

The following information is taken from the One-Stop Data Shop's special information data package on fires at LP-Gas bulk storage plants. If you are interested in fire incidents involving LP-Gas bulk storage plants, please contact Nancy Schwartz at 617-984-7450 or e-mail osds@nfpa.org.

FIRES AT LP-GAS BULK STORAGE PLANTS

STATISTICAL ANALYSIS

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Fires at LP-Gas Bulk Storage Plants

This analysis examines trends and causal factors of fires at LP-Gas bulk storage plants, identified in Version 4.1 of the National Fire Incident Reporting System (NFIRS) by fixed property use code 843, and, in Version 5.0, by property use code 849 (tank storage) and on-site material 522 (LP-Gas, propane or butane). Because of the differences between the two versions, data must be analyzed separately. The statistics shown are national estimates of the fire problem at these properties based on projections made from the NFIRS data used together with NFPA's annual fire department survey. The methodology used is described in the Appendix.

Readers should be aware that these codes do not correspond exactly with the NFPA standards regulating these occupancies. NFPA 58, *Storage and Handling of Liquefied Petroleum Gases*, 2001 edition, defines a bulk plant as "A facility, the primary purpose of which is the distribution of LP-Gas, that receives LP-Gas by cargo tank vehicle, railroad tank car, or piping, distributing this gas by portable container (package) delivery, by cargo tank vehicle, or through gas piping." (Section 1.7.12.) "Bulk plants receive gas through a variety of methods, such as railroad tank car, transport, cargo tank vehicle, gas piping or watercraft. These plants are generally utilized for domestic, commercial, agricultural, institutional, and industrial applications, or for the storage of product waiting delivery to the end user. A facility that transfers LP-Gas from railroad tank cars from a private track directly into cargo tank vehicles is also in this category. Such plants may have container-filling and truck loading/unloading facilities on the premises. Normally, no persons other than the plant management or plant employees have access to these facilities." (Section A.1.7.12.)

Some properties that fall into LP-Gas bulk storage plant category under the NFIRS system are not covered by this standard. For example, a 1992 Texas fire in an LP-Gas bulk storage facility caused \$6,000,000 in damage. However, this facility was in a former underground salt dome. Salt domes are not covered under NFPA 58, which specifically states in Section 1.1.2:

"This code shall not apply to
(a) Frozen ground containers and underground storage in caverns
including associated piping and appurtenances used for the
storage of LP-Gas."

The number of fires reported at these properties is typically small. The estimation methods are much more reliable with larger number of fires. Consequently, one large fire can artificially inflate loss statistics for an entire year or even a multi-year period. Some fluctuation is normal. With small numbers, it is less likely that the normal fluctuation will even out over the course of a year, and so the normal fluctuation may appear more dramatic. Because the annual averages for 1994-1998 are based on five years of data, they should be considered more representative than the 1999 data.

Also, for some data elements in 1999, more than half of the incidents had unknown data. The allocation of unknown data adds to the uncertainty and potential unrepresentativeness of the small number of reported fires.

An estimated 49 of these fires were reported per year in 1994-1998 and 58 in 1999. During the five-year period from 1994 through 1998, an estimated 49 fires, on average, were reported per year. These fires caused an annual average of one civilian death, five civilian injuries and \$754,000 in direct property damage. In 1999, an estimated 58 reported fires caused four civilian injuries and \$722,000 in direct property damage. No civilian deaths from fires on these properties were reported to NFIRS in 1999. These 58 fires accounted for .003% of the fires reported in 1999.

The 49 fires per year during 1994-1998 included an annual average of nine (19%) structure fires, 14 (28%) vehicle fires, and 26 (53%) outside or other fires. (Outside and other fires include: outdoor rubbish fires; brush, tree, lawn or forest fires; outside fires involving property of value; outside spills or leaks with ensuing fires; explosions with no after-fire; and unclassified or unknown-type fires.) The nine structure fires caused an annual average of one civilian death, four civilian injuries and \$590,000 in direct property damage. The 14 vehicle fires caused an annual average of \$47,000 in direct property damage. Civilian injuries averaged less than one per year. The 26 outside and other fires caused an annual average of one civilian injury and \$117,000 in direct property damage.

The 58 fires reported in 1999 included an estimated 14 (25%) structure fires that caused four civilian injuries and \$644,000 in direct property damage. No vehicle fires on these properties were reported to NFIRS during that year. Forty-four (75%) outside and other fires caused \$78,000 in direct property damage. (See Table 1 for more details.)

Table 2 and Figure 1 show that the total number of LP-Gas bulk storage plant fires and explosions fell 44% from the 103 reported in 1980 to 58 in 1999. From 1998 to 1999, fires at these facilities increased 21%. However, the number of fires fluctuated widely, particularly for structure and vehicle fires. (See Tables 3 and 4.) Outside and other fires at these facilities have generally been less frequent in the late 1990s than they were in the 1980s. (See Table 5.)

Causal information is presented as annual averages for 1994-1998, and separately for 1999.

Information about causal factors of: 1) structure fires, and 2) outside and other fires, is presented first in five-year annual averages for fires reported from 1994 through 1998, then separately for 1999 fires. Because of the considerable overlap in causal information between these groups of fires, the tables are grouped by causal factor rather than incident type. Tables are provided for the following causal factors:

- Ignition Factor (Factor Contributing to Ignition and Identified Cause for 1999);
- Equipment Involved in Ignition;
- Area of Origin;
- Form of Heat of Ignition (Heat Source in 1999);
- Form of Material First Ignited (item First Ignited in 1999); and
- Type of Material First Ignited.

The final table shows mobile property type for vehicle fires at these properties.

Fuel spill or unintentional release was the leading cause of these structure fires.

Tables 6 show that fuel spills or unintentional releases caused 22% of the structure fires at these facilities in 1994-1998 and half of these structure fires in 1999. Seventeen percent in 1994-1998 and 50% in 1999 were caused by part failures, leaks or breaks.

Fifteen percent of the outside and other fires at LP-Gas bulk plant storage facilities in 1994-1998 were incendiary or suspicious. Thirteen percent were caused by part failures, leaks or breaks.

In 1999, 22% of the outside and other fires at these properties were caused by electrical failures or malfunctions. Fourteen percent of these fires were intentional. (See Table 7.)

“No equipment” was the leading equipment involved.

Tables 8 and 9 show that “no equipment” (a code choice in NFIRS) was involved in the ignition of 28% of the structure fires in 1994-1998, in any of the structure fires in 1999, and 67% of the outside and other fires at these facilities in 1994-1998, and 25% of the outside and other fires in 1999.

Product storage area, tank or bin was predictable leading area of origin for structure fires in 1994-1998.

Twenty-one percent of the structure fires in 1994-1998, 33% of the structure fires in 1999, 18% of the outside and other fires in 1994-1998 and 36% of the outside and other fires in 1999 started in product storage areas, tanks or bins. Thirty to thirty-six percent of the outside and other fires began on lawns, fields or open areas and 14% began in trash or rubbish areas or containers. (See Tables 10 and 11.)

“Sparks, embers or flames from operating equipment” was leading heat source in 1999.

Tables 12 and 13 show that gas-fueled equipment provided the heat of ignition in 18% of the structure fires and 14% of the outside and other fires during 1994-1998. The field changed in Version 5.0. In 1999, sparks, embers or flames from operating equipment provided the heat in all of the structure fires and 29% of the outside and other fires.

Gas or liquid from pipes or containers were most common forms of material first ignited.

The form of material first ignited was described as an accelerant or gas or liquid in or from a pipe or container in 42% of the structure fires and 29% of the outside and other fires in 1994-1998, and 50% of the outside and other fires in 1999. Of the small number of structure fires reported in 1999, all began with multiple items. A growing or living form was first ignited in 20% of the outside and other fires in 1994-1998, and light vegetation was first ignited in 25% of the outside and other fires in 1999. Tables 14 and 15 provide more details.

The leading type of material first ignited was gas.

Gas was the type of material first ignited in 55% of the structure fires and 52% of the outside and other fires at these facilities during 1994-1998. LP-Gas accounted for 45% of the structure fires in 1994-1998, 32% of the outside and other fires during that time period, and 67% of the structure fires in 1999. Some type of natural product was first ignited in 20% of the outside and other fires in 1994-1998. Tables 16 and 17 provide more information about the types of material first ignited.

In Version 5.0 of NFIRS, the type of material first ignited is required only for fires with item first ignited codes 00-69: structural components and finishes; furniture or utensils; soft goods or wearing apparel; adornment, recreational material or signs; storage supplies; and liquids, piping or filters. In Version 5.0, the type of material first ignited is not required for organic materials such as vegetation or cooking materials, and general materials, such as rubbish, fences, poles, electrical wire or cable insulation, books, magazines, adhesives, explosives, dust, lint or multiple items. Because most of the 1999 data was collected in older versions, these rules did not apply. Table 17B shows the 1999 type of material first ignited outside and other fires first for all items first ignited (including converted data collected under the old rules) and then under the Version 5.0 rules. LP-Gas accounted for 38-50% of the outside and other fires on these properties during 1999.

Roughly half of the vehicle fires in 1994-1998 on these properties involved automobiles.

Table 18 shows that 48% of the vehicle fires at these facilities in 1994-1998 were in automobiles, 13% were in general use trucks over one ton, 11% involved motor homes and 7% involved tank trucks for compressed or LP-Gas. As mentioned earlier, no vehicle fires on these properties were reported to NFIRS in 1999.

CONCLUSIONS

The number of reported fires at LP-Gas bulk storage facilities remains small and has fallen since 1980, but substantial variation exists from year to year. Additional information on safe practices with LP-Gas may be found in NFPA 58, *Liquefied Petroleum Gas Code*

Table 1A.
Fires at LP-Gas Bulk Plants, by Incident Type
1994-1998 Annual Averages

Incident Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Vehicle fire	14	(28.3%)	0	(0.0%)	0	(7.4%)	\$47,000	(6.2%)
Structure fire	9	(19.0%)	1	(100.0%)	4	(70.4%)	\$590,000	(78.2%)
Tree, brush or grass fire	6	(12.6%)	0	(0.0%)	0	(0.0%)	\$0	(0.0%)
Outside fire involving property of value	6	(12.1%)	0	(0.0%)	0	(0.0%)	\$6,000	(0.7%)
Outside rubbish fire	5	(9.7%)	0	(0.0%)	0	(0.0%)	\$0	(0.0%)
Outside spill or leak with ensuing fire	4	(8.5%)	0	(0.0%)	0	(3.7%)	\$40,000	(5.3%)
Unclassified fire	3	(6.5%)	0	(0.0%)	1	(11.1%)	\$66,000	(8.7%)
Unknown-type fire	1	(2.0%)	0	(0.0%)	0	(7.4%)	\$0	(0.1%)
Explosion with no after-fire	1	(1.2%)	0	(0.0%)	0	(0.0%)	\$5,000	(0.7%)
Total	49	(100.0%)	1	(100.0%)	5	(100.0%)	\$754,000	(100.0%)

Table 1B.
1999 Fires at LP-Gas Bulk Plants, by Incident Type

Incident Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Brush, tree or grass fire	17	(29.0%)	0	(NA)	0	(0.0%)	\$0	(0.0%)
Structure fire	14	(24.6%)	0	(NA)	4	(100.0%)	\$644,000	(89.2%)
Special outside fire or explosion with no after fire	10	(17.4%)	0	(NA)	0	(0.0%)	\$77,000	(10.7%)
Outside equipment fire	7	(11.6%)	0	(NA)	0	(0.0%)	\$0	(0.0%)
Cultivated vegetation or crop fire	7	(11.6%)	0	(NA)	0	(0.0%)	\$1,000	(0.1%)
Unclassified or unknown-type fire	3	(5.8%)	0	(NA)	0	(0.0%)	\$0	(0.0%)
Total	58	(100.0%)	0	(NA)	4	(100.0%)	\$722,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Property damage figures have not been adjusted for inflation. Because 1999 is based on only the small number of fires in these occupancies reported to NFIRS during the single year, the five-year averages should be considered more reliable. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 2.
Fires at LP-Gas Bulk Plants, by Year
(All Incident Types)
1980-1999

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
1980	103	0	14	\$1,994,000
1981	72	0	5	\$894,000
1982	116	0	21	\$437,000
1983	41	0	0	\$113,000
1984	81	0	11	\$331,000
1985	92	0	2	\$99,000
1986	63	0	3	\$13,000
1987	48	0	0	\$27,000
1988	94	0	4	\$1,977,000
1989	35	0	1	\$581,000
1990	49	0	0	\$4,000
1991	52	0	2	\$696,000
1992	51	0	2	\$12,054,000
1993	66	0	1	\$415,000
1994	44	0	5	\$347,000
1995	58	2	2	\$538,000
1996	59	0	6	\$803,000
1997	37	0	0	\$268,000
1998	48	2	14	\$1,814,000
1980-1998 Annual average	64	0	5	\$1,232,000
1994-1998 Annual average	49	1	5	\$754,000
1999*	58	0	4	\$722,000

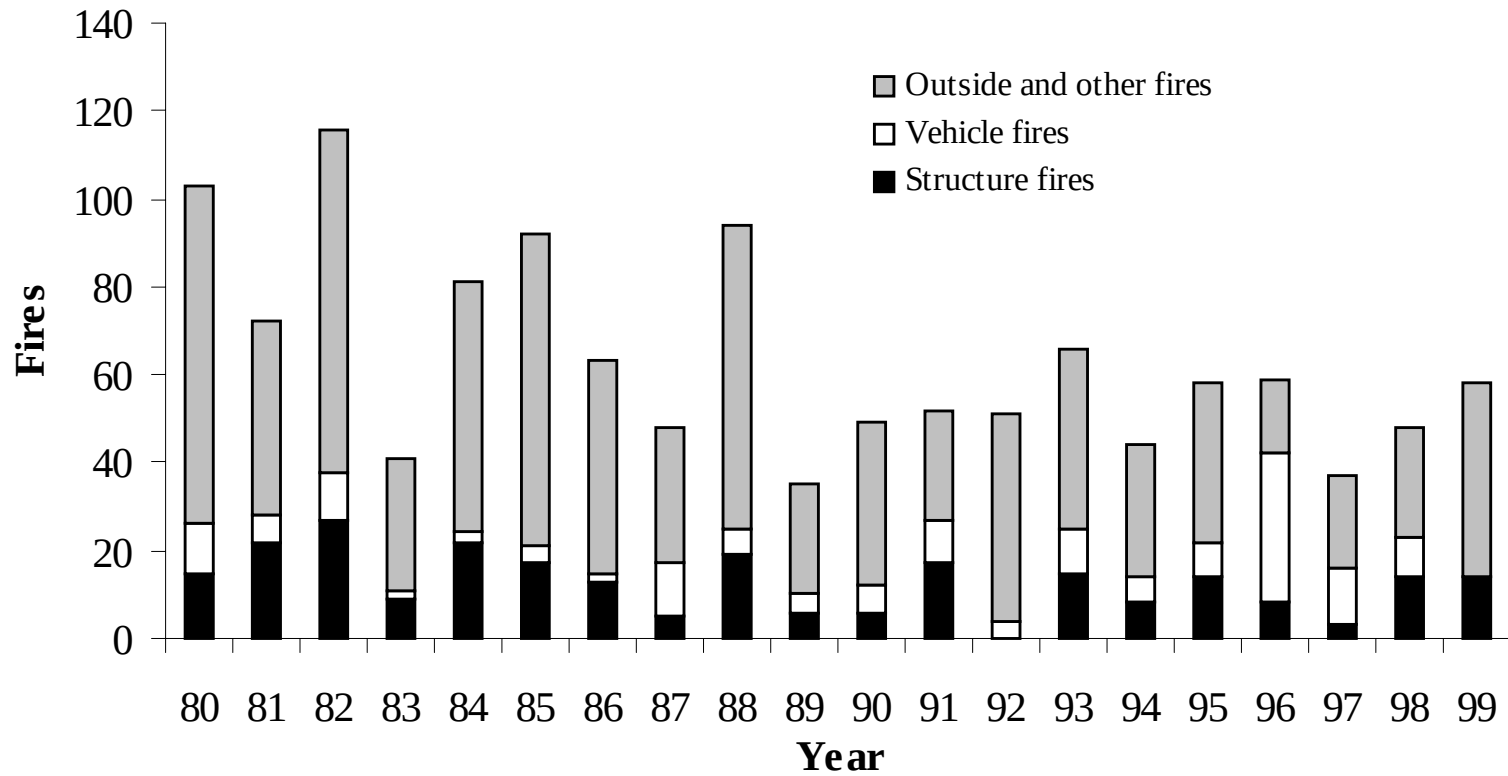
* The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Property damage figures have not been adjusted for inflation. The 1980-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Figure 1.

LP-Gas Bulk Plant Fires, by Incident Type and Year



Source: National estimates based on NFIRS and NFPA survey.

Table 3.
Structure Fires at LP-Gas Bulk Plants, by Year
1980-1999

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
1980	15	0	8	\$1,990,000
1981	22	0	0	\$380,000
1982	27	0	8	\$250,000
1983	9	0	0	\$50,000
1984	22	0	10	\$250,000
1985	17	0	2	\$60,000
1986	13	0	2	\$10,000
1987	5	0	0	\$0
1988	19	0	4	\$1,920,000
1989	6	0	0	\$0
1990	6	0	0	\$0
1991	17	0	1	\$670,000
1992	0	0	0	\$0
1993	15	0	0	\$300,000
1994	8	0	3	\$290,000
1995	14	2	0	\$480,000
1996	8	0	5	\$730,000
1997	3	0	0	\$190,000
1998	14	2	11	\$1,270,000
1980-1998 Annual average	13	0	3	\$470,000
1994-1998 Annual average	9	1	4	\$590,000
1999*	14	0	4	\$644,000

* The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Property damage figures have not been adjusted for inflation. The 1980-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 4.
Vehicle Fires at LP-Gas Bulk Plants, by Year
1980-1999

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
1980	11	0	4	\$2,000
1981	6	0	0	\$0
1982	11	0	9	\$145,000
1983	2	0	0	\$0
1984	2	0	0	\$0
1985	4	0	0	\$11,000
1986	2	0	0	\$0
1987	12	0	0	\$20,000
1988	6	0	0	\$22,000
1989	4	0	0	\$2,000
1990	6	0	0	\$1,000
1991	10	0	0	\$26,000
1992	4	0	0	\$8,000
1993	10	0	0	\$6,000
1994	6	0	0	\$26,000
1995	8	0	2	\$13,000
1996	34	0	0	\$76,000
1997	13	0	0	\$75,000
1998	9	0	0	\$44,000
1980-1998 Annual average	8	0	1	\$25,000
1994-1998 Annual average	14	0	0	\$47,000
1999*	0	0	0	\$0

* The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Property damage figures have not been adjusted for inflation. The 1980-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 5.
Outside and Other Fires at LP-Gas Bulk Plants, by Year
1980-1999

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
1980	77	0	2	\$6,000
1981	44	0	5	\$515,000
1982	78	0	4	\$46,000
1983	30	0	0	\$58,000
1984	57	0	1	\$79,000
1985	71	0	0	\$25,000
1986	48	0	1	\$2,000
1987	31	0	0	\$3,000
1988	69	0	0	\$36,000
1989	25	0	1	\$578,000
1990	37	0	0	\$1,000
1991	25	0	1	\$2,000
1992	47	0	2	\$12,046,000
1993	41	0	1	\$108,000
1994	30	0	2	\$32,000
1995	36	0	0	\$48,000
1996	17	0	1	\$1,000
1997	21	0	0	\$7,000
1998	25	0	3	\$499,000
1980-1998 Annual average	43	0	1	\$742,000
1994-1998 Annual average	26	0	1	\$117,000
1999*	44	0	0	\$78,000

* The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Property damage figures have not been adjusted for inflation. The 1980-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 6A.
Structure Fires at LP-Gas Bulk Plants, by Ignition Factor
1994-1998 Annual Averages

Ignition Factor	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Fuel spilled or unintentionally released	2 (21.7%)	1 (100.0%)	3 (80.0%)	\$182,000 (30.8%)
Part failure, leak or break	2 (16.8%)	0 (0.0%)	0 (0.0%)	\$33,000 (5.7%)
Other electrical failure	1 (11.9%)	0 (0.0%)	0 (0.0%)	\$64,000 (10.9%)
Incendiary or suspicious	1 (10.6%)	0 (0.0%)	0 (0.0%)	\$9,000 (1.5%)
Property too close	1 (10.6%)	0 (0.0%)	0 (0.0%)	\$237,000 (40.1%)
Cutting or welding too close	1 (6.1%)	0 (0.0%)	0 (0.0%)	\$3,000 (0.6%)
Lightning	1 (6.1%)	0 (0.0%)	0 (0.0%)	\$0 (0.0%)
Abandoned material	1 (5.6%)	0 (0.0%)	1 (20.0%)	\$61,000 (10.3%)
Unclassified operational deficiency	1 (5.4%)	0 (0.0%)	0 (0.0%)	\$0 (0.0%)
Unclassified mechanical failure or malfunction	0 (5.2%)	0 (0.0%)	0 (0.0%)	\$0 (0.0%)
Total	9 (100.0%)	1 (100.0%)	4 (100.0%)	\$590,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the ignition factors, factors contributing to ignition or identified causes were unknown or, for ignition factor, not reported have been allocated proportionally among fires of known ignition factor, factor contributing ignition or identified cause. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane). Because 1999 is based on only the small number of fires in these occupancies reported to NFIRS during the single year, the five-year averages should be considered more reliable.

Source: National estimates based on NFIRS and NFPA survey.

Table 6B.
1999 Structure Fires at LP-Gas Bulk Plants, by Factor Contributing to Ignition

Contributing Factor	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Flammable liquid or gas spilled	7	(50.0%)	0	(NA)	2	(50.0%)	\$446,000	(69.2%)
Leak or break	7	(50.0%)	0	(NA)	2	(50.0%)	\$198,000	(30.8%)
Total	14	(100.0%)	0	(NA)	4	(100.0%)	\$644,000	(100.0%)

Table 6C.
1999 Structure Fires at LP-Gas Bulk Plants, by Identified Cause

Identified Cause	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Unintentional	7	(50.0%)	0	(NA)	2	(50.0%)	\$446,000	(69.2%)
Failure of equipment or heat source	7	(50.0%)	0	(NA)	2	(50.0%)	\$198,000	(30.8%)
Total	14	(100.0%)	0	(NA)	4	(100.0%)	\$644,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the ignition factors, factors contributing to ignition or identified causes were unknown or, for ignition factor, not reported have been allocated proportionally among fires of known ignition factor, factor contributing ignition or identified cause. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane). Because 1999 is based on only the small number of fires in these occupancies reported to NFIRS during the single year, the five-year averages should be considered more reliable.

Source: National estimates based on NFIRS and NFPA survey.

Table 7A.
Outside and Other Fires at LP-Gas Bulk Plants, by Ignition Factor
1994-1998 Annual Averages

Ignition Factor	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Incendiary or suspicious	4 (15.0%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Part failure, leak or break	3 (12.7%)	0 (NA)	0 (33.2%)	\$2,000 (1.3%)
Inadequate control of open fire	3 (10.0%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Unclassified ignition factor	3 (9.7%)	0 (NA)	0 (33.4%)	\$6,000 (5.1%)
Fuel spilled or unintentionally released	2 (7.5%)	0 (NA)	0 (0.0%)	\$37,000 (31.7%)
Lightning	2 (7.5%)	0 (NA)	0 (0.0%)	\$5,000 (4.0%)
Spontaneous heating	1 (5.1%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Cutting or welding too close	1 (4.6%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Other electrical failure	1 (4.6%)	0 (NA)	0 (33.4%)	\$0 (0.3%)
Unclassified mechanical failure or malfunction	1 (2.8%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Rekindled from a previous fire	1 (2.8%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Improper fueling technique	1 (2.7%)	0 (NA)	0 (0.0%)	\$62,000 (52.4%)
Property too close	1 (2.7%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Unclassified operational deficiency	1 (2.7%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Unclassified misuse heat of ignition	1 (2.4%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Improper storage	1 (2.4%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Abandoned material	1 (2.3%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Improper start-up or shutdown procedure	1 (2.3%)	0 (NA)	0 (0.0%)	\$6,000 (5.1%)
Total	26 (100.0%)	0 (NA)	1 (100.0%)	\$117,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the ignition factors, factors contributing to ignition, or identified causes, were unknown or, for ignition factor, not reported have been allocated proportionally among fires of known ignition factor. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 7B.
1999 Outside and Other Fires at LP-Gas Bulk Plants,
by Factor Contributing to Ignition

Contributing Factor	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Electrical failure or malfunction	10 (22.2%)	0 (NA)	0 (NA)	\$0 (0.0%)
Unintentionally turned on or not turned off	5 (11.1%)	0 (NA)	0 (NA)	\$78,000 (100.0%)
Unclassified misuse of material or product	5 (11.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Heat source too close to combustibles.	5 (11.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Cutting or welding too close to combustibles	5 (11.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Improper container or storage	5 (11.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Natural condition	5 (11.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Not reported	5 (11.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Total	44 (100.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)

Table 7C.
1999 Outside and Other Fires at LP-Gas Bulk Plants, by Identified Cause

Identified Cause	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Unintentional	31 (71.4%)	0 (NA)	0 (NA)	\$78,000 (100.0%)
Intentional	6 (14.3%)	0 (NA)	0 (NA)	\$0 (0.0%)
Act of nature	6 (14.3%)	0 (NA)	0 (NA)	\$0 (0.0%)
Total	44 (100.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the ignition factors, factors contributing to ignition, or identified causes, were unknown or, for ignition factor, not reported have been allocated proportionally among fires of known ignition factor. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 8A.
Structure Fires at LP-Gas Bulk Plants, by Equipment Involved in Ignition
1994-1998 Annual Averages

Ignition Factor	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
No equipment involved	3 (28.3%)	0 (0.0%)	3 (76.7%)	\$438,000 (74.3%)
Fixed wiring	1 (12.5%)	1 (100.0%)	0 (0.0%)	\$96,000 (16.3%)
Fixed area heater	1 (11.6%)	0 (0.0%)	0 (0.0%)	\$21,000 (3.5%)
Light fixture, lamp holder, ballast or sign	1 (11.0%)	0 (0.0%)	0 (0.0%)	\$21,000 (3.5%)
Chimney connector or vent connector	1 (6.4%)	0 (0.0%)	0 (0.0%)	\$0 (0.0%)
Unclassified special equipment	1 (6.4%)	0 (0.0%)	0 (0.0%)	\$9,000 (1.6%)
Torch	1 (6.4%)	0 (0.0%)	0 (0.0%)	\$5,000 (0.8%)
Vehicle	1 (6.4%)	0 (0.0%)	1 (23.3%)	\$0 (0.0%)
Painting equipment	1 (5.7%)	0 (0.0%)	0 (0.0%)	\$0 (0.0%)
Unclassified equipment involved	1 (5.5%)	0 (0.0%)	0 (0.0%)	\$0 (0.1%)
Total	9 (100.0%)	1 (100.0%)	4 (100.0%)	\$590,000 (100.0%)

Table 8B.
1999 Structure Fires at LP-Gas Bulk Plants, by Equipment Involved in Ignition

After the unknown data were allocated, no equipment was involved in the estimated 14 structure fires at these facilities during 1999. These 14 fires caused four civilian injuries and \$644,000 in direct property damage.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which equipment involved in ignition was unknown or not reported have been allocated proportionally among fires of known equipment involved in ignition. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 9A.
Outside and Other Fires at LP-Gas Bulk Plants, by Equipment Involved in Ignition
1994-1998 Annual Averages

Equipment Involved	Fires		Civilian Deaths	Civilian Injuries		Direct Property Damage	
No equipment involved	17	(66.5%)	0 (NA)	1	(66.6%)	\$99,000	(84.3%)
Unclassified or unknown-type other equipment involved	3	(13.2%)	0 (NA)	0	(0.0%)	\$5,000	(4.0%)
Torch	1	(4.9%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Heat treating equipment	1	(3.0%)	0 (NA)	0	(0.0%)	\$1,000	(1.2%)
Vehicle	1	(2.6%)	0 (NA)	0	(0.0%)	\$6,000	(5.0%)
Unknown type electrical distribution equipment	1	(2.5%)	0 (NA)	0	(33.4%)	\$0	(0.3%)
Transformer or associated overcurrent or disconnect equipment	1	(2.5%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Unknown-type special equipment	1	(2.5%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Separate pump or compressor	1	(2.5%)	0 (NA)	0	(0.0%)	\$6,000	(5.1%)
Total	26	(100.0%)	0 (NA)	1	(100.0%)	\$117,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the equipment involved in ignition was unknown or not reported have been allocated proportionally among fires of known equipment involved. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 9B.
1999 Outside and Other Fires at LP-Gas Bulk Plants,
by Equipment Involved in Ignition

Equipment Involved	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Unclassified equipment	11	(25.0%)	0	(NA)	0	(NA)	\$78,000	(100.0%)
No equipment involved	11	(25.0%)	0	(NA)	0	(NA)	\$0	(0.0%)
Electrical wiring	5	(12.5%)	0	(NA)	0	(NA)	\$0	(0.0%)
Panel board, switchboard or circuit breaker board	5	(12.5%)	0	(NA)	0	(NA)	\$0	(0.0%)
Cutting torch	5	(12.5%)	0	(NA)	0	(NA)	\$0	(0.0%)
Stove or range	5	(12.5%)	0	(NA)	0	(NA)	\$0	(0.0%)
Total	44	(100.0%)	0	(NA)	0	(NA)	\$78,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the equipment involved in ignition was unknown or not reported have been allocated proportionally among fires of known equipment involved. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 10A.
Structure Fires at LP-Gas Bulk Plants, by Area of Origin
1994-1998 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Product storage area, tank or bin	2	(21.4%)	0	(0.0%)	1	(37.3%)	\$144,000	(24.5%)
Supply storage room or area	1	(15.3%)	0	(0.0%)	0	(8.8%)	\$70,000	(11.8%)
Maintenance shop or area	1	(10.8%)	0	(47.1%)	2	(53.9%)	\$189,000	(32.1%)
Office	1	(9.8%)	0	(52.9%)	0	(0.0%)	\$4,000	(0.6%)
Wall assembly or concealed space	1	(6.1%)	0	(0.0%)	0	(0.0%)	\$61,000	(10.4%)
Process or manufacturing area	1	(5.7%)	0	(0.0%)	0	(0.0%)	\$6,000	(1.1%)
Chimney	1	(5.7%)	0	(0.0%)	0	(0.0%)	\$3,000	(0.5%)
Other known area	2	(25.1%)	0	(0.0%)	0	(0.0%)	\$112,000	(19.0%)
Total	9	(100.0%)	1	(100.0%)	4	(100.0%)	\$590,000	(100.0%)

Table 10B.
1999 Structure Fires at LP-Gas Bulk Plants, by Area of Origin

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Storage room, area, tank or bin	5	(33.3%)	0	(NA)	0	(0.0%)	\$536,000	(83.3%)
Storage of supplies or tools or dead storage	5	(33.3%)	0	(NA)	2	(50.0%)	\$74,000	(11.5%)
Bedroom or sleeping area	5	(33.3%)	0	(NA)	2	(50.0%)	\$33,000	(5.1%)
Total	14	(100.0%)	0	(NA)	4	(100.0%)	\$644,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the areas of origin were unknown or not reported have been allocated proportionally among fires of known areas of fire origin. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 11A.
Outside and Other Fires at LP-Gas Bulk Plants, by Area of Origin
1994-1998 Annual Averages

Area of Origin	Fires		Civilian Deaths	Civilian Injuries		Direct Property Damage	
Lawn, field or open area	8	(30.3%)	0 (NA)	0	(0.0%)	\$0	(0.1%)
Product storage area, tank or bin	5	(18.1%)	0 (NA)	0	(0.0%)	\$8,000	(6.9%)
Trash or rubbish area or container	4	(13.7%)	0 (NA)	0	(0.0%)	\$0	(0.1%)
Area of origin not applicable	1	(5.7%)	0 (NA)	0	(0.0%)	\$80,000	(68.1%)
Maintenance shop or area	1	(5.6%)	0 (NA)	1	(46.1%)	\$20,000	(17.4%)
Unclassified area of origin	1	(5.1%)	0 (NA)	0	(0.0%)	\$0	(0.4%)
Unclassified service or equipment area	1	(3.1%)	0 (NA)	0	(0.0%)	\$2,000	(1.5%)
Multiple areas of origin	1	(2.9%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Shipping, receiving or loading area	1	(2.7%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Engine, running gear or wheel area of vehicle	1	(2.7%)	0 (NA)	0	(0.0%)	\$6,000	(5.0%)
Unclassified function area	1	(2.5%)	0 (NA)	0	(18.0%)	\$0	(0.1%)
Supply storage room or area	1	(2.5%)	0 (NA)	0	(18.0%)	\$1,000	(0.4%)
Switchgear area or transformer vault	1	(2.5%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Trunk or load area of vehicle	1	(2.5%)	0 (NA)	0	(17.9%)	\$0	(0.0%)
Total	26	(100.0%)	0 (NA)	1	(100.0%)	\$117,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the areas of origin were unknown or not reported have been allocated proportionally among fires of known area of origin. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 11B.
1999 Outside and Other Fires at LP-Gas Bulk Plants, by Area of Origin

Area of Origin	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Storage room, area, tank or bin	16 (36.4%)	0 (NA)	0 (NA)	\$78,000 (100.0%)
Outside open area	16 (36.4%)	0 (NA)	0 (NA)	\$0 (0.0%)
Unclassified storage area	4 (9.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Unclassified service facility area	4 (9.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Exterior wall surface	4 (9.1%)	0 (NA)	0 (NA)	\$0 (0.0%)
Total	44 (100.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the areas of origin were unknown or not reported have been allocated proportionally among fires of known area of origin. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 12A.
Structure Fires at LP-Gas Bulk Plants, by Form of Heat of Ignition
1994-1998 Annual Averages

Form of Heat of Ignition	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Heat from gas-fueled equipment	2 (18.1%)	0 (*.*)	1 (23.3%)	\$16,000 (2.7%)
Unclassified or unknown-type electrical equipment arc or overload	1 (13.2%)	0 (*.*)	0 (0.0%)	\$76,000 (13.0%)
Cutting torch	1 (6.4%)	0 (*.*)	0 (0.0%)	\$4,000 (0.6%)
Lightning	1 (6.4%)	0 (*.*)	0 (0.0%)	\$0 (0.0%)
Cigarette	1 (5.8%)	0 (*.*)	1 (19.1%)	\$66,000 (11.1%)
Arc or spark from operating equipment or switch	1 (5.7%)	0 (*.*)	0 (0.0%)	\$0 (0.0%)
Match	1 (5.7%)	0 (*.*)	0 (0.0%)	\$10,000 (1.7%)
Static discharge	1 (5.7%)	0 (*.*)	2 (57.5%)	\$163,000 (27.6%)
Heat from direct flame or convection current	1 (5.7%)	0 (*.*)	0 (0.0%)	\$98,000 (16.6%)
Heat from liquid-fueled equipment	1 (5.5%)	0 (*.*)	0 (0.0%)	\$158,000 (26.7%)
Fluorescent light ballast	1 (5.5%)	0 (*.*)	0 (0.0%)	\$0 (0.0%)
Heat from unknown-type open flame or spark	1 (5.5%)	0 (*.*)	0 (0.0%)	\$0 (0.0%)
Rekindle or reignition	1 (5.5%)	0 (*.*)	0 (0.0%)	\$0 (0.0%)
Unclassified form of heat	1 (5.5%)	0 (*.*)	0 (0.0%)	\$0 (0.0%)
Total	9 (100.0%)	1 (100.0%)	4 (100.0%)	\$590,000 (100.0%)

* The form of heat of ignition was unknown or not reported in all of the fire deaths reported in these fires.

Table 12B.
1999 Structure Fires at LP-Gas Bulk Plants, by Heat Source

After the unknown data were allocated, sparks, embers or flames from operating equipment provided the heat in the estimated 14 structure fires at these facilities during 1999. These 14 fires caused four civilian injuries and \$644,000 in direct property damage.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the forms of heat of ignition or heat sources were unknown or, for 1994-1998, not reported, have been allocated proportionally among fires of known form of heat of ignition or heat sources. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 13A.
Outside and Other Fires at LP-Gas Bulk Plants, by Form of Heat of Ignition
1994-1998 Annual Averages

Form of Heat of Ignition	Fires		Civilian Deaths	Civilian Injuries		Direct Property Damage	
Gas-fueled equipment	4	(14.2%)	0 (NA)	0	(0.0%)	\$92,000	(78.7%)
Open fire	3	(10.0%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Lightning	3	(10.0%)	0 (NA)	0	(0.0%)	\$7,000	(5.8%)
Liquid-fueled equipment	2	(7.0%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Spontaneous ignition or chemical reaction	2	(6.9%)	0 (NA)	0	(0.0%)	\$0	(0.1%)
Match	2	(6.5%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Unspecified short circuit arc	2	(6.4%)	0 (NA)	0	(0.0%)	\$9,000	(7.3%)
Heat from unclassified or unknown-type open flame or spark	2	(6.4%)	0 (NA)	0	(0.0%)	\$0	(0.1%)
Static discharge	2	(6.2%)	0 (NA)	1	(66.6%)	\$0	(0.1%)
Rekindle or reignition	1	(3.8%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Incendiary device	1	(3.8%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Heat or spark from friction	1	(3.3%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Short circuit arc from mechanical damage	1	(3.1%)	0 (NA)	0	(0.0%)	\$9,000	(7.5%)
Arc or spark from operating equipment or switch	1	(3.1%)	0 (NA)	0	(33.4%)	\$1,000	(0.5%)
Cigarette	1	(3.1%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Cutting torch	1	(3.1%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Torch, not cutting or welding	1	(3.1%)	0 (NA)	0	(0.0%)	\$0	(0.0%)
Total	26	(100.0%)	0 (NA)	1	(100.0%)	\$117,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the forms of heat of ignition or heat source were unknown, or, for 1994-1998, not reported, have been allocated proportionally among fires of known form of heat of ignition. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 13B.
1999 Outside and Other Fires at LP-Gas Bulk Plants, by Heat Source

Form of Heat of Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage	
Spark, ember or flame from operating equipment	13	(28.6%)	0	(NA)	0	(NA)	\$0	(0.0%)
Heat or spark from friction	6	(14.3%)	0	(NA)	0	(NA)	\$78,000	(100.0%)
Radiated or conducted heat from operating equipment	6	(14.3%)	0	(NA)	0	(NA)	\$0	(0.0%)
Unclassified heat from powered equipment	6	(14.3%)	0	(NA)	0	(NA)	\$0	(0.0%)
Pipe or cigar	6	(14.3%)	0	(NA)	0	(NA)	\$0	(0.0%)
Heat spread from another fire	6	(14.3%)	0	(NA)	0	(NA)	\$0	(0.0%)
Total	44	(100.0%)	0	(NA)	0	(NA)	\$78,000	(100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the forms of heat of ignition or heat source were unknown, or, for 1994-1998, not reported, have been allocated proportionally among fires of known form of heat of ignition. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 14A.
Structure Fires at LP-Gas Bulk Plants, by Form of Material First Ignited
1994-1998 Annual Averages

Form of Material Ignited	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Accelerant or gas or liquid in or from pipe or container	4 (41.7%)	0 (47.1%)	4 (91.9%)	\$380,000 (64.4%)
Multiple forms of material	1 (13.6%)	0 (0.0%)	0 (0.0%)	\$139,000 (23.6%)
Structural member or framing	1 (13.2%)	0 (0.0%)	0 (8.1%)	\$21,000 (3.6%)
Unclassified	1 (8.5%)	0 (0.0%)	0 (0.0%)	\$9,000 (1.5%)
Electrical wire or cable insulation	1 (5.3%)	0 (0.0%)	0 (0.0%)	\$37,000 (6.3%)
Other known form	2 (17.7%)	0 (52.9%)	0 (0.0%)	\$4,000 (0.6%)
Total	9 (100.0%)	1 (100.0%)	4 (100.0%)	\$590,000 (100.0%)

Table 14B.
1999 Structure Fires at LP-Gas Bulk Plants, by Item First Ignited

After the unknown data were allocated, multiple items were first ignited in the estimated 14 structure fires at these facilities during 1999. These 14 fires caused four civilian injuries and \$644,000 in direct property damage.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the forms of material first ignited or items first ignited were unknown or not reported have been allocated proportionally among fires of known form of material first ignited. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 15A.
Outside and Other Fires at LP-Gas Bulk Plants, by Form of Material First Ignited
1994-1998 Annual Averages

Form of Material	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Accelerant or gas or liquid in or from pipe or container	7 (28.6%)	0 (NA)	1 (64.0%)	\$93,000 (79.4%)
Growing or living form	5 (19.8%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Fuel	4 (15.6%)	0 (NA)	0 (18.0%)	\$10,000 (8.3%)
Rubbish, trash or waste	3 (10.2%)	0 (NA)	0 (0.0%)	\$0 (0.1%)
Unclassified	1 (5.4%)	0 (NA)	0 (0.0%)	\$0 (0.1%)
Not applicable	1 (5.0%)	0 (NA)	0 (0.0%)	\$8,000 (6.5%)
Pyrotechnics or explosives	1 (2.9%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Tire	1 (2.8%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Agricultural product	1 (2.5%)	0 (NA)	0 (0.0%)	\$6,000 (5.0%)
Exterior sidewall covering or finish	1 (2.4%)	0 (NA)	0 (0.0%)	\$0 (0.2%)
Box, carton or bag	1 (2.4%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Atomized or vaporized liquid	1 (2.4%)	0 (NA)	0 (18.0%)	\$1,000 (0.4%)
Total	26 (100.0%)	0 (NA)	1 (100.0%)	\$117,000 (100.0%)

Table 15B.
1999 Outside and Other Fires at LP-Gas Bulk Plants, by Item First Ignited

Form of Material	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Accelerant or gas or liquid in or from pipe or container	22 (50.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)
Light vegetation	11 (25.0%)	0 (NA)	0 (NA)	\$0 (0.0%)
Unclassified liquid, piping or filter	5 (12.5%)	0 (NA)	0 (NA)	\$0 (0.0%)
Animal, living or dead	5 (12.5%)	0 (NA)	0 (NA)	\$0 (0.0%)
Total	44 (100.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the forms of material first ignited or items first ignited were unknown or not reported have been allocated proportionally among fires of known form of material first ignited. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane). Source: National estimates based on NFIRS and NFPA survey.

Table 16A.
Structure Fires at LP-Gas Bulk Plants, by Type of Material First Ignited
1994-1998 Annual Averages

Type of Material Ignited	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Gas	5 (54.5%)	1 (100.0%)	4 (100.0%)	\$396,000 (67.1%)
LP-Gas	4 (45.4%)	0 (52.9%)	2 (50.5%)	\$281,000 (47.7%)
Volatile solid or chemical	1 (13.6%)	0 (0.0%)	0 (0.0%)	\$2,000 (0.3%)
Adhesive, resin or tar	1 (9.2%)	0 (0.0%)	0 (0.0%)	\$2,000 (0.3%)
Wood or paper	1 (13.0%)	0 (0.0%)	0 (0.0%)	\$16,000 (2.6%)
Unknown-type wood or paper	1 (8.5%)	0 (0.0%)	0 (0.0%)	\$8,000 (1.4%)
Natural product	1 (5.3%)	0 (0.0%)	0 (0.0%)	\$37,000 (6.3%)
Rubber	1 (5.3%)	0 (0.0%)	0 (0.0%)	\$37,000 (6.3%)
Other type of material	1 (13.6%)	0 (0.0%)	0 (0.0%)	\$139,000 (23.6%)
Multiple types of material	1 (13.6%)	0 (0.0%)	0 (0.0%)	\$139,000 (23.6%)
Total	9 (100.0%)	1 (100.0%)	4 (100.0%)	\$590,000 (100.0%)

Table 16B.
1999 Structure Fires at LP-Gas Bulk Plants, by Type of Material First Ignited

According to the rules of Version 5.0 of NFIRS, the type of material first ignited is required only when the item first ignited is in the code range off 00-69. If these rules are used, no data is available for this field. Because much of the data was collected in older versions and converted, these rules didn't apply at the time of data collection.

Type of Material Ignited	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
LP-Gas	10 (66.7%)	0 (NA)	4 (100.0%)	\$558,000 (86.7%)
Multiple types of material	5 (33.3%)	0 (NA)	0 (0.0%)	\$86,000 (13.3%)
Total	14 (100.0%)	0 (NA)	4 (100.0%)	\$644,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the types of material first ignited were unknown or not reported have been allocated proportionally among fires of known type of material first ignited. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane). Source: National estimates based on NFIRS and NFPA survey.

Table 17A.
Outside and Other Fires at LP-Gas Bulk Plants, by Type of Material First Ignited
1994-1998 Annual Averages

Type of Material Ignited	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Gas	13 (51.8%)	0 (NA)	1 (82.0%)	\$116,000 (99.2%)
LP-Gas	8 (31.6%)	0 (NA)	1 (64.0%)	\$109,000 (92.5%)
LP-city gas	3 (12.5%)	0 (NA)	0 (18.0%)	\$8,000 (6.6%)
Manufactured gas	1 (4.9%)	0 (NA)	0 (0.0%)	\$0 (0.1%)
Unclassified gas	1 (2.8%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Natural product	5 (20.1%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Grass, leaves, hay or straw	4 (17.3%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Rubber	1 (2.8%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Wood or paper	3 (10.2%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Sawn wood	1 (5.3%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Growing wood	1 (2.5%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Unknown-type wood or paper	1 (2.4%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Flammable or combustible liquid	1 (5.3%)	0 (NA)	0 (18.0%)	\$1,000 (0.5%)
Class IA flammable liquid	1 (2.4%)	0 (NA)	0 (18.0%)	\$1,000 (0.4%)
Unclassified flammable or combustible liquid	1 (2.9%)	0 (NA)	0 (0.0%)	\$0 (0.1%)
Volatile solid or chemical	1 (5.3%)	0 (NA)	0 (0.0%)	\$0 (0.2%)
Adhesive, resin or tar	1 (2.4%)	0 (NA)	0 (0.0%)	\$0 (0.2%)
Unclassified volatile solid or chemical	1 (2.9%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Other type of material	2 (7.3%)	0 (NA)	0 (0.0%)	\$0 (0.1%)
Multiple types of material	1 (4.8%)	0 (NA)	0 (0.0%)	\$0 (0.1%)
Not applicable	1 (2.5%)	0 (NA)	0 (0.0%)	\$0 (0.0%)
Total	26 (100.0%)	0 (NA)	1 (100.0%)	\$117,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the type of material first ignited was unknown or not reported have been allocated proportionally among fires of known type of material first ignited. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 17B.
1999 Outside and Other Fires at LP-Gas Bulk Plants,
by Type of Material First Ignited

According to the rules of Version 5.0 of NFIRS, the type of material first ignited is required only when the item first ignited is in the code range of 00-69. Because much of the data was collected in older versions and converted, these rules didn't apply at the time of data collection. The table below includes all the data found in the field and disregard the rule. The second table is based on only incidents for which the type of material first ignited is required.

Type of Material Ignited	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
LP-Gas	16 (37.5%)	0 (NA)	0 (NA)	\$77,000 (99.2%)
Grass, leaves, hay or straw	16 (37.5%)	0 (NA)	0 (NA)	\$0 (0.0%)
Gasoline	5 (12.5%)	0 (NA)	0 (NA)	\$1,000 (0.8%)
Cooking oil, transformer or lubricating oil	5 (12.5%)	0 (NA)	0 (NA)	\$0 (0.0%)
Total	44 (100.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)

Based on the Version 5.0 Rules
that Require Information Only When Item First Ignited = 00-69

Type of Material Ignited	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
LP-Gas	8 (50.0%)	0 (NA)	0 (NA)	\$77,000 (99.2%)
Gasoline	4 (25.0%)	0 (NA)	0 (NA)	\$1,000 (0.8%)
Cooking oil, transformer or lubricating oil	4 (25.0%)	0 (NA)	0 (NA)	\$0 (0.0%)
Total	17 (100.0%)	0 (NA)	0 (NA)	\$78,000 (100.0%)

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the type of material first ignited was unknown or not reported have been allocated proportionally among fires of known type of material first ignited. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Table 18A.
Vehicle Fires at LP-Gas Bulk Plants, by Mobile Property Type
1994-1998 Annual Averages

Mobile Property Type	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Automobile	7 (48.3%)	0 (NA)	0 (0.0%)	\$27,000 (58.0%)
General use truck over 1 ton	2 (13.0%)	0 (NA)	0 (0.0%)	\$11,000 (24.3%)
Motor home	2 (10.9%)	0 (NA)	0 (0.0%)	\$0 (0.2%)
Tank truck for compressed or LP-Gas	1 (6.8%)	0 (NA)	0 (0.0%)	\$1,000 (2.0%)
Unclassified special vehicle	1 (6.1%)	0 (NA)	0 (0.0%)	\$2,000 (3.5%)
Tank truck for flammable or combustible liquid or chemical	1 (6.0%)	0 (NA)	0 (0.0%)	\$0 (0.4%)
General use truck under 1 ton	1 (5.8%)	0 (NA)	0 (0.0%)	\$5,000 (10.8%)
Unclassified mobile property type	0 (3.2%)	0 (NA)	0 (100.0%)	\$0 (0.8%)
Total	14 (100.0%)	0 (NA)	0 (100.0%)	\$47,000 (100.0%)

Table 18B.
1999 Vehicle Fires at LP-Gas Bulk Plants, by Mobile Property Type

Based on national estimates derived from NFIRS and the NFPA survey, no vehicle fires were reported on these properties during 1999.

Note: These are fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Fires, civilian deaths and civilian injuries are rounded to the nearest one and property damage is rounded to the nearest thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures have not been adjusted for inflation. Percentages are calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the mobile property type was unknown or not reported have been allocated proportionally among fires of known mobile property type. The 1999 data was in Version 5.0 of NFIRS and must be analyzed separately. The 1994-1998 fires were identified by fixed property use 853, which specifically identifies these properties. The 1999 fires were identified by property use 849 (storage tank) and on-site material 522 (LP-Gas, butane and propane).

Source: National estimates based on NFIRS and NFPA survey.

Appendix A: How National Estimates Statistics Are Calculated

Estimates are made using the National Fire Incident Reporting System (NFIRS) of the Federal Emergency Management Agency's (FEMA's) United States Fire Administration (USFA), supplemented by the annual stratified random-sample survey of fire experience conducted by the National Fire Protection Association (NFPA), which is used for calibration.

Data Bases Used

NFIRS provides annual computerized data bases of fire incidents, with data classified according to a standard format based on the NFPA 901 Standard. Roughly three-fourths of all states have NFIRS coordinators, who receive fire incident data from participating fire departments and combine the data into a state data base. These data are then transmitted to FEMA/USFA. Participation by the states, and by local fire departments within participating states, is voluntary. NFIRS captures roughly one-third to one-half of all U.S. fires each year. More than one-third of all U.S. fire departments are listed as participants in NFIRS, although not all of these departments provide data every year.

The strength of NFIRS is that it provides the most detailed incident information of any national data base not limited to large fires. NFIRS is the only data base capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. (The NFPA survey separates fewer than 20 of the hundreds of property use categories defined by NFPA 901 and solicits no cause-related information except for incendiary and suspicious fires.) NFIRS also captures information on the avenues and extent of flame spread and smoke spread and on the performance of detectors and sprinklers.

The NFPA survey is based on a stratified random sample of roughly 3,000 U.S. fire departments (or just over one of every ten fire departments in the country). The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined by the NFPA 901 Standard; (2) the number of on-duty fire fighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results.

The NFPA survey begins with the NFPA Fire Service Inventory, a computerized file of about 30,000 U.S. fire departments, which is the most complete and thoroughly validated such listing in existence. The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities protect fewer people per department and are less likely to respond to the survey, so a large number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not

respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

Projecting NFIRS to National Estimates

To project NFIRS results to national estimates, one needs at least an estimate of the NFIRS fires as a fraction of the total so that the fraction can be inverted and used as a multiplier or scaling ratio to generate national estimates from NFIRS data. But NFIRS is a sample from a universe whose size cannot be inferred from NFIRS alone. Also, participation rates in NFIRS are not necessarily uniform across regions and sizes of community, both of which are factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second data base - the NFPA survey - is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

There are separate projection formulas for four major property classes (residential structures, non-residential structures, vehicles, and other) and for each measure of fire severity (fire incidents, civilian deaths, and civilian injuries, and direct property damage).

For example, the scaling ratio for 1998 civilian deaths in residential structures is equal to the total number of 1998 civilian deaths in residential structure fires reported to fire departments, according to the NFPA survey (3,250), divided by the total number of 1998 civilian deaths in residential structure fires reported to NFIRS (1,224). Therefore, the scaling ratio is $3,250/1,224 = 2.66$.

The scaling ratios for civilian deaths and injuries and direct property damage are often significantly different from those for fire incidents. Except for fire service injuries, average severity per fire is generally higher for NFIRS than for the NFPA survey. Use of different scaling ratios for each measure of severity is equivalent to assuming that these differences are due either to NFIRS under-reporting of small fires, resulting in a higher-than-actual loss-per-fire ratio, or possible biases in the NFIRS sample representation by region or size of community, resulting in severity-per-fire ratios characteristic only of the oversampled regions or community sizes.

Note that this approach also means that the NFPA survey results for detailed property-use classes (e.g., fires in storage structures) may not match the national estimates of the same value.

Calculating National Estimates of Particular Types of Fires

Most analyses of interest involve the calculation of the estimated number of fires not only within a particular occupancy but also of a particular type. The types that are mostly frequently of interest are those defined by some ignition-cause characteristic. The six cause-related characteristics most commonly used to describe fires are: form of the heat that caused the ignition, equipment involved in ignition, form or type of material first ignited, the ignition factor that brought heat source and ignited material together, and area of origin. Other characteristics of interest are victim characteristics, such as ages of persons killed or injured in fire.

For any characteristic of interest in NFIRS, some reported fires have that characteristic unknown or not reported. If the unknowns are not taken into account, then the propensity to report or not report a characteristic may influence the results far more than the actual patterns on that characteristic. For example, suppose the number of fires remained the same for several consecutive years, but the percentage of fires with cause unreported steadily declined over those years. If the unknown-cause fires were ignored, it would appear as if fires due to every specific cause increased over time while total fires remained unchanged. This, of course, does not make sense.

Consequently, most national estimates analyses allocate unknowns. This is done by using scaling ratios defined by NFPA survey estimates of totals divided by only those NFIRS fires for which the dimension in question was known and reported. This approach is equivalent to assuming that the fires with unreported characteristics, if known, would show the same proportions as the fires with known characteristics. For example, it assumes that the fires with unknown ignition factor contain the same relative shares of child-playing fires, incendiary-cause fires, short circuit fires, and so forth, as are found in the fires where ignition factor was reported.

Rounding Errors

The possibility of rounding errors exists in all our calculations. One of the notes on each table indicates the extent of rounding for that table, e.g., deaths rounded to the nearest one, fires rounded to the nearest hundred, property damage rounded to the nearest hundred thousand dollars. In rounding to the nearest one, functional values of 0.5 or more are rounded up and functional values less than 0.5 are rounded down. For example, 2.5 would round to 3, and 3.4 would round to 3. In rounding to the nearest one, a stated estimate of 1 could be any number from 0.5 to 1.49, a roughly threefold range.

The impact of rounding is greatest when the stated number is small relative to the degree of rounding. As noted, rounding to the nearest one means that stated values of 1 may vary by a factor of three. Similarly, the cumulative impact of rounding error - the potential gap between the estimated total and the sum of the estimated values as rounded - is greatest when there are a large number of values and the total is small relative to the extent of rounding.

Suppose a table presented 5-year averages of estimated deaths by item first ignited, all rounded to the nearest one. Suppose there were a total of 30 deaths in the 5 years, so the total average would be $30/5 = 6$.

In case 1, suppose 10 of the possible items first ignited each accounted for 3 deaths in 5 years. Then there would be 10 entries of $3/5 = 0.6$, rounded to 1, and the sum would be 10, compared to the true total of 6.

In case 2, suppose 15 of the possible items first ignited each accounted for 2 deaths in 5 years. Then there would be 15 entries of $2/5 = 0.4$, rounded to 0, and the sum would be 0, compared to the true total of 6.

Here is another example: Suppose there were an estimate of 7 deaths total in 1992 through 1996. The 5-year average would be 1.4, which would round to 1, the number we would show as the total. Each death would represent a 5-year average of 0.2.

If those 7 deaths split as 4 deaths in one category (e.g., smoking) and 3 deaths in a second category (e.g., heating), then we would show $4 \times 0.2 = 0.8$ deaths per year for smoking and $3 \times 0.2 = 0.6$ deaths per year for heating. Both would round to 1, there would be two entries of 1, and the sum would be 2, higher than the actual rounded total.

If those 7 deaths split as 1 death in each of 7 categories (quite possible since there are 12 major cause categories), then we would show 0.2 in each category, always rounding to 0, and the sum would be 0, lower than the actual rounded total. The more categories there are, the farther apart the sum and total can -- and often do -- get.

Note that percentages are calculated from unrounded values, and so it is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero.

Firefighter Deaths and Injuries

There are special procedures for fire service deaths and injuries. NFPA maintains a comprehensive listing of fire service on-duty deaths which can be used to produce answers not dependent on projection from samples. This is desirable because the number of fire service deaths at the fireground for fires of a particular cause is typically very small - less than 10 a year - so sample-based estimates would have very large uncertainty ranges, relative to the statistics being estimated.

For fire service injuries, the NFPA survey does not produce projections of fire service injuries at the fireground by major property type. Therefore, one must use a single scaling ratio instead of the four ratios (one each for residential structures, non-residential structures, vehicles, and other properties) that are used to scale up the other measures of fire severity.

Cause Categories Defined

Intentional causes

Fires that were proven or believed to have been deliberately set are captured here. Prior to Version 5.0 of NFIRS, these were identified by ignition factor 11, 12, 21 or 22. In Version 5.0, these incidents are identified by cause code 1 - intentional (code 7 – incendiary on the wildland module.) All fires with intentional causes are included in this category regardless of the age of the person involved. Certain fires with a completed arson module are also captured here. The cause “suspicious” has been dropped from Version 5.0, although all suspicious fires converted to intentional. See also *U.S. Arson Trends and Patterns* from the Fire Analysis and Research Division.

Child playing

Incidents in which a child was playing with the form of heat of ignition or the material first ignited are captured here. Prior to Version 5.0, the age of the child is not specified or limited and incidents were identified by ignition factor 36 or 48. Version 5.0 rules capture incidents in which “playing with heat source (19) was the factor contributing to ignition and human factor “age was a factor” (code 7) and was age less than 10 or blank. Certain incidents in which the juvenile fire module was completed and all juveniles were less than ten are also included. Other groups or analysts may use different age cut-offs. Prior to Version 5.0, fire with an ignition factor of child playing could not simultaneously be intentional. In Version 5.0, if the cause is intentional, