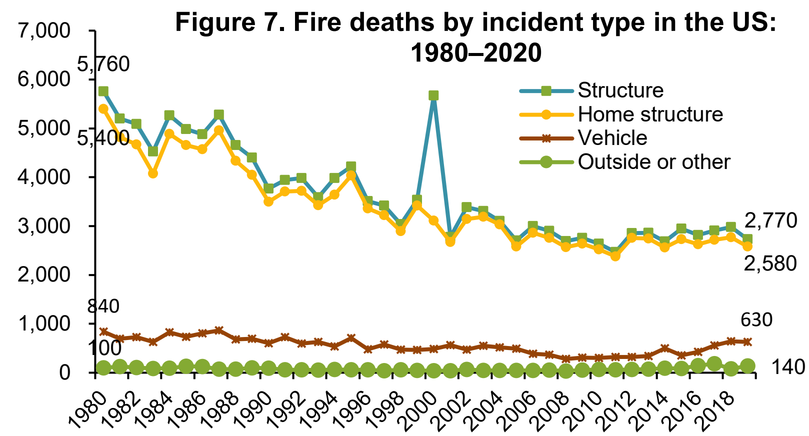
In 2020, the estimated 490,500 structure fires (35 percent of the reported fires) caused 2,730 civilian fire deaths (78 percent of total civilian fire deaths); 13,000 civilian injuries (86 percent); and $12.1 billion in direct property damage (55 percent). While structure fires probably dominated the $4.2 billion in property loss from California wildfires, it is not possible to disaggregate these fires by incident type or occupancy.

Table 1. Reported Fires in 2020 by Incident Type

Incident Type	Fires		Civilian Deaths		Civilian Injuries		Property Loss (In Millions)[1]	
Fires in California Wildland-Urban Interface (WUI)							**$4,200**	**(19%)**
Structure Fire	**490,500**	**(35%)**	**2,730**	**(78%)**	**13,000**	**(86%)**	**$12,107**	**(55%)**
Residential structure fire	**379,500**	**(27%)**	**2,630**	**(75%)**	**11,900**	**(78%)**	**$8,703**	**(40%)**
Home structure fire	356,500	(26%)	2,580	(74%)	11,500	(76%)	$8,400	(38%)
One- and two-family home, including manufactured homes	*270,500*	*(19%)*	*2,230*	*(64%)*	*8,600*	*(57%)*	*$6,771*	*(31%)*
Apartment or other multifamily housing	*86,000*	*(6%)*	*350*	*(10%)*	*2,900*	*(19%)*	*$1,629*	*(7%)*
Other residential structure fire	*23,000*	(2%)	50	(1%)	400	(3%)	$303	(1%)
Non-residential structure fire	111,000	(8%)	100	(3%)	1,100	(7%)	$3,404	(16%)
Vehicle Fire	**209,500**	**(15%)**	**630**	**(18%)**	**1,700**	**(11%)**	**$5,170**	**(24%)**
Highway vehicle fire	173,000	(12%)	580	(17%)	1,500	(10%)	$1,615	(7%)
Other vehicle fire*	36,500	(3%)	50	(1%)	200	(1%)	$3,555*	(16%)
Outside and Other Fire**	**688,500**	**(50%)**	**140**	**(4%)**	**500**	**(3%)**	**$389**	**(2%)**
Fire outside but no vehicle (outside storage, crops, timber, etc.)	84,000	(6%)	**	**	**	**	$210	(1%)
Fires in brush, grass, or wildland (excluding crops and timber) with no dollar loss	277,000	(20%)	**	**	**	**	**	**
Outside rubbish fire	225,000	(16%)	**	**	**	**	**	**
All other fires	102,500	(7%)	**	**	**	**	$179	(1%)
Total	**1,388,500**	**(100%)**	**3,500**	**(100%)**	**15,200**	**(100%)**	**$21,866**	**(100%)**

* Includes a $3 billion naval ship fire in California.
** Casualty data is not reported for subcategories of outside and other fires. Property damage is not captured for brush, grass, or wildland with no loss or outside rubbish fires.
Note: Sums may not equal totals due to rounding errors.
Source: NFPA's 2020 survey of fire departments for US fire experience and surveys of state fire authorities for large loss and catastrophic multiple-death fires.





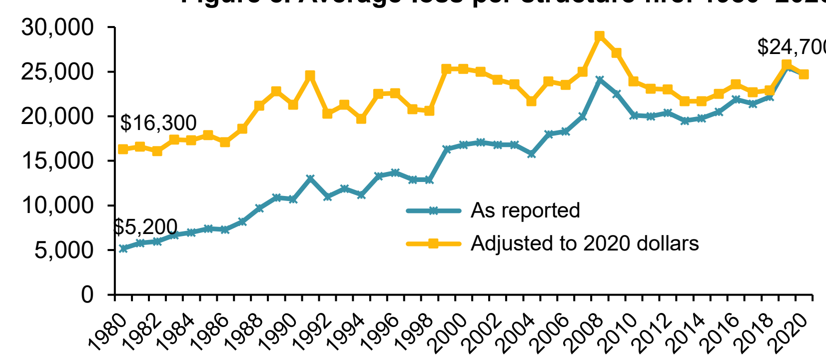
In 2020, on average, fire departments responded to a structure fire every 64 seconds, a structure fire death occurred every three hours and 13 minutes, and a structure fire injury occurred every 41 minutes.

From 2019 to 2020, the number of structure fires rose 2 percent, while associated civilian deaths fell 8 percent, civilian injuries fell 6 percent, and property damage fell 1 percent. The estimate of the total number of structure fires was 54 percent lower in 2020 than in 1980, while structure fire death and injury estimates were 52 percent and 47 percent lower, respectively, over the same period. Although somewhat lower in 2020, structure fires cause 80–90 percent of the civilian fire deaths and injuries in most years, with the events of September 11, 2001, contributing to a high of 92 percent in 2001. See Figures 6 and 7.

Figure 8 shows that the average loss per structure fire, adjusted for inflation, was 1.5 times as high in 2020 ($24,700) as in 1980 ($16,300).

In 2020, an estimated 379,500 total residential structure fires (27 percent) caused 2,630 civilian deaths (75 percent); 11,900 civilian injuries (78 percent); and $8.7 billion in direct property damage (40 percent). From 2019 to 2020, residential structure fires rose 5 percent, associated civilian deaths fell 8 percent, civilian injuries fell 6 percent, and residential fire property damage rose 9 percent. The increase in residential fires was statistically significant.

Figure 8. Average loss per structure fire: 1980–2020



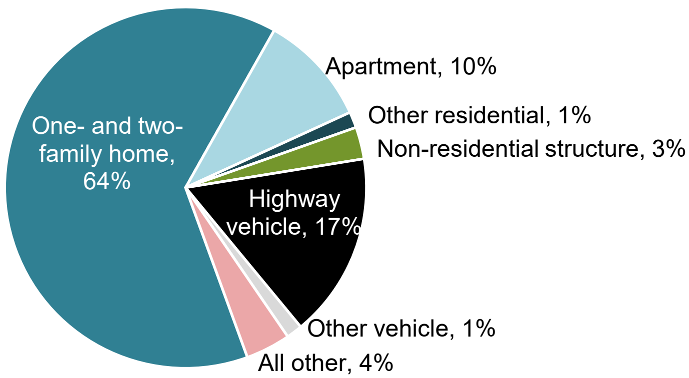
Excludes the $33.4 billion loss from 9/11/2001, which would adjust to $64.4 billion in 2020 dollars.

The estimate of 379,500 residential structure fires reported in 2020 was 50 percent lower than the 757,500 in 1980. Residential structure fire deaths fell 52 percent from 5,446 in 1980 to 2,630 in 2020.

The 2020 estimate of 11,900 residential fire injuries was 44 percent lower than the 21,100 in 1980.

See Figure 9 for a breakdown of 2020 fire deaths by type of fire.

Figure 9. Civilian fire deaths by incident type and occupancy: 2020



Home Structure Fires

The 356,500 home structure fires in 2020 (26 percent) caused 2,580 civilian fire deaths (74 percent); 11,500 civilian injuries (76 percent), and $8.4 billion in direct property damage (38 percent). On average, a home structure fire was reported every 89 seconds, a home fire death occurred every three hours and 24 minutes, and a home fire injury occurred every 46 minutes.

From 2019 to 2020, the number of home structure fires rose 5 percent, associated civilian deaths fell 7 percent, civilian injuries fell 6 percent, and home fire property damage rose 8 percent. With the COVID-19 pandemic, more people spent more time at home during 2020. This meant more cooking; more use of heating, air conditioning, and other equipment; and other activities that can contribute to home fires, which could account for the increase.

However, more people at home also means more people are available to assist in the event of a fire. This could have contributed to the reduction in fire deaths. Sesseng, Storesund, and Steen-Hansen found that being alone at the time of a fire was one of the common factors in fatal fires in Norway.[4]

With homes accounting for 94 percent of residential structure fires, it is not surprising that the pattern for home fires resembles that of residential structure fires. The estimated number of home structure fires was 51 percent lower in 2020 than in 1980, while estimates for home fire deaths and injuries were 50 percent and 42 percent lower, respectively.

Figure 4 shows that the population-based rates of home fires and home deaths were both 66 percent lower in 2020 than in 1980. The rate of reported home fires fell from 3.2 per thousand population in 1980 to 1.1 in 2020, while the home fire death rate dropped from 23.0 per million population to 7.8 per million population over the same period. The trend lines for the home fire death rate and total fire death rate are very similar.

For information on the causes and circumstances of home fires, see NFPA's report, *Home Structure Fires.* For information about deaths and injuries caused by home fires, see NFPA's report, *Home Fire Victims by Age and Gender.*

In 2020, the 270,500 one- or two-family home structure fires (19 percent) caused 2,230 civilian fire deaths (64 percent); 8,600 civilian fire injuries (57 percent); and $6.8 billion in direct property damage (31 percent). From 2019 to 2020, fires in one- or two-family homes rose 2 percent, while deaths fell 7 percent, injuries fell 2 percent, and property damage rose 5 percent. The estimated number of structure fires in one- or two-family homes was 54 percent lower in 2020 than in 1980, while estimated deaths and injuries were both 47 percent lower.

The 86,000 apartment or other multifamily housing fires in 2020 (6 percent) caused 350 civilian fire deaths (10 percent); 2,900 civilian fire injuries (19 percent), and $1.6 billion in direct property damage (7 percent). From 2019 to 2020, the number of reported apartment fires jumped 15 percent, a statistically significant increase, returning to roughly the 2018 level after a steep decline from 2018 to 2019. From 2019 to 2020, apartment fire deaths fell 8 percent, injuries fell 15 percent, and property damage jumped 22 percent, returning to 2017–2018 levels.

The estimated number of apartment structure fires was 40 percent lower in 2020 than in 1980, while apartment fire deaths and apartment fire injuries were 66 percent and 19 percent lower, respectively. The 2020 apartment injury estimate is the lowest seen since the survey began.

Less progress has been made in reducing deaths and injuries in reported home fires. In 1980, there were 7.1 deaths per 1,000 reported home fires overall. This was also true for one- or two-family homes and apartments. In 2020, the 7.2 deaths per 1,000 reported home fires was actually 2 percent higher than in 1980. In comparison, the death rate per 1,000 reported apartment fires dropped 43 percent to 4.1.

Apartment buildings, particularly high-rise apartments, are more regulated than one- or two-family homes where the 2020 rate of 8.2 deaths per 1,000 reported fires was 16 percent higher than in 1980.

While the rates fluctuated, 1984 was the only one year in which the death rate (6.5) per 1,000 one- or two-family home fires was lower than it was in 1980. Apartment fire-based death rates have had a fairly consistent downward trend. In many years, the death rate per 1,000 total home fires was higher than in 1980 because there are more reported fires in one- or two-family than there are in apartments. See Figure 10.

