RESEARCH

Methodology used in calculating national estimates from NFPA's fire experience survey

Sample Selection

The NFPA Fire Service Inventory file currently lists 29,537 public fire departments in the US. Based on the desired levels of statistical precision and available resources, the NFPA set a target of 2,700 fire department survey responses for the 2019 sample. We fell short of this number due partially to declining response rates, and likely due to the COVID-19 pandemic. Our data collection runs from January through May, coinciding with a very difficult and busy time for first responders.

Because of the variation in fire loss results by community size, fire departments were placed in one of the following 10 strata by the size of the community protected (Table 1).

Table 1. Fire Department Stratum by Size of Community Protected

Stratum	Population Size of Community Protected
1	1,000,000 and up
2	500,000 to 999,999
3	250,000 to 499,999
4	100,000 to 249,999
5	50,000 to 99,999
6	25,000 to 49,999
7	10,000 to 24,999
8	5,000 to 9,999
9	2,500 to 4,999
10	2.499 and under

Sample sizes for the individual strata were chosen to ensure the best estimate of civilian deaths in one-and two-family dwellings, the statistic that most aptly reflects the overall severity of the fire problem. All departments that protect 5,000 people or more were included. The 8,672 departments in the eight highest strata protect a population of 280 million, or 85%, of the US population as of July 2019.

The rest of the sample included 15,478 randomly selected departments from strata 9 and 10 (less than 5,000 population protected), for a total sample size of 24,150, or 83%, of all fire departments in the United States known to the NFPA.

Data Collection

Surveys were mailed in early January 2020. Although NFPA normally sends a second mailing to fire departments that had not responded to the first mailing in mid-March, this was omitted this year due to the added pressures first responders were facing due to the coronavirus. A total of 2,432 departments responded to the questionnaire. Table 2 shows the number of departments that responded by the region and the size of community.

Table 2. Number of Fire Departments That Responded to 2019 NFPA Survey, by Region and Community Size

Population of **Community**	All	**Northeast**	Midwest	South	West
1,000,000 or More	10	1	0	3	6
500,000 to 999,999	28	1	4	14	9
250,000 to 499,999	25	0	4	13	8
100,000 to 249,999	90	7	19	37	27
50,000 to 99,999	183	19	63	61	40
25,000 to 49,999	300	46	136	81	37
10,000 to 24,999	529	104	241	139	45
5,000 to 9,999	385	92	151	102	40
2,500 to 4,999	307	59	138	82	28
Fewer than 2,500	575	84	283	118	90
Total	2,432	413	1,039	650	330

Source: NFPA's Survey of Fire Departments for the 2019Fire Experience.

The overall response rate was 10 percent. Response rates were considerably higher for departments protecting larger communities than they were for departments protecting smaller communities. The overall response rate was 62% for departments protecting communities with the populations of 50,000 or more (more than the previous survey); 20% for departments protecting communities of 10,000 to 49,999 (less than as the previous survey); and 7% for departments protecting communities with populations of less than 10,000, which are comprised of mostly volunteers (same as the previous survey). Some fire departments were moved into different population strata when they reported changes in the size of the population they protect. The 2,432 departments that did respond protect 98 million people, or 30% of the total US population.

Technical staff members of the Data and Analytics group reviewed the submitted surveys for completeness and consistency. When appropriate, they followed up on questions with a telephone call.

After the edit procedures were completed, the survey data were keyed into a computer file, where additional checks were made. The file was then ready for data analysis and estimation procedures.

Estimation Methodology

The estimation method used for the survey was ratio estimation[1] with stratification by community size. For each fire statistic, a sample loss rate was computed for each stratum. This rate consisted of the total for that particular statistic from all the fire departments reporting it divided by the total population protected by the departments reporting the statistic. Note that this means that the departments used in calculating each statistic could be different, reflecting differences in unreported statistics. The sample fire loss rates by stratum were then multiplied by the population weighting factors to determine the estimates and then combined to provide the overall national estimate.

If this method of estimation is to be effective, estimates of the total number of fire departments and the total population protected in each stratum must be accurate. The NFPA makes every effort to ensure that this is the case. The population weights used for the national estimates were developed using the NFPA FSI (Fire Service Inventory) file and US Census population figures.

For each estimate, a corresponding standard error was also calculated. The standard error is a measure of the error caused by the fact that estimates are based on a sampling of fire losses rather than on a complete census of the fire problem. Due to the fact that the survey is based on a random sample of the smaller departments, we can be confident, based on the data we received, that the actual value falls within the percentage noted in parentheses for the overall national fire loss statistics: number of fires (2 percent), number of civilian deaths (10 percent), number of civilian injuries (11 percent), and property loss (5 percent). We have heard about, but not confirmed, one fire that may have caused $1 billion in property loss. That fire is not captured in our statistics.

Table 3. Estimates of 2019 Fires, Civilian Deaths, Civilian Injuries, and Property Loss in the United States

	Estimate	Range[1]	Percent Change from 2018
Number of Fires	1,291,500	1,264,500 to 1,318,500	-2%
Number of Civilian Deaths	3,704	3,330 to 4,080	1%
Number of Civilian Injuries	16,600	14,700 to 18,500	9%
Property Loss[2]	$13.7 Billion	$13.0 to $14.4 Billion	-46%

The standard error helps in determining whether year-to-year differences are statistically significant. Differences that were found to be statistically significant were noted in the tables. Property loss estimates are particularly prone to large standard errors because they are sensitive to unusually high losses, and, as a result, large percentage differences from year to year may not always be statistically significant. In general, response rates have fallen over the past few years, and this has increased the uncertainty inherent in the estimates. Table 4 shows statistically significant changes for 2018 to 2019. Significance was not calculated for some summed categories.

[1]William G. Cochran, *Sampling Techniques* (New York City: John Wiley, 1977), pp.150-161.

Table 4. Statistically Significant Changes in Estimates from 2018 to 2019

Attribute	2019 Value	Percent Change	Significance Level
Residential fires	361,500	-7%	.01
Apartment fires	75,000	-13%	.05
Fires in brush, grass, or wildland fires	244,500	-9%	.01
Highway vehicle property loss	$1,645,000,000	17%	.01
Other vehicle property loss	$584,000,000	23%	.05
Outside, non-structure, non-vehicle fire	$206,000,000	48%	.01
All other fire property loss	$98,000,000	-44%	.01
Other residential property loss	$209,000,000	-21%	.05
All other injuries	700	-30%	.01

In addition to sampling errors, there are non-sampling errors. These include biases of the survey methodology, incomplete or inaccurate reporting of data to the NFPA, and differences in data collection methods by responding fire departments. As an example of a non-sampling error, most of the fires included in the survey took place in highly populated residential areas because the fire departments selected for the surveys are primarily public fire departments that protect sizable residential populations. Fires that occur in sparsely populated areas protected primarily by State and Federal Departments of Forestry are not likely to be included in the survey results. There may be systemic differences in which fires are reported to local fire departments.

The NFPA Fire Incident Data Organization (FIDO) database was also used in conjunction with the annual survey to help identify any large-loss fires or deaths that the survey might have missed. Occasionally, documentation cannot be found to provide specific costs for very large fires. Without that documentation, these incidents are not included in the analysis.

The editors of the survey data attempted to verify all the reported civilian deaths in vehicle fires. They contacted most of the fire departments that reported fire-related deaths in vehicles and found that many of the deaths were indeed the result of fire. In some instances, however, impact was found to have been the cause of death. This can have a considerable impact on the estimates.

The results presented in this report are based on fire incidents attended by public fire departments. No adjustments were made for unreported fires and losses (e.g., fires extinguished by the occupant without a fire department response). Also, no adjustments were made for fires attended solely by private fire brigades (e.g., industry and military installations), or for fires extinguished by fixed suppression systems with no fire department response.

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