Figure 11 shows that the 2020 rate of 34 civilian injuries per 1,000 apartment fires was 34 percent higher than the 1980 rate of 25. For one- or two-family home fires, the 2020 rate of 32 injuries per 1,000 fires was 17 percent higher than the 1980 rate of 27. The 32 injuries per 1,000 reported home fires overall in 2020 was 20 percent higher than the rate of 27 in 1980.

Caution should be used when interpreting these results. Occupants who are alerted by smoke alarms may handle a small fire without fire department assistance, resulting in fewer small fires being reported. In addition, many apartment buildings have monitored fire detection that can result in a fire department response even when the system is triggered by a minor fire.

Figure 10. Deaths per 1,000 reported home fires by year and occupancy: 1980–2020

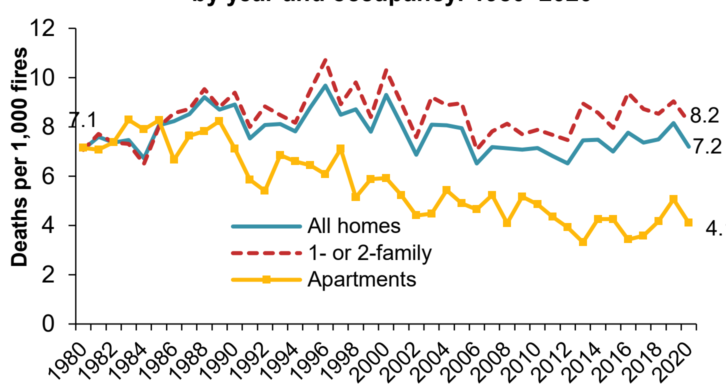
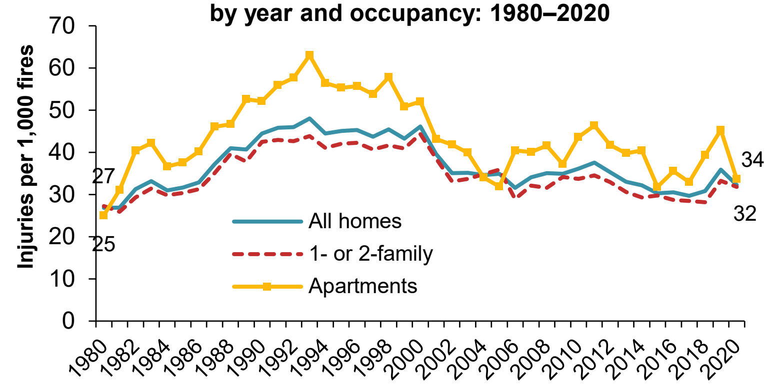


Figure 11. Injuries per 1,000 reported home fires by year and occupancy: 1980–2020



Non-Home Structure Fires

Non-home occupancies, including other residential properties such as dormitories, hotels and motels, rooming houses, and residential board and care occupancies, and non-residential properties, such as public assembly, educational, institutional, retail, office, manufacturing, and industrial or utility occupancies, are more regulated than home properties.

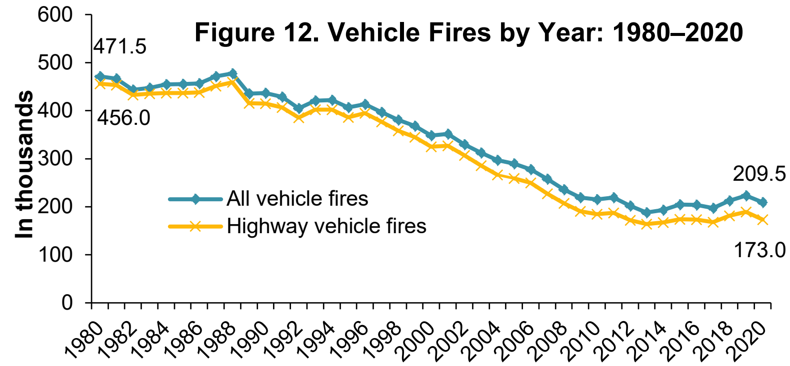
In 2020, the estimated 23,000 structure fires in other residential properties (2 percent) — including unclassified residential structures — caused 50 civilian fire deaths (1 percent), 400 civilian fire injuries (3 percent), and $303 million in direct property damage (1 percent). From 2019 to 2020, other residential structure fires rose 5 percent, deaths fell 50 percent, and injuries fell 20 percent. Direct property damage climbed 45 percent. The 2020 estimated number of other residential structure fires was 2 percent lower than in 1980; 2020 estimates of civilian fire deaths and injuries were 80 and 71 percent lower, respectively.

In 2020, the 111,000 non-residential structure fires (8 percent) caused an estimated 100 civilian fire deaths (3 percent); 1,100 civilian injures (7 percent); and $3.4 billion in direct property damage (16 percent). From 2019 to 2020, non-residential structure fires fell 8 percent, deaths fell 9 percent, injuries fell 8 percent, and direct property damage fell 21 percent. The 2020 estimate of non-residential structure fires was 64 percent lower than the 1980 estimate, while the estimates for civilian deaths and injuries were 56 and 70 percent lower, respectively.

NFPA has reports on the causes and circumstances of fires in many of these occupancies. For the latest annual averages of fires, civilian casualties, and property damage by occupancy or property use (currently 2015–2019), see *Fires by Occupancy or Property Type.*

Vehicle Fires in 2020

Vehicle fires are an often-overlooked part of the fire problem, yet in 2020, an estimated 209,500 vehicle fires (15 percent) caused 630 civilian fire deaths (18 percent); 1,700 civilian fire injuries (11 percent); and $5.2 billion in direct property damage (24 percent). More than half of the vehicle property loss resulted from a July 2020 naval ship fire in California that resulted in an estimated loss of $3 billion.



From 2019 to 2020, vehicle fires overall fell 6 percent, while vehicle fire deaths fell 2 percent, vehicle fire injuries fell 15 percent, and property damage more than doubled. The estimated number of vehicle fires was 56 percent lower in 2020 than in 1980. Estimates of deaths and injuries were 15 and 58 percent lower, respectively.

Eighty-three percent of the vehicle fires, 92 percent of the associated deaths, and 88 percent of the associated injuries resulted from fires involving highway vehicles. The 173,000 highway vehicle fires (12 percent of total fires) in 2020 caused an estimated 580 civilian fire deaths (17 percent); 1,500 civilian fire injuries (10 percent); and $1.6 billion in direct property damage (7 percent). Fire departments responded to an average of one highway vehicle fire every 3 minutes and 3 seconds.

The 9 percent decline in highway vehicle fires from 2019 to 2020 was statistically significant. In addition, highway vehicle fire deaths rose 5 percent, injuries fell 12 percent, and property damage fell 2 percent. The estimated number of highway vehicle fires in 2020 was 62 percent lower than the 1980 estimate, while the associated fire death estimate was only 11 percent lower, and the injury estimate was 47 percent lower.

For more information on the causes and circumstances of highway vehicle fires, see NFPA's 2020 report *Vehicle Fires*. Vehicles that burn inside a garage or other structure but do not damage the structure or spread to other contents are counted as vehicle fires and are the exception to the structure fire definition discussed earlier.

Other non-highway vehicles, such as boats or ships; aircraft; trains; and agricultural, garden, or industrial vehicles, were involved in an estimated 36,500 fires (3 percent) in 2020. These fires caused 50 civilian deaths (1 percent), 200 civilian injuries (1 percent), and $3.6 billion in direct property damage (16 percent). From 2019 to 2020, other vehicle fires rose 9 percent, while deaths fell 47 percent, injuries fell 33 percent, and property damage rose to six times the previous estimate.

The 2020 estimate of other non-highway vehicle fires was more than twice the 1980 estimate. It is possible that more such vehicles, including boats, planes, construction vehicles, and garden vehicles, are in use today. Despite this large increase in fires, the estimated number of deaths was 44 percent lower, and the number of injuries was 84 percent lower.

Outside and Other Fires in 2020

Half of the reported fires in 2020 (50 percent) were non-structural, non-vehicle fires or "other fires" that did not fit into any of the standard categories. The estimated 688,500 outside and other fires caused 140 civilian fire deaths (4 percent), 500 civilian fire injuries (3 percent), and $389 million in direct property damage (2 percent). Casualties were grouped together in this broad category and not subdivided further. A fire in an outside or unclassified property was reported every 46 seconds.

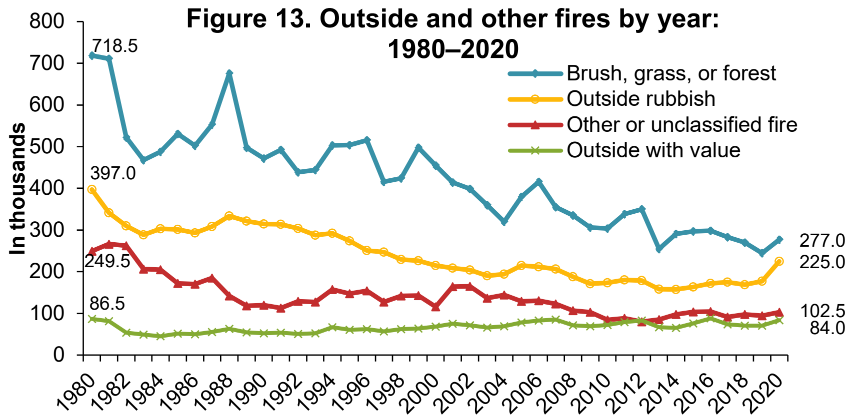
The 84,000 outside fires involving property of value (6 percent), such as outside storage, crops, timber, etc., caused $210 million in direct property damage (1 percent). Outside and other fires also included 277,000 brush, grass, and wildland fires, excluding crops and timber, (20 percent) and 225,000 outside rubbish fires (16 percent). Property damage information was not collected for these two incident types in NFPA's survey. The remaining 102,500 other non-structural, non-vehicle fires (7 percent) caused $179 million in direct property damage (1 percent).

From 2019 to 2020, outside and other fires of all types combined rose 17 percent, while associated deaths jumped 75 percent, injuries fell 29 percent, and direct property damage climbed 28 percent (excluding the major WUI fires in 2020). The estimated number of outside fires involving property of value, such as outside storage, crops, or timber — but not structures or vehicles — rose 19 percent, while property damage from these incidents rose 2 percent. Brush, grass, or wildland fires with no value or loss involved rose 13 percent. Outside rubbish fires rose 27 percent. Other fires rose 8 percent. Direct property damage from these other fires jumped 83 percent.

The increases in outside rubbish fires; outside fires involving property of value; and brush, grass, or wildland fires were statistically significant. Amidst the pandemic, the Centers for Disease Control and Prevention advised that outdoor activities carried less risk of exposure to COVID-19 than socializing indoors.[5] Increased outdoor time may have contributed to the increased prevalence of these fires.

The estimated number of outside and other non-structural, non-vehicular fires was 53 percent lower in 2020 than it was in 1980. The death estimate from these fires was 56 percent higher, while the estimated number of injuries was 64 percent lower. The estimated number of outside fires involving property of value was 3 percent lower in 2020 than in 1980. Figure 13 shows that the biggest decreases in this category were in the estimated number of brush, grass, or wildland fires with no value or loss (61 percent), other fires (59 percent), and outside rubbish fires (43 percent).

Figure 13. Outside and other fires by year: 1980–2020



Acknowledgments

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Fire Loss in the United States:
Trend Tables

September 2021

NFPA Applied Research

Fire Losses in the United States — List of Trend Tables: 1980–2020

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NFPA Index No. 3118

The US Fire Problem

All Fires in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI), caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations, handled by industrial fire brigades, or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] As Reported	In 2020 Dollars
1980	2,988,000	6,505	30,200	$6.3	$19.8
1981	2,893,500	6,700	30,450	$6.7	$19.1
1982	2,538,000	6,020	30,525	$6.4	$17.2
1983	2,326,500	5,920	31,275	$6.6	$17.1
1984	2,343,000	5,240	28,125	$6.7	$16.7
1985	2,371,000	6,185	28,425	$7.3	$17.6
1986	2,271,500	5,850	26,825	$6.7	$15.8
1987	2,330,000	5,810	28,215	$7.2	$16.4
1988	2,436,500	6,215	30,800	$8.4	$18.4
1989	2,115,000	5,410	28,250	$8.7	$18.2
1990	2,019,000	5,195	28,600	$7.8	$15.5
1991	2,041,500	4,465	29,375	$9.5	$18.1
1992	1,964,500	4,730	28,700	$8.3	$15.3
1993	1,952,500	4,635	30,475	$8.5	$15.2
1994	2,054,500	4,275	27,250	$8.2	$14.3
1995	1,965,500	4,585	25,775	$8.9	$15.1
1996	1,975,000	4,990	25,550	$9.4	$15.5
1997	1,795,000	4,050	23,750	$8.5	$13.7
1998	1,755,500	4,035	23,100	$8.6	$13.7
1999	1,823,000	3,570	21,875	$10.0	$15.5
2000	1,708,000	4,045	22,350	$11.2	$16.9
2001[2]	1,734,500	6,196	21,100	$44.0	$64.5
2002	1,687,500	3,380	18,425	$10.3	$14.8
2003	1,584,500	3,925	18,125	$12.3	$17.3
2004	1,550,500	3,900	17,875	$9.8	$13.5
2005	1,602,000	3,675	17,925	$10.7	$14.2

All Fires in the United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] As Reported	In 2020 Dollars
2006	1,642,500	3,245	16,400	$11.3	$14.5
2007	1,557,500	3,430	17,675	$14.6	$18.2
2008	1,451,500	3,320	16,705	$15.5	$18.7
2009	1,348,500	3,010	17,050	$12.5	$15.1
2010	1,331,500	3,120	17,720	$11.6	$13.8
2011	1,389,500	3,005	17,500	$11.7	$13.5
2012	1,375,000	2,855	16,500	$12.4	$14.0
2013	1,240,000	3,240	15,925	$11.5	$12.8
2014	1,298,000	3,275	15,775	$11.6	$12.7
2015	1,345,500	3,280	15,700	$14.3	$15.6
2016	1,342,000	3,390	14,650	$13.6	$14.7
2017	1,319,500	3,400	14,670	$23.0	$24.3
2018	1,318,500	3,655	15,200	$25.6	$26.4
2019	1,291,500	3,704	16,600	$14.8	$15.0
2020	1,388,500	3,500	15,200	$21.9	$21.9

[1]Individual incidents with large losses can affect the total for a given year.
[2]Estimates include 2,451 civilian deaths; 800 civilian injuries; and $33.44 billion in property loss resulting from the events of 9/11/01.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Structure Fire Problem in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.)

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations, handled by industrial fire brigades, or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] As Reported	In 2020 Dollars
1980	1,065,000	5,675	24,725	$5.5	$17.3
1981	1,027,500	5,760	25,700	$6.0	$17.1
1982	946,500	5,200	25,575	$5.7	$15.3
1983	868,500	5,090	26,150	$5.8	$15.1
1984	848,000	4,525	23,025	$5.9	$14.7
1985	859,500	5,265	23,350	$6.4	$15.4
1986	800,000	4,985	22,750	$5.8	$13.7
1987	758,000	4,880	23,815	$6.2	$14.1
1988	745,000	5,280	26,275	$7.2	$15.8
1989	688,000	4,655	24,025	$7.5	$15.7
1990	624,000	4,400	24,075	$6.7	$13.3
1991	640,500	3,765	24,975	$8.3	$15.8
1992	637,500	3,940	24,325	$7.0	$12.9
1993	621,500	3,980	26,550	$7.4	$13.3
1994	614,000	3,590	23,125	$6.9	$12.1
1995	573,500	3,985	21,725	$7.6	$12.9
1996	578,500	4,220	21,875	$7.9	$13.1
1997	552,000	3,510	20,375	$7.1	$11.5
1998	517,500	3,420	19,425	$6.7	$10.7
1999	523,000	3,040	18,525	$8.5	$13.2
2000	505,500	3,535	19,600	$8.5	$12.8
2001[2]	521,500	3,220	17,225	$8.9	$13.0
2002	519,000	2,775	15,600	$8.7	$12.5
2003	519,500	3,385	15,600	$8.7	$12.3
2004	526,000	3,305	15,525	$8.3	$11.4
2005	511,000	3,105	15,325	$9.2	$12.2

Structure Fire Problem in the United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1]	
				As Reported	In 2020 Dollars
2006	524,000	2,705	14,350	$9.6	$12.3
2007	530,500	3,000	15,350	$10.6	$13.2
2008	515,000	2,900	14,960	$12.4	$14.9
2009	480,500	2,695	14,740	$10.8	$13.0
2010	482,000	2,755	15,420	$9.7	$11.5
2011	484,500	2,640	15,635	$9.7	$11.2
2012	480,500	2,470	14,700	$9.8	$11.1
2013	487,500	2,855	14,075	$9.5	$10.6
2014	494,000	2,860	13,425	$9.8	$10.7
2015	501,500	2,685	13,000	$10.3	$11.3
2016	475,500	2,950	12,775	$10.4	$11.2
2017	499,000	2,815	12,160	$10.7	$11.3
2018	499,000	2,910	12,700	$11.1	$11.4
2019	481,500	2,980	13,900	$12.3	$12.5
2020	490,500	2,730	13,000	$12.1	$12.1

[1]Individual incidents with large losses can affect the total for a given year.
[2]Does not include the events of 9/11/01, which caused 2,451 civilian deaths; 800 civilian injuries; and $33.44 billion in property loss.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Home Structure Fire Problem in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.) The term *home* encompasses one- and two-family homes, including manufactured homes, apartments, or other multifamily homes.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. For more information about home structure fires, see the NFPA report *Home Structure Fires* and the accompanying supporting tables.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)[1] As Reported	Direct Property Damage (in Millions)[1] In 2020 Dollars
1980	734,000	5,200	19,700	$2,848	$8,965
1981	711,000	5,400	19,125	$3,128	$8,898
1982	654,500	4,820	20,450	$3,147	$8,438
1983	625,500	4,670	20,750	$3,205	$8,328
1984	605,500	4,075	18,750	$3,362	$8,370
1985	606,000	4,885	19,175	$3,693	$8,879
1986	565,500	4,655	18,575	$3,464	$8,193
1987	536,500	4,570	19,965	$3,599	$8,205
1988	538,500	4,955	22,075	$3,897	$8,541
1989	498,500	4,335	20,275	$3,876	$8,103
1990	454,500	4,050	20,225	$4,157	$8,249
1991	464,500	3,500	21,275	$5,463	$10,388
1992	459,000	3,705	21,100	$3,775	$6,973
1993	458,000	3,720	22,000	$4,764	$8,541
1994	438,000	3,425	19,475	$4,215	$7,371
1995	414,000	3,640	18,650	$4,264	$7,247
1996	417,000	4,035	18,875	$4,869	$8,048
1997	395,500	3,360	17,300	$4,453	$7,187
1998	369,500	3,220	16,800	$4,273	$6,797
1999	371,000	2,895	16,050	$4,965	$7,718
2000	368,000	3,420	16,975	$5,525	$8,316
2001	383,500	3,110	15,200	$5,516	$8,074
2002	389,000	2,670	13,650	$5,931	$8,543
2003	388,500	3,145	13,650	$5,949	$8,384
2004	395,500	3,190	13,700	$5,833	$8,009
2005	381,000	3,030	13,300	$6,729	$8,926

Home Structure Fire Problem in the United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)[1] As Reported	In 2020 Dollars
2006	396,000	2,580	12,500	$6,832	$8,779
2007	399,000	2,865	13,600	$7,389	$9,227
2008	386,500	2,755	13,160	$8,243	$9,930
2009	362,500	2,565	12,650	$7,616	$9,194
2010	369,500	2,640	13,350	$6,928	$8,238
2011	370,000	2,520	13,910	$6,914	$7,971
2012	365,000	2,380	12,875	$7,010	$7,918
2013	369,500	2,755	12,200	$6,792	$7,549
2014	367,500	2,745	11,825	$6,826	$7,367
2015	365,500	2,560	11,075	$6,960	$7,512
2016	352,000	2,735	10,750	$7,231	$7,712
2017	357,000	2,630	10,600	$7,741	$8,078
2018	363,000	2,720	11,200	$8,022	$8,166
2019	339,500	2,770	12,200	$7,767	$7,767
2020	356,500	2,580	11,500	$8,400	$8,400

[1]Individual incidents with large losses can affect the total for a given year.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

One- and Two-Family Home Structure Fires[1] in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.) Manufactured homes are considered one- or two-family homes.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. For more information about home structure fires, see the NFPA report *Home Structure Fires* and the accompanying supporting tables.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)[2] As Reported	In 2020 Dollars
1980	590,500	4,175	16,100	$2,447	$7,702
1981	574,000	4,430	14,875	$2,713	$7,717
1982	538,000	3,960	15,750	$2,794	$7,492
1983	523,500	3,825	16,450	$2,792	$7,255
1984	506,000	3,290	15,100	$2,945	$7,332
1985	501,500	4,020	15,250	$3,217	$7,734
1986	468,000	4,005	14,650	$2,992	$7,077
1987	433,000	3,780	15,200	$3,078	$7,017
1988	432,500	4,125	17,125	$3,349	$7,340
1989	402,500	3,545	15,225	$3,335	$6,972
1990	359,000	3,370	15,250	$3,534	$7,013
1991	363,000	2,905	15,600	$3,354	$6,378
1992	358,000	3,160	15,275	$3,178	$5,870
1993	358,000	3,035	15,700	$4,111	$7,370
1994	341,000	2,785	14,000	$3,537	$6,185
1995	320,000	3,035	13,450	$3,615	$6,144
1996	324,000	3,470	13,700	$4,121	$6,811
1997	302,500	2,700	12,300	$3,735	$6,028
1998	283,000	2,775	11,800	$3,642	$5,793
1999	282,500	2,375	11,550	$4,123	$6,409
2000	283,500	2,920	12,575	$4,639	$6,983
2001	295,500	2,650	11,400	$4,652	$6,809
2002	300,500	2,280	9,950	$5,005	$7,209
2003	297,000	2,735	10,000	$5,052	$7,120
2004	301,500	2,680	10,500	$4,948	$6,794
2005	287,000	2,570	10,300	$5,781	$7,668

One- and Two-Family Home Structure Fires[1] in the United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)[2] As Reported	In 2020 Dollars
2006	304,500	2,155	8,800	$5,936	$7,628
2007	300,500	2,350	9,650	$6,225	$7,773
2008	291,000	2,365	9,185	$6,892	$8,303
2009	272,500	2,100	9,300	$6,391	$7,716
2010	279,000	2,200	9,400	$5,895	$7,010
2011	274,500	2,105	9,485	$5,746	$6,624
2012	268,000	2000	8,825	$5,818	$6,572
2013	271,500	2,430	8,300	$5,626	$6,253
2014	273,500	2,345	8,025	$5,844	$6,389
2015	270,500	2,155	8,050	$5,799	$6,340
2016	257,000	2,410	7,375	$6,142	$6,635
2017	262,500	2,290	7,470	$6,141	$6,491
2018	276,500	2,360	7,800	$6,493	$6,695
2019	264,500	2,390	8,800	$6,428	$6,511
2020	270,500	2,230	8,600	$6,771	$6,771

[1]Includes manufactured homes.
[2]Individual incidents with large losses can affect the total for a given year.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Apartment or Multifamily Housing Structure Fires in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.) In NFIRS 5.0, row houses and townhouses are considered apartments. Apartments in two-family homes or duplexes are not included here.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. For more information about home structure fires, see the NFPA report *Home Structure Fires* and the accompanying supporting tables.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)[1] As Reported	In 2020 Dollars
1980	143,500	1,025	3,600	$401	$1,262
1981	137,000	970	4,250	$415	$1,180
1982	116,500	860	4,700	$353	$947
1983	102,000	845	4,300	$413	$1,073
1984	99,500	785	3,650	$417	$1,038
1985	104,500	865	3,925	$476	$1,144
1986	97,500	650	3,925	$472	$1,116
1987	103,500	790	4,765	$521	$1,188
1988	106,000	830	4,950	$548	$1,201
1989	96,000	790	5,050	$541	$1,131
1990	95,500	680	4,975	$623	$1,236
1991	101,500	595	5,675	$609	$1,158
1992	101,000	545	5,825	$597	$1,103
1993	100,000	685	6,300	$653	$1,171
1994	97,000	640	5,475	$678	$1,186
1995	94,000	605	5,200	$649	$1,103
1996	93,000	565	5,175	$748	$1,236
1997	93,000	660	5,000	$718	$1,159
1998	86,500	445	5,000	$631	$1,004
1999	88,500	520	4,500	$842	$1,309
2000	84,500	500	4,400	$886	$1,334
2001	88,000	460	3,800	$864	$1,265
2002	88,500	390	3,700	$926	$1,334
2003	91,500	410	3,650	$897	$1,264
2004	94,000	510	3,200	$885	$1,215
2005	94,000	460	3,000	$948	$1,257

Apartment or Multifamily Housing Structure Fires in United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)[1] As Reported	In 2020 Dollars
2006	91,500	425	3,700	$896	$1,151
2007	98,500	515	3,950	$1,164	$1,453
2008	95,500	390	3,975	$1,351	$1,628
2009	90,000	465	3,350	$1,225	$1,479
2010	90,500	440	3,950	$1,033	$1,228
2011	95,500	415	4,425	$1,168	$1,347
2012	97,000	380	4,050	$1,192	$1,346
2013	98,000	325	3,900	$1,166	$1,296
2014	94,000	400	3,800	$982	$1,074
2015	95,000	405	3,025	$1,161	$1,269
2016	95,000	325	3,375	$1,089	$1,176
2017	95,000	340	3,130	$1,600	$1,691
2018	86,500	360	3,400	$1,529	$1,577
2019	75,000	380	3,400	$1,339	$1,356
2020	86,000	350	2,900	$1,629	$1,629

[1]Individual incidents with large losses can affect the total for a given year.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Residential Structure Fire Problem in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.) Residential structures include homes, hotels and motels, dormitories and related properties, rooming houses, unclassified residential properties, and, since NFIRS 5.0, residential board and care properties.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. To find annual averages of fires and losses by property use and broad incident type, use the NFPA Fires by Occupancy or Property Type tool.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] As Reported	In 2020 Dollars
1980	757,500	5,446	21,100	$3.0	$9.4
1981	733,000	5,540	20,375	$3.3	$9.4
1982	676,500	4,940	21,100	$3.3	$8.8
1983	641,500	4,820	21,450	$3.3	$8.6
1984	623,000	4,240	19,275	$3.4	$8.5
1985	622,000	5,025	19,825	$3.8	$9.1
1986	581,500	4,770	19,025	$3.6	$8.5
1987	551,500	4,660	20,440	$3.7	$8.4
1988	552,500	5,065	22,600	$4.0	$8.8
1989	513,500	4,435	20,750	$4.0	$8.4
1990	467,000	4,115	20,650	$4.3	$8.5
1991	478,000	3,575	21,850	$5.6[1]	$10.7
1992	472,000	3,765	21,600	$3.9	$7.2
1993	470,000	3,825	22,600	$4.8[2]	$8.6
1994	451,000	3,465	20,025	$4.3	$7.5
1995	425,500	3,695	19,125	$4.4	$7.5
1996	428,000	4,080	19,300	$5.0	$8.3
1997	406,500	3,390	17,775	$4.6	$7.4
1998	381,500	3,250	17,175	$4.4	$7.0
1999	383,000	2,920	16,425	$5.1	$7.9
2000	379,500	3,445	17,400	$5.7	$8.6
2001	396,500	3,140	15,575	$5.6	$8.2
2002	401,000	2,695	14,050	$6.1	$8.8
2003	402,000	3,165	14,075	$6.1	$8.6
2004	410,500	3,225	14,175	$5.9	$8.1
2005	396,000	3,055	13,825	$6.9	$9.2

Residential Structure Fires in the United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] As Reported	In 2020 Dollars
2006	412,500	2,620	12,925	$7.0	$9.0
2007	414,000	2,895	14,000	$7.5	$9.4
2008	403,000	2,780	13,560	$8.6	$10.4
2009	377,000	2,590	13,050	$7.8	$9.4
2010	384,000	2,665	13,800	$7.1	$8.4
2011	386,000	2,550	14,360	$7.1	$8.2
2012	381,000	2,405	13,125	$7.2	$8.1
2013	387,000	2,785	12,575	$7.0	$7.8
2014	386,500	2,795	12,175	$7.0	$7.7
2015	388,000	2,605	11,575	$7.2	$7.9
2016	371,500	2,800	11,125	$7.4	$8.0
2017	379,000	2,710	10,910	$7.9	$8.4
2018	387,000	2,820	11,600	$8.3	$8.6
2019	361,500	2,870	12,700	$8.0	$8.1
2020	379,500	2,630	11,900	$8.7	$8.7

[1]Individual incidents with large losses can affect the total for a given year.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Non-Home Structure Fires in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.) Non-home properties exclude one- or two-family homes and apartments but *include* other residential properties such as hotels and motels, dormitories and related properties, rooming houses, unclassified residential properties, and, since NFIRS 5.0, residential board and care properties.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. To find annual averages of fires and losses by property use and broad incident type, use the NFPA Fires by Occupancy or Property Type tool.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] as Reported	in 2020 Dollars
1980	331,000	475	5,025	$2.6	$8.2
1981	316,500	360	6,575	$2.8	$8.0
1982	292,000	380	5,125	$2.6	$7.0
1983	243,000	420	5,400	$2.6	$6.8
1984	242,500	450	4,275	$2.5	$6.2
1985	253,500	380	4,175	$2.7	$6.5
1986	234,500	330	4,175	$2.4	$5.7
1987	221,500	310	3,850	$2.6	$5.9
1988	206,500	325	4,200	$3.3[3]	$7.2
1989	189,500	320	3,750	$3.6[4]	$7.5
1990	169,500	350	3,850	$2.6	$5.2
1991	176,000	265	3,700	$2.9	$5.5
1992	178,500	235	3,225	$3.2	$5.9
1993	163,500	260	4,550	$2.6	$4.7
1994	176,000	165	3,650	$2.7	$4.7
1995	159,500	345	3,075	$3.4	$5.8
1996	161,500	185	3,000	$3.1	$5.1
1997	156,500	150	3,075	$2.6	$4.2
1998	148,000	200	2,625	$2.4	$3.8
1999	152,000	145	2,475	$3.5	$5.4
2000	137,500	115	2,625	$3.0	$4.5
2001[2]	138,000	110	2,025	$3.4	$5.0
2002	130,000	105	1,950	$2.8	$4.0
2003	131,000	240	1,950	$2.7	$3.8
2004	130,500	115	1,825	$2.5	$3.4
2005	130,000	75	2,025	$2.5	$3.3

Non-Home Structure Fires in the United States Problem (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] as Reported	in 2020 Dollars
2006	128,000	125	1,850	$2.8	$3.6
2007	131,500	135	1,750	$3.2	$4.0
2008	128,500	145	1,800	$4.1	$4.9
2009	118,000	130	2,090	$3.2	$3.9
2010	112,500	115	2,070	$2.8	$3.3
2011	114,500	120	1,725	$2.8	$3.2
2012	115,500	90	1,825	$2.8	$3.2
2013	118,000	100	1,875	$2.7	$3.0
2014	126,500	115	1,600	$3.0	$3.3
2015	136,000	125	1,925	$3.3	$3.6
2016	123,500	215	2,025	$3.2	$3.5
2017	142,000	185	1,560	$3.0	$3.2
2018	136,000	190	1,500	$3.0	$3.1
2019	142,000	210	1,700	$4.5	$4.6
2020	134,000	150	1,500	$3.7	$3.7

[1]Individual incidents with large losses can affect the total for a given year.

[2]Does not include the events of 9/11/01, which caused 2,451 civilian deaths; 800 civilian injuries; and $33.44 billion in property loss.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Non-Residential Structure Fires in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS). In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.) Non-residential properties exclude one- or two-family homes and apartments, hotels and motels, dormitories and related properties, rooming houses, unclassified residential properties, and, since NFIRS 5.0, residential board and care properties.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations, handled by industrial fire brigades, or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. To find annual averages of fires and losses by property use and broad incident type, use the NFPA Fires by Occupancy or Property Type tool.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] as Reported	in 2020 Dollars
1980	307,500	229	3,625	$2.4	$7.6
1981	294,500	220	5,325	$2.7	$7.7
1982	270,000	260	4,475	$2.5	$6.7
1983	227,000	270	4,700	$2.5	$6.5
1984	225,000	285	3,750	$2.5	$6.2
1985	237,500	240	3,525	$2.7	$6.5
1986	218,500	215	3,725	$2.3	$5.4
1987	206,500	220	3,375	$2.5	$5.7
1988	192,500	215	3,675	$3.2	$7.0
1989	174,500	220	3,275	$3.5	$7.3
1990	157,000	285	3,425	$2.5	$5.0
1991	162,500	190	3,125	$2.8	$5.3
1992	165,500	175	2,725	$3.1	$5.7
1993	151,500	155	3,950	$2.6	$4.7
1994	163,000	125	3,100	$2.6	$4.5
1995	148,000	290	2,600	$3.3	$5.6
1996	150,500	140	2,575	$3.0	$5.0
1997	145,500	120	2,600	$2.5	$4.0
1998	136,000	170	2,250	$2.3	$3.7
1999	140,000	120	2,100	$3.4	$5.3
2000	126,000	90	2,200	$2.8	$4.2
2001[2]	125,000	80	1,650	$3.2	$4.7
2002	118,000	80	1,550	$2.7	$3.9
2003	117,500	220	1,525	$2.6	$3.7
2004	115,500	80	1,350	$2.4	$3.3
2005	115,000	50	1,500	$2.3	$3.1
2006	111,500	85	1,425	$2.6	$3.3
2007	116,500	105	1,350	$3.1	$3.3
2008	112,000	120	1,400	$3.8	$3.9
2009	103,500	105	1,690	$3.0	$4.6
2010	98,000	90	1,620	$2.6	$3.6

Non-Residential Structure Fires in the United States (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] as Reported	in 2020 Dollars
2011	98,500	90	1,275	$2.6	$3.1
2012	99,500	65	1,525	$2.6	$3.0
2013	100,500	70	1,500	$2.6	$2.9
2014	107,500	65	1,250	$2.9	$2.9
2015	113,500	80	1,425	$3.1	$3.2
2016	104,000	150	1,650	$3.0	$3.4
2017	120,000	105	1,250	$2.8	$3.2
2018	112,000	90	1,100	$2.8	$3.0
2019	120,000	110	1,200	$4.4	$2.9
2020	111,000	100	1,100	$3.4	$4.5

[1]Individual incidents with large losses can affect the total for a given year.

[2]Does not include the events of 9/11/01, which caused 2,451 civilian deaths; 800 civilian injuries; and $33.44 billion in property loss.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Highway Vehicle Fires in the United States

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey (FES). The FES uses definitions from the US Fire Administration's National Fire Incident Reporting System (NFIRS.) Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire. Highway vehicles include cars, trucks, motorcycles, buses, recreational vehicles in transit, and other vehicles intended for roadway use. The term *highway* describes the type of vehicle, not the location of the fire. See the NFPA report *Vehicle Fires* for more information on the causes and circumstances of these incidents.

In some years, large conflagrations, such as the events of September 11, 2001, or fires in the wildland/urban interface (WUI) or other areas, caused large losses that were not broken out by incident type. Such losses are part of the US fire problem but are not included in the tables about specific types of fires.

Fires that were reported to federal or state firefighting organizations or not reported at all are not captured here. Estimates can be skewed by the inclusion or omission of one very serious fire. Anyone who is not a firefighter is considered a civilian.

For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see NFPA's *Large-Loss Fires in the United States* and *Catastrophic Multiple-Death Fires* reports and the associated tables on the costliest and deadliest fires over time. To find annual averages of fires and losses by property use and broad incident type, use the NFPA Fires by Occupancy or Property Type tool.

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] as Reported	Direct Property Damage (in Billions)[1] in 2020 Dollars
1980	456,000	650	2,850	$0.5	$1.6
1981	453,000	770	2,900	$0.5	$1.4
1982	433,000	575	3,250	$0.5	$1.3
1983	435,500	670	3,400	$0.6	$1.6
1984	437,000	530	3,250	$0.6	$1.5
1985	437,000	770	3,250	$0.7	$1.7
1986	438,000	665	2,850	$0.7	$1.7
1987	451,000	755	2,900	$0.7	$1.6
1988	459,000	800	2,750	$0.8	$1.8
1989	415,500	560	2,750	$0.8	$1.7
1990	415,000	645	3,025	$0.8	$1.6
1991	406,500	530	2,675	$0.8	$1.5
1992	385,500	665	2,750	$0.8	$1.5
1993	402,000	540	2,400	$0.9	$1.6
1994	402,000	555	2,325	$1.0	$1.7
1995	386,000	490	2,275	$1.0	$1.7
1996	395,000	550	2,075	$1.1	$1.8
1997	377,000	450	1,950	$1.1	$1.8
1998	358,500	545	2,050	$1.1	$1.7
1999	345,000	450	1,600	$1.1	$1.7
2000	325,000	450	1,325	$1.2	$1.8
2001	327,000	470	1,750	$1.3	$1.9
2002	307,000	540	1,700	$1.2	$1.7
2003	286,000	455	1,400	$1.1	$1.6
2004	266,500	520	1,300	$1.0	$1.4
2005	259,000	500	1,450	$1.0	$1.3

Highway Vehicle Fires in the United States, (Continued)

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Billions)[1] as Reported	in 2020 Dollars
2006	250,000	445	1,075	$1.0	$1.3
2007	227,500	365	1,500	$1.1	$1.4
2008	207,000	350	850	$1.2	$1.4
2009	190,500	260	1,455	$1.0	$1.2
2010	184,500	285	1,440	$1.0	$1.2
2011	187,500	270	1,020	$1.0	$1.2
2012	172,500	300	800	$1.3	$1.5
2013	164,000	300	925	$1.1	$1.2
2014	167,500	310	1,275	$1.1	$1.2
2015	174,000	445	1,550	$1.2	$1.3
2016	173,000	280	1,075	$1.3	$1.4
2017	168,000	400	1,370	$1.5	$1.6
2018	181,500	490	1,300	$1.4	$1.4
2019	189,500	550	1,700	$1.6	$1.6
2020	173,000	580	1,500	$1.6	$1.6

[1]Individual incidents with large losses can affect the total for a given year.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Number of Fires by Type of Fire

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey. Fires that were reported to federal or state firefighting organizations, handled by industrial fire brigades, or not reported at all are not captured here. The term *highway vehicle* refers to vehicles intended for roadway use, such as cars, trucks, buses, motorcycles, recreational vehicles in transit, etc.

Year	Total	Structures	Outside of Structures with Value but No Vehicle (outside storage, crops, timber, etc.)	Highway Vehicles	Other Vehicles (Trains, Boats, Ships, Aircraft, Farm Vehicles, and Construction Vehicles)	Brush, Grass, and Wildland (excluding crops and timber) with No Value or Loss Involved	Rubbish Including Dumpsters (outside of structures), with No Value or Loss Involved	All Other Fires
1980	2,988,000	1,065,000	86,500	456,000	15,500	718,500	397,000	249,500
1981	2,893,500	1,027,500	81,000	453,000	13,500	711,000	341,000	266,500
1982	2,538,000	946,500	54,000	433,000	10,000	522,500	309,500	262,500
1983	2,326,500	868,500	49,500	435,500	11,500	467,500	288,000	206,000
1984	2,343,000	848,000	45,000	437,000	17,500	487,500	303,000	205,000
1985	2,371,000	859,500	51,500	437,000	18,500	531,000	301,500	172,000
1986	2,271,500	800,000	50,000	438,000	18,500	502,000	293,000	170,000
1987	2,330,000	758,000	55,000	451,000	20,000	553,000	308,500	184,500
1988	2,436,500	745,000	63,000	459,000	18,500	675,500	333,500	142,000
1989	2,115,000	688,000	54,500	415,500	20,000	498,000	321,000	118,000
1990	2,019,000	624,000	52,000	415,000	21,500	472,000	314,500	120,000
1991	2,041,500	640,500	53,500	406,500	22,000	492,000	314,000	113,000
1992	1,964,500	637,500	50,500	385,500	19,500	439,000	304,000	128,500
1993	1,952,500	621,500	52,000	402,000	18,500	444,000	287,500	127,000
1994	2,054,500	614,000	66,500	402,000	20,000	503,000	292,000	157,000
1995	1,965,500	573,500	61,000	386,000	20,500	503,500	274,000	147,000
1996	1,975,000	578,500	62,500	395,000	18,500	515,000	251,000	154,500
1997	1,795,000	552,000	56,500	377,000	20,000	415,500	247,000	127,000
1998	1,755,500	517,500	62,000	358,500	22,500	424,000	229,000	142,000
1999	1,823,000	523,000	64,000	345,000	23,500	498,000	226,500	143,000
2000	1,708,000	505,500	68,500	325,000	23,500	455,000	215,000	115,500
2001	1,734,500	521,500	75,000	327,000	24,500	414,000	208,500	164,000
2002	1,687,500	519,000	71,000	307,000	22,500	399,000	204,000	165,000
2003	1,584,500	519,500	66,000	286,000	26,000	360,000	190,500	136,500
2004	1,550,500	526,000	69,000	266,500	30,500	320,000	194,000	144,500
2005	1,602,000	511,000	78,000	259,000	31,000	379,500	215,000	128,500

Number of Fires by Type of Fire (Continued)

Year	Total	Structures	Outside of Structures with Value but No Vehicle (outside storage, crops, timber, etc.)	Highway Vehicles	Other Vehicles (Trains, Boats, Ships, Aircraft, Farm Vehicles, and Construction Vehicles)	Brush, Grass, and Wildland (excluding crops and timber), with No Value or Loss Involved	Rubbish Including Dumpsters (outside of structures), with No Value or Loss Involved	All Other Fires
2006	1,642,500	524,000	82,500	250,000	28,000	415,500	212,000	130,500
2007	1,557,500	530,500	85,000	227,500	30,500	355,000	206,500	122,500
2008	1,451,500	515,000	71,000	207,000	29,000	335,000	188,000	106,500
2009	1,348,500	480,500	69,000	190,500	28,500	306,000	171,000	103,000
2010	1,331,500	482,000	72,500	184,500	31,000	304,000	173,000	84,500
2011	1,389,500	484,000	79,000	187,500	31,500	338,000	180,500	88,500
2012	1,375,000	480,500	83,000	172,000	30,000	350,000	179,000	80,000
2013	1,240,000	487,500	67,000	164,000	24,000	254,500	158,000	85,000
2014	1,298,000	494,000	65,000	167,500	26,000	290,500	157,500	97,500
2015	1,345,500	501,500	76,000	174,000	30,000	297,000	163,000	103,500
2016	1,342,000	475,500	88,000	173,000	31,000	298,500	172,000	104,000
2017	1,319,500	499,000	74,000	168,000	29,500	283,000	174,500	91,000
2018	1,318,500	499,000	70,500	181,500	31,000	270,000	169,000	97,500
2019	1,291,500	481,500	70,500	189,500	33,500	244,500	177,500	94,500
2020	1,388,500	490,500	84,000	173,000	36,500	277,000	225,000	102,500

These estimates are based on data reported to the NFPA by fire departments that responded to the 1980–2018 fire experience survey.

Note: Direct property damage figures do not include indirect losses, like business interruption.
Inflation adjustment to 2020 dollars was done using the Consumer Price Index Purchasing Power of the Dollar.

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

Number of Civilian Fire Deaths by Type of Fire

The estimates below are based on fires reported to local (including county) fire departments and derived from the NFPA annual fire experience survey.

Anyone who is not a firefighter is considered a civilian. For details about fires resulting in unusually large numbers of fire deaths or exceptionally large property losses, see the NFPA report *Catastrophic Multiple-Death Fires* and the associated tables on the deadliest fires over time.

In general, any fire that occurs in or on a structure is considered a structure fire, even if no damage was done to the structure itself. (Since the inception of Version 5.0 of NFIRS, a vehicle that burns inside a structure but does not damage the structure is considered a vehicle fire.)

Year	Total	Structure	Home Structure	Vehicle	Outside or Other
1980	6,505	5,675	5,200	740	90
1981	6,700	5,760	5,400	840	100
1982	6,020	5,200	4,820	695	125
1983	5,920	5,090	4,670	725	105
1984	5,240	4,525	4,075	630	85
1985	6,185	5,265	4,885	825	95
1986	5,850	4,985	4,655	735	130
1987	5,810	4,880	4,570	805	125
1988	6,215	5,280	4,955	865	70
1989	5,410	4,655	4,335	685	70
1990	5,195	4,400	4,050	695	100
1991	4,465	3,765	3,500	605	95
1992	4,730	3,940	3,705	730	60
1993	4,635	3,980	3,720	595	60
1994	4,275	3,590	3,425	630	55
1995	4,585	3,985	3,640	535	65
1996	4,990	4,220	4,035	710	60
1997	4,050	3,510	3,360	480	60
1998	4,035	3,420	3,220	575	40
1999	3,570	3,040	2,895	470	60
2000	4,045	3,535	3,420	465	45
2001	6,196	5,671	3,110	485	40
2002	3,380	2,775	2,670	565	40
2003	3,925	3,385	3,145	475	65
2004	3,900	3,305	3,190	550	45
2005	3,675	3,105	3,030	520	50
2006	3,245	2,705	2,580	490	50
2007	3,430	3,000	2,865	385	45
2008	3,320	2,900	2,755	365	55
2009	3,010	2,695	2,565	280	35
2010	3,120	2,755	2,640	310	55

Number of Civilian Fire Deaths by Type of Fire (Continued)

Year	Total	Structure	Home Structure	Vehicle	Outside or Other
2011	3,005	2,640	2,520	300	65
2012	2,855	2,470	2,380	325	60
2013	3,240	2,855	2,755	320	65
2014	3,275	2,860	2,745	345	70
2015	3,280	2,685	2,560	500	95
2016	3,390	2,950	2,735	355	85
2017	3,390	2,815	2,630	430	145
2018	3,655	2,910	2,720	560	185
2019	3,704	2,980	2,770	644	80
2020	3,500	2,730	2,580	630	140

Source: *Fire Loss in the United States During 2020* and previous reports in the series.

RB313.1-21

VRC: R313.1, R313.1.1

Proponents: Andrew Milliken (amilliken@staffordcountyva.gov)

2018 Virgina Residential Code

Revise as follows:

R313.1 Townhouse automatic fire sprinkler systems. ~~Notwithstanding the requirements of Section 103.3, where installed, an~~ An automatic residential fire sprinkler system ~~for *townhouses*~~ shall be ~~designed and installed in accordance with NFPA 13D or Section P2904.~~ installed in *townhouses.*

> **Exception:** An automatic residential fire sprinkler system shall not be required when additions or alterations are made to existing *townhouses* that do not have an automatic residential fire sprinkler system installed.

R313.1.1 Design and installation. Automatic residential fire sprinkler systems for *townhouses* shall be designed and installed in accordance with Section P2904 or NFPA 13D, 13, or 13R.

Reason Statement: This proposal is the same townhouse fire sprinkler requirement initially approved by the Board of Housing and Community Development during the 2018 Code Development Cycle. Recognizing that townhomes require homeowners to put their trust in their neighbors for fire safety, requiring fire sprinklers in townhomes provides active and built-in protection for homeowners against that risk for each townhome in the row.

Home fires are fast; sprinklers are faster. According to Underwriters Laboratories, modern home furnishing burn tests have measured the burn rates and times of older home furnishings, made up of materials using solid wood, wool and down, and compared them with today's home furnishings that contain mostly synthetic materials and electronics in addition to open-floor plans, larger homes and engineered lumber. The results? Today's home fires burn much faster, leaving less time for residents to get out of structures and posing new challenges for firefighters (www.youtube.com/watch?v=aDNPhq5ggoE).

Home fires are deadly; sprinklers save lives. According to National Fire Protection Association statistics for 2020, 74% of fire deaths occur in the home. Home fire sprinklers can save lives and property from fire. They respond quickly and effectively to fire, often extinguishing the fire before the fire department arrives. Only the sprinkler closest to the fire will activate, spraying water on the fire.

Homes need to be affordable; sprinklers are too. The national average for installing automatic fire sprinklers in new homes is $1.35 per sprinklered square foot. Putting that figure in perspective, people pay similar amounts for carpet upgrades, whirlpool baths, or granite countertops.

MYTH: "A smoke alarm provides enough protection." FACT: Smoke alarms alert occupants to the presence of danger, but do nothing to extinguish the fire. Home fire sprinklers respond quickly to reduce heat, flames, and smoke from a fire, giving residents valuable time to get out safely. Having a working smoke alarm cuts the chances of dying in a reported fire in half. However, if you have a reported fire in your home, the risk of dying decreases by about 85% when sprinklers are present.

MYTH: "Newer homes are safer homes; the fire and death problem is limited to older homes." FACT: Age of housing is a poor predictor of fire death rates. Yes, new construction codes allow for tighter construction and better draft-stopped homes, which help slow the spread of fire. However, these safeguards have not completely mitigated the home fire problem. The majority of home fires are caused by candles, smoking materials, cooking, arcing, and other occupant-based activities. These types of fires happen in old and new construction alike. Moreover, new methods of construction negatively impact occupant and firefighter life safety under fire conditions. The National Research Council of Canada (NRC) tested the performance of unprotected floor assemblies exposed to fire. The findings of the study, "The Performance of Unprotected Floor Assemblies in Basement Fire Scenarios," assert that these structures are prone to catastrophic collapse as early as six minutes from the onset of fire. The same UL study found that the synthetic construction of today's home furnishings add to the increased risk by providing a greater fuel load. Larger homes, open spaces, increased fuel loads, void spaces, and changing building materials contribute to: faster fire propagation, shorter time to flashover, rapid changes in fire dynamics, shorter escape time, shorter time to collapse

MYTH: "Home fire sprinklers are expensive and will make housing unaffordable, especially for first-time buyers moving to our area." FACT: The fact is that home fire sprinklers are affordable. In 2013, the Fire Protection Research Foundation issued its updated Home Fire Sprinkler Cost Assessment report, which revealed that the cost of installing home fire sprinklers averages $1.35 per sprinklered square foot for new construction. That's down from $1.61 per sprinklered square foot that was in the Foundation's 2008 report. To put the cost of sprinklers into perspective, many people pay similar amounts for carpet upgrades, a paving stone driveway, or a whirlpool bath. Installing home fire sprinklers can help residents significantly reduce property loss in the event of fire, cut homeowner insurance premiums, and help support local fire service efforts.

MYTH: "We don't need sprinkler requirements; they can be installed in homes voluntarily."FACT: Fire sprinklers are a U.S. model building code requirement for all new, one- and two-family homes. If a new home is lacking this safety feature, it is not adhering to national model building codes, and should therefore be considered substandard. Adopting this requirement to sprinkler new homes provides a greater overall level of safety in communities. By requiring this technology, you are ensuring that a large number of residents can enjoy the same level of safety found in many offices, schools, apartments, and public buildings. Beyond the life-saving benefits of home sprinklers, there are other incentives; cities can reduce the strain on fire service personnel, limit damage to property, and help conserve municipal water resources by reducing the amount of water needed to fight fires.

MYTH: “Home fire sprinklers often leak or activate accidentally.” FACT: Leaks from fire sprinklers are very rare. Scottsdale, Arizona, for instance, has had an ordinance for home fire sprinklers since 1986. According to ***NFPA's "U.S. Experience with Sprinklers" report, a survey conducted there found that the majority of residents living in sprinklered homes had never experienced a leak or maintenance problem. The report also noted that sprinklers operated in 94 percent of home fires in which sprinklers were present and fires were considered large enough to activate them. They were effective at controlling the fire in 96 percent of fires in which they operated. In three of every five home fires in which sprinklers failed to operate, the system had been shut off.***

MYTH: "If you want your home fire sprinklers to be reliable, they will need frequent, expensive maintenance.” FACT: The standard design for home fire sprinklers is much simpler than the design for more traditional sprinklers used in commercial buildings. If you install home fire sprinklers, the only “inspection and maintenance” you need to do are simple tasks outlined by the Home Fire Sprinkler Coalition, including simple flow tests and visual inspections.

MYTH: “When a fire occurs, every sprinkler will activate and everything in the house will be ruined." FACT: In the event of a fire, typically, only the sprinkler closest to the fire will activate, spraying water directly on the fire, leaving the rest of the house dry and secure. Roughly 85 percent of the time, only one sprinkler activates during a fire.

MYTH: “The water damage caused by fire sprinklers will be more extensive than fire damage.” FACT: Home fire sprinklers can significantly reduce property loss and damage due to a fire. The sprinkler will quickly control the heat and smoke from the fire, limiting damage to other areas of the house and giving residents valuable time to get out safely. Any resulting impact from the sprinkler will be much less severe than the damage caused by water from fire-fighting hose lines. Fire departments use up to eight-and-a-half times more water to extinguish a home fire as fire sprinklers would use to extinguish the same fire.

MYTH: “Home fire sprinklers are not practical in colder climates, as the pipes will freeze and cause water damage.” FACT: With proper installation, home fire sprinklers will not freeze in cold settings. NFPA 13D, Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes, sets forth guidelines on proper insulation to avoid pipes freezing.

MYTH: “Home fire sprinklers are unattractive and will ruin the aesthetics of our residents’ homes.”FACT: New home fire sprinkler models are very unobtrusive, can be mounted flush with walls or ceilings, and can be concealed behind decorative covers.

MYTH: “Any time a smoke alarm goes off it will activate the home fire sprinklers.” FACT: Each individual sprinkler is designed and calibrated to activate only during the heat from a fire. They do not operate in response to smoke, burned toast, cooking vapors, steam, or an activating smoke alarm.

https://ul.org/new-demonstration-video-shows-you-only-have-three-minutes-escape-home-fire

https://www.nfpa.org/Public-Education/Staying-safe/Safety-equipment/Home-fire-sprinklers/Fire-Sprinkler-Initiative/Take-action/Free-downloads/Myths-vs-facts

Resiliency Impact Statement: This proposal will increase Resiliency
This proposal will increase the minimum life safety infrastructure of new residential townhouses such that they are more resilient to the impact of fire. It ensures that fire sprinkler protection is built-in with each townhome and remains for the life span of the structure.

Cost Impact: The code change proposal will increase the cost of construction
According to a 2013 study by the Fire Research Foundation, the national average cost for installing a residential sprinkler system is $1.35 per square foot or $3,375 for a 2,500-square-foot home. A copy of that report is available at https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Suppression/HomeFireSprinklerCostAssessment2013.ashx. With the average construction cost of a new home at $114 per square foot in 2019, that’s paying a little more than 1% of a home’s value for 24/7 fire protection.

Attached Files

- **Fact Sheet - water supply.pdf**
  https://va.cdpaccess.com/proposal/1134/1554/files/download/659/
- **Fact Sheet - Townhouses.pdf**
  https://va.cdpaccess.com/proposal/1134/1554/files/download/658/

INTERNATIONAL RESIDENTIAL CODE
FIRE SPRINKLER COALITION

FACT SHEET

Water Supplies for Home Fire Sprinkler Systems

This document has been developed to dispel myths by providing factual information about water supply requirements for home fire sprinkler systems.

MYTH: ***Home fire sprinkler systems require expensive upgrades to a new home's water supply system.***

FACTS: Home fire sprinkler systems have become so efficient that they can often be designed to use the same or even less water than a new home's plumbing system.

- Fire sprinklers typically require only 7 pounds-per-square-inch (psi) to operate, which is less than the minimum required pressure for residential plumbing fixtures.

  Plumbing systems require:
  - 8 psi minimum pressure for any plumbing fixture.[1]
  - 20 psi minimum pressure for temperature controlled shower valves (these are mandatory in new homes).[2]
  - 40 psi minimum pressure for the main supply connection (applies to all homes with indoor plumbing, even those supplied by wells).[3]
- A single fire sprinkler can use as little as 8 gallons-per-minute (gpm). With home fire sprinkler systems typically designed to accommodate two simultaneously flowing sprinklers, 16 gpm may be all that's needed to supply fire sprinklers. This is actually less than the 18 gpm minimum that would be required by the Plumbing Code to supply plumbing fixtures in a typical entry-level home with 3 bedrooms, 2 bathrooms and 2 outdoor hose connections.[4]
- Fire sprinklers will typically require more water in larger, more expensive homes, but such homes tend to have more plumbing fixtures, which require an increased water supply for plumbing as well. One or two sprinklers must flow for a minimum of 7-10 minutes, which can be provided by a well and/or a small tank when sprinklers are not supplied by a water distribution system.

MYTH: ***Home fire sprinkler systems require big, expensive water meters.***

FACTS: When a fire sprinkler system is supplied by a water distribution system, water meter size is based on the required pressure and flow, which as stated above, may actually be greater for plumbing than for fire sprinklers. Fire sprinklers won't lead to increased meter or tap fees when the sprinkler system is able to be supplied by the same size meter that serves household plumbing.

A typical 5/8-inch meter will flow up to 20 gpm, which is adequate to operate a fire sprinkler system in many homes.[5] A 3/4-inch meter, which will flow well over 30 gpm, is capable of handling just about any home fire sprinkler system. Most often, the size of underground pipe leading to a house is much more limiting than the meter itself. Upsizing the underground piping

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[1] International Residential Code (IRC) Table P2903.1
[2] IRC Section P2708
[3] IRC Section P2903.3
[4] IRC Table P2903.6 [17.5 fixture units: 2 bathroom groups, 1 kitchen group, 1 laundry group and 2 hose bibs], and IRC Table P2903.6(1)
[5] IRC Table P2904.6.2(2) [This is the prescriptive allowance for any meter. When a meter of known flow characteristics flows more, the higher flow may be used.]

between the meter and the house is an easy and inexpensive way to improve pressure and flow for all plumbing, including fire sprinklers, without a larger meter.

It's important to note some meter manufacturers' literature specify lesser flow limits, focusing on the range over which a meter will accurately measure continuous flow. With respect to supplying home fire sprinklers, meter flow limits should be evaluated based on the maximum flow rate rather than continuous flow accuracy limits. Water authorities should recognize that sprinklers will always use less water than fire hoses connected to unmetered fire hydrants that would otherwise be needed to put out a fire, so there is no legitimate value in requiring accurate measurement of sprinkler flow in the event of a fire

MYTH: Fire sprinkler systems require expensive backflow preventers.

FACTS: National plumbing codes never require backflow protection for home fire sprinkler systems fabricated with materials approved for household plumbing, such as CPVC, PEX or copper.[6] Occasionally, a local plumbing authority may nevertheless request a backflow preventer, not recognizing that fire sprinkler systems can be safety connected directly to a potable water supply.

Where backflow prevention is an issue because of a local requirement, there are several options whereby additional backflow controls for fire sprinklers can be avoided.

- Fire sprinklers can be incorporated as part of a multipurpose plumbing system that feeds both sprinklers and plumbing fixtures from a home's cold water plumbing pipes.
- Fire sprinklers can be supplied by a separate water connection, with a toilet connected to the end of sprinkler piping to ensure that the piping is occasionally purged by flushing the toilet to prevent stagnant water. This arrangement is referred to as "passive purge."
- Where a yard irrigation system is installed, backflow prevention will be required because such systems are subject to backflow of non-potable water. Fire sprinklers can share the irrigation backflow preventer; thereby, eliminating the need for an additional device.

MYTH: Rural water distribution systems and wells don't have enough water to supply home fire sprinklers.

FACTS: As indicated above, if the water distribution system or well provides enough water to supply household plumbing needs, the supply may be adequate for fire sprinklers. In some cases a larger pump or tank may be needed for sprinklers, but standard, off-the-shelf pumps and tanks suitable for plumbing systems are permitted. When such upgrades are provided, they actually benefit the owner on a daily basis beyond fire protection, because the home's plumbing system will be more robust. Additional water storage can also be invaluable for emergency use in the event of a natural disaster that interrupts utilities.

It should also be noted that, were a rural water distribution system found to be inadequate to supplying 16 gpm for fire sprinklers, it would probably fall short of the minimum code-required plumbing demand, and it would surely fall far short of the 1,000+ gpm needed from fire hydrants to support a fire department extinguishing a fire in an unsprinklered home.

About IRC Fire Sprinkler Coalition
Founded in 2007, the IRC Fire Sprinkler Coalition has grown to include more than 100 international, national and regional public safety organizations, including associations representing 45 states, all of whom support the mission of promoting residential fire sprinkler systems in new home construction. More information can be found at www.IRCFireSprinkler.org.

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[6] IRC Section P2904.1

INTERNATIONAL RESIDENTIAL CODE
FIRE SPRINKLER COALITION

FACT SHEET

Fire Sprinkler Systems for Townhouses

Beginning with the 2009 edition, the International Residential Code (IRC) requires fire sprinkler systems to be provided as a standard feature in all newly constructed townhouses. This document provides information to dispel myths about the background and costs associated with townhouse fire sprinkler systems.

MYTH: Fire sprinkler systems are an expensive add-on in new townhouses that will negatively impact affordability.

FACTS: The IRC provides numerous financial offsets that reduce the cost of fire sprinklers. For example, townhouse separation walls are permitted to be 1-hour fire rated, rather than 2-hour, when sprinklers are provided. This single incentive can dramatically reduce the overall construction costs, when comparing the total cost of building a sprinklered townhouse with 1-hour separation walls vs an unsprinklered townhouse with 2-hour walls.

According to a 2010 estimate provided by a national “Top 10” multifamily builder, the cost savings associated with reducing a townhouse separation wall from a 2-hour rated assembly to a 1-hour rated assembly is approximately $2.20 per square foot of separation wall. Assuming a 2-story, 1,200 square foot townhouse measuring 20-feet by 30-feet with a pitched roof and attic, the incremental cost of providing a 2-hour wall versus a 1-hour wall would be $1,567. In comparison, the sprinkler system for this building, using the most recent national average cost of $1.35 per square foot cited by the National Fire Protection Research Foundation would be $1,620. Therefore, the firewall incentive alone could reduce the net cost of sprinklers to $53 in this example.

When other factors are considered, such as reduced fire access roadway widths, reduced fire hydrant and water main requirements, and the fact that sprinkler installation costs are often less for townhouses vs. single-family homes due to economies of scale, the overall cost of constructing a sprinklered townhouse community may be less than a non-sprinklered community.

MYTH: Residential sprinkler systems in townhouses are a new and unproven technology that is not yet ready for widespread use.

FACTS: The first residential sprinkler standard was written more than 45 years ago, in 1975, and according to U.S. government statistics, millions of families now live in sprinkler-properties. With respect to townhouses, the **Maryland Building Officials Association**, one of the original proponents of the IRC sprinkler requirement for townhouses in 2008, summed up their extensive experience with fire sprinklers in townhouses in their justification statement, as follows:

> “*Since 1990, townhouses in Maryland have been sprinklered and being so has not been detrimental to the home building industry, but has been a major success to saving lives over the past 18 years. To address reasonable fire protection and affordable housing, many Maryland jurisdictions over the years have permitted townhouse separation of one hour with sprinklers installed in accordance with NFPA 13D. Therefore, based on our past success with sprinklered townhouses with one-hour separations between the townhouses, MBOA is in support of mandatory sprinklers in townhouses with one-hour dwelling unit separations.*

MYTH: The IRC requirement to install fire sprinklers in townhouses was initiated by the fire service and the fire sprinkler industry and it was forced on builders.

FACTS: The code change proposal that added the IRC fire sprinkler requirement (Proposal RB66-07/08) was actually submitted by a major multifamily builder, AvalonBay Communities, and public comments supporting this change were submitted by the Maryland Building Officials Association and the New York State Building Officials Conference. As a major builder of multifamily residential properties, AvalonBay Communities developed extensive experience in installing fire sprinkler systems in townhouses and concluded that sprinkler systems were desirable, cost-effective and should be required as a standard feature in new townhouses.

MYTH: It's best to give home buyers the right to choose whether or not to have sprinklers, as opposed to having codes mandate these systems in all townhouses.

FACTS: It is a fundamental function of building codes to ensure safe housing. Home buyers don't get to choose whether their homes are built to withstand seismic forces, wind loads or snow loads. Likewise, home buyers aren't given the choice of having or not having safe electrical, plumbing, or mechanical systems or smoke alarms. Codes provide minimum requirements for all of these aspects of safe housing in the interest of public safety.

Fire sprinkler systems are no different. Just as car safety regulations have evolved over time from only requiring seat belts to now requiring air bags and backup cameras, building codes have evolved from requiring only smoke alarms to now requiring sprinkler systems for fire safety.

In the case of townhouses, it particularly makes sense for codes to require sprinkler systems because each family's safety is reliant on their neighbors. An accident or careless behavior in one unit often impacts multiple units in non-sprinklered townhouses. Fire sprinklers are the most effective way to ensure that a fire in one townhouse will not threaten families in adjacent units.

Furthermore, townhouses are typically constructed as "spec homes," without buyer involvement during the design or construction process. Adding sprinklers after-the-fact to a finished townhouse unit would greatly increase the cost and complexity of the installation, if it were feasible at all. Likewise, it makes no sense to allow an initial buyer, or the builder in the case of a speculative home, to opt out of fire sprinklers, knowing that such a choice will deny all future owners the option of having sprinklers, given that retrofit installations are typically not feasible.

About IRC Fire Sprinkler Coalition. Founded in 2007, the IRC Fire Sprinkler Coalition has grown to include more than 100 international, national and regional public safety organizations, including associations representing 45 states, all of whom support the mission of promoting residential fire sprinkler systems in new home construction. More information can be found at www.IRCFireSprinkler.org.

RB313.1(2)-21

VRC: SECTION R313, R313.1, R313.1.1, R313.2, R313.2.1

Proponents: Glenn Dean

2018 Virgina Residential Code

SECTION R313
AUTOMATIC FIRE SPRINKLER SYSTEMS

Revise as follows:

R313.1 Townhouse automatic fire sprinkler systems. ~~Notwithstanding the requirements of Section 103.3, where installed, an~~ An automatic residential fire sprinkler ~~system for *townhouses*~~ systems shall be ~~designed and installed in accordance with NFPA 13D or Section P2904.~~ installed in *townhouses* .

> **Exception:** An automatic residential fire sprinkler system shall not be required when additions or alterations are made to existing *townhouses* that do not have an automatic residential fire sprinkler system installed.

R313.1.1 Design and installation. Automatic residential fire sprinkler systems for *townhouses* shall be designed and installed in accordance with Section P2904 or NFPA ~~13D, 13, or 13R.~~ 13D.

R313.2 One- and two-family dwellings automatic fire sprinkler systems. ~~Notwithstanding the requirements of Section 103.3, where installed, a an~~ An automatic residential fire sprinkler system shall be designed and installed in ~~accordance with Section P2904 or NFPA 13D, 13 or 13R.~~ one- and two-family dwellings.

> **Exception:** An automatic residential fire sprinkler system shall not be required for additions or alterations to existing buildings that are not already provided with an automatic residential fire sprinkler system.

R313.2.1 Design and installation. Automatic residential fire sprinkler systems shall be designed and installed in accordance with Section P2904 or NFPA ~~13D, 13 or 13R.~~ 13D.

Reason Statement: I'm submitting this to revert to model code language because the facts supporting a sprinkler requirement in NEW residential construction have not changed over the years, nor have the falsehoods against it. The facts and falsehoods need not be enumerated – again – in this supporting statement. We already know what they are and have for decades. Because of materials used, lightweight construction, density of housing and so on, newly constructed houses burn quickly making the incorporation of sprinklers more imperative. Having a residential sprinkler system provides time for occupants to vacate before untenable conditions are created as they would be without the presence of sprinklers. The fragility of the construction industry is nothing new either. It has been fragile for decades and will continue to fragile for years to come. The same with the increase of housing costs. That's not new. It's always gone up and will continue to go up. By comparison, what I can't understand is the sacrificial cost of a human life when compared to the now relatively insignificant cost of installing residential sprinklers in new construction.

Resiliency Impact Statement: This proposal will increase Resiliency
If construction resiliency means to reduce, respond, adapt or avoid a failure due to a destructive event such as a fire, then yes, this proposal will increase resiliency.

Cost Impact: The code change proposal will increase the cost of construction
This code change might increase construction cost approximately one percent - OR LESS - particularly in light of the tradeoffs available.

RB313.1(3)-21

VRC: R313.1, R313.1.1

Proponents: Jeffrey Shapiro (jeff.shapiro@intlcodeconsultants.com)

2018 Virgina Residential Code

Revise as follows:

R313.1 Townhouse automatic fire sprinkler systems. An automatic sprinkler system shall be installed in townhouses.~~Notwithstanding the requirements of Section 103.3, where installed, an automatic residential fire sprinkler system for *townhouses* shall be *townhouses* designed and installed in accordance with NFPA 13D or Section P2904.P2904.~~

~~**Exception**~~ **Exceptions :** 1. *Townhouses* containing no more than three *townhouse units.*

2. An automatic ~~residential fire~~ sprinkler system shall not be required when additions or alterations are made to existing *townhouses* that do not have an automatic ~~residential fire~~ sprinkler system installed.

R313.1.1 Design and installation. Automatic ~~residential fire~~ sprinkler systems for *townhouses* shall be designed and installed in accordance with Section P2904 or NFPA 13D, 13, or 13R.

Reason Statement: This proposal provides a reasonable approach to providing fire safety in newly constructed Virginia townhouses, by including an option for townhouses with less than four units to be built without fire sprinklers. This exception specifically responds to concerns that have previously been raised in Virginia about the feasibility and cost of providing sprinklers in smaller townhouse projects and projects built in rural areas that lack a public water supply. Although 12 of the 13 states/DC that currently adopt the IRC requirement for townhouse sprinklers do not amend in an un-sprinklered unit threshold, and all of these states include the same types of rural and remote area that have been cited as being of concern in Virginia, it is hoped that this Virginia exception will provide a path that building officials, industry, and the fire service will view as reasonable and worthy of support.

Below is a list of considerations that are commonly discussed when reviewing adoption of the IRC's townhouse sprinkler requirement.

1. **Precedence - Adopt the model code requirement:** This proposal will realign the Virginia Residential Code with the IRC by retaining the IRC requirement for fire sprinklers in new townhouses, as modified by an exclusion for less than 4 townhouse units. The IRC requirement was first published in the 2009 IRC and has been retained in the 2012, 2015, 2018, 2021, and 2024 editions of the code. Thirteen state-level code adoptions [California, District of Columbia, Hawaii, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New York (3+ stories above grade), Oklahoma, Pennsylvania, Washington (more than 4 units), Wisconsin] and numerous other jurisdictions, include the IRC townhouse sprinkler requirement. There is no evidence of negative impacts on home affordability or other detrimental issues associated with the adoption of townhouse sprinklers in any jurisdictions where the IRC requirement is in place.
2. **Parity with the Virginia Building Code:** Section 903.2.8 of the Virginia Building Code requires all townhouses, regardless of height or area, to be sprinklered. There is no technical basis for requiring fire sprinklers to be installed under the Virginia Building Code yet exempt the same requirement under the Residential Code. It is the intent of the IRC and this proposal to provide equal protection to residents of all townhouses with four or more units, regardless of which code they are built under.
3. **Increased fire risk associated with townhouses – They are multifamily occupancies:** Unlike detached homes, where an owner has direct control over personal safety, townhouses are multifamily structures that include many unrelated individuals and families living under a single roof. Clearly, there is no "owner's choice" argument in the case of townhouses because the fire safety of at least two other families relies on the behavior of someone else who lives under the same roof, i.e. a neighbor's accident, carelessness, or perhaps even unlawful activities such as a drug lab will impact your safety, your family's safety, your pets' safety (who may be home unattended when a fire occurs) and your property. There have been many incidents where a fire in one townhouse unit had catastrophic consequences on neighbors who had nothing to do with the cause of the fire. Residential fire sprinklers prevent such tragedies by keeping fires contained to the unit of origin, either controlling the fire or extinguishing it altogether. It is also worth noting that the National Fire Incident Reporting System codes townhouses as multifamily occupancies, separate from one- and two-family dwellings and recognizing that the risk associated with a townhouse fires is that of a multifamily occupancy.
4. **Increased danger of residential fire behavior:** Research conducted by the National Institute of Standards and Technology and Underwriters Laboratories on residential fire behavior and the value of residential fire sprinklers to firefighter and occupant safety provides a technical basis for this recommendation. Research shows that the rate of fire growth in modern residential structures has increased, partly attributed to an increased heat release rate and an increased heat of combustion associated with modern synthetic materials used in household goods and furnishings. Faster fire growth in a multifamily structure means that occupants of adjacent units will be endangered more quickly than was the case with legacy furnishings
5. **Increased risk to firefighters and demand on fire service resources from townhouses:** Townhouses place significantly increased demand on fire service resources as compared to detached dwellings. Townhouses increase the complexity of rescue operations, and firefighting is hampered because fire spread into adjacent units cannot be easily followed by firefighters from unit to unit. There are no access openings in party walls allowing firefighters to pass back and forth between opposite sides when fighting a fire. Furthermore, townhouses with

four or more units, which are the focus of this proposal, tend to be large structures that create the potential for large fires. Wind-driven flames from an uncontrolled residential fire can bypass rated separations and result in fire extension to adjacent units and structures and are challenging to emergency responders, particularly in rural areas served by diminishing volunteer and equipment resources.

6. **Sustainable housing and environmental impact:** In addition to life-safety and property protection attributes of fire sprinklers, research by FM Global has also verified the value of fire sprinklers in sustainable housing and protecting the environment from pollution associated with toxic smoke and contaminated runoff from manual firefighting. Of particular interest is the conclusion that a single fire event, in addition to destroying a townhouse, can offset the cumulative value of green construction and energy saving appliances, i.e. green efforts are negated if a fire occurs and sprinklers aren't installed as an insurance policy that remains ready to control it.
7. **Financial impact of townhouse sprinklers recognized by builders and cannot be equated to one- and two-family dwellings:** Arguments often conveyed by the building industry in opposition to residential sprinklers based on possible cost implications aren't relevant to townhouses because sprinklered townhouses can actually be less expensive to build than non-sprinklered townhouses. The difference is attributed to incentives that are offered by the IRC and the International Fire Code (IFC) for sprinklered properties. Unlike single family developments, where multiple builders might not be able to directly recoup the value of infrastructure incentives, townhouses are typically built in communities where the developer is the builder, so the cost reductions are directly realized. There's no better testament to this cost comparison than the fact that the IRC's townhouse sprinkler requirement was proposed (RB66-07/08) by a major national multifamily builder, Avalon Bay Communities, not the fire service or public safety interest group. Prior to the 2009 edition, the IRC didn't include an allowance to reduce the fire rating of townhouse separation walls from 2-hours to 1-hour, which had been permitted by the IBC. Avalon Bay Communities proposed adding the IBC wall reduction to the IRC with the quid pro quo of also adding the IBC's requirement to sprinkler all townhouses. Avalon Bay Communities knew that the cost savings associated with the reduced wall rating alone may equal or exceed the cost of installing sprinklers. When combined with other incentives offered by the IFC for access roads and water supply, the company knew that they could actually save money by sprinklering townhouses.
8. **Economic impact:** Installation costs for fire sprinklers in townhouses are offset by cost savings that can be realized in other aspects of construction. Cost incentives for townhouse development/buildings may include:
    1. Reduced material and labor costs associated with reductions in the required fire rating of townhouse separation walls from 2-hours to 1-hour. This incentive has an added benefit, particularly in the current market of tight material and labor supplies, of significantly reducing the amount of drywall that must be secured to construct a project and the associated challenge of securing labor resources to apply additional drywall layers needed to achieve a 2-hour assembly rating. In addition, Code Change RB67-19 resulted in a change to the 2021 IRC that permits sprinkler piping to penetrate and be routed in townhouse common walls. This can reduce sprinkler installation costs by allowing a single water supply for multiple sprinkler systems in a townhouse building, and by allowing sidewall sprinklers to be used as a means of improved coverage and avoid the need to install pipe in attic areas that might be subject to freezing.
    2. Reductions in minimum required water supply for firefighting, allowing for smaller water mains, and typically eliminating some fire hydrants.
    3. Somewhat unique to Virginia is an allowance in R310.1, Exception 1, which eliminates the IRC requirement to provide emergency escape and rescue openings for dwellings that are equipped with a fire sprinkler system. Accordingly, there is a significant design advantage with respect to allowing builders to used fixed glazing or windows that do not meet the minimum size and operability requirements of the IRC for escape openings. In addition, for townhouses, which typically have small fenced yards that may not easily connect to a public way, the elimination of escape and rescue openings can solve site layout issues by eliminating the need for accessways from yards to a public way. Additionally, eliminating escape window or door openings for basements deletes not only additional windows for sleeping rooms, but also the associated window well, escape ladder, fall protection for the window well opening and issues with sealing below-grade wall openings from water infiltration, and associated costs.
    4. Increased portion of roof area permitted to have solar panels (R324.6), which increases available solar generating capacity.
    5. Permissible area of a mezzanine increases from 1/3 of the floor area of the room with a mezzanine to 1/2 (R325.3). This permits increased design flexibility for a top-story mezzanine vs. having a 4^{th} story in a townhouse, which falls out of the IRC scope and forces IBC compliance.
    6. Permissible enclosure of mezzanines in rooms not exceeding 2 stories above grade plane vs requiring openness to the room with walls not exceeding 36 inches in height (R325.5).

Many of these cost offsets relate to design options that are difficult to specifically quantify because they relate to unique architectural design features, such as the inclusion of mezzanines, or on local fire code requirements that are specific to individual jurisdictions. However, the cost offsets associated with permissible reductions in townhouse separations and unfinished basement floor-ceiling assemblies can be quantified.

To quantify these values, a calculation model was created using data from the Craftsman National Construction Estimator program. For the purpose of this submittal, four sample runs were performed on a sample townhouse using two wall types (back-to-back 1-hour walls in a non-sprinklered building vs. a staggered stud 1-hour wall in a sprinklered building) and two sprinkler installation costs ($1.50/sqft and $2.00/sqft). Although the NFPA published a report "Home Fire Sprinkler Cost Assessment – 2013" (attached) estimates a national average cost of $1.35/sqft installation costs, the Virginia model runs used costs of $1.50/sqft and $2.00/sqft in an effort to be reasonably conservative, even though townhouse sprinkler systems may cost less than NFPA's estimated costs because there is an economy of scale in townhouse communities.

The sample townhouse building contains five units that are three stories tall with a pitched roof and dimensions 20ft x 30ft x 10ft floor-to-floor. Summary sheets for each run with full documentation of the wall designs and costs are available. Cumulative results for the four runs provided below. Each run includes a national average cost and four additional data point multipliers for unique communities. The value modifiers are based on cumulative average cost adjustments for labor and materials recommended by the Craftsman estimator, intended to provide a reasonable representation of costs in different areas.

It should be noted that builders often claim that reductions in the fire resistance of wall assemblies are not realistic because the 2-hour assemblies are needed for control of sound transmission. However, research on Sound Transmission Classes (STCs) of various wall designs indicates that this is not accurate. STC ratings are a measure of the effectiveness of partitions in reducing airborne sound transmission, with higher numbers having better performance in resisting sound transmission. For reference, there is no minimum in the IRC, but optional IRC Appendix K recommends a minimum of 45. The IBC requires a minimum STC of 50 by design or 45 by field test.

For the purpose of this analysis, two different types of 1-hour rated wall assemblies were evaluated and compared to a back-to-back set of 1-hour wall assemblies, sometimes used as a permissible alternate to a listed 2-hour assembly. STCs for these walls are reported as follows:

- Base level staggered stud 1-hour wall (one layer of insulation, which could be increased to 50-52 with modifications) – STC 45-48

- Base level double stud 1-hour wall (insulation in each stud channel) – STC 57

- Back-to-back 1-hour walls sometimes used as a 2-hr substitute (STC can be increased by adding additional insulating material in the space between the inner wall membranes at additional cost. Empty air space between these inner membranes actually reduces sound performance, which is why the base wall STC is not at high-performance level) – STC 45

Other wall designs with higher STC ratings can be modeled upon request if wall construction details are provided. To put the cost results into perspective of a monthly mortgage payment, a calculation was performed to evaluate the net cost of a $2,000 price increase (the highest of costs in the four model runs) to a homeowner after reductions associated with homeowners insurance (assumed at 5% based on NAHB's insurance analysis for major carriers and which is a common reduction offered by insurers in many states for NFPA 13D protection) and income tax deductions (assumed at 24% Federal marginal rate and excluding Virginia income tax). Based on a review of online interest rates, properties and sample insurance rates, a mortgage value of $400,000 was selected at an interest rate of 4.25% and an annual homeowner's insurance cost of $1,500 for a property estimated at $500,000 value. <u>Based on the highest-cost system from model runs and parameters described above, the net monthly payment for fire sprinklers is $1.23, or approximately $15/year. This is far less than even a minor fluctuation in interest rates that buyers may experience at any time.</u>

Note that permit and plan review fees and time vary from jurisdiction to jurisdiction. Some jurisdictions do not require any plan review for residential fire sprinklers, which is consistent with the "developed pipe length" methodology prescribed in IRC Section P2904. Alternately, some jurisdictions use a flow test of the installed system in lieu of design plans and plan review, which requires a single onsite inspection that can be performed by a regular building or plumbing inspector when performing other on-site inspections.

With respect to maintenance, there is no mandatory maintenance required for typical residential sprinkler systems supplied by a public or private water service, other than not interfering with the system by closing valves, painting sprinklers, etc. Homeowners may choose to perform voluntary verification test for water flow alarms (which are not required by NFPA 13D or IRC P2904).

Specific cost model documentation will be provided separately since cdpVA would not support inclusion of tables in the reason statement.

Resiliency Impact Statement: This proposal will increase Resiliency
See reason statement.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
See reason statement. It is difficult to quantify net cost or savings because these are going to vary based on individual projects and the extent to which developers/builders take advantage of savings incentives to offset costs associated with sprinkler installation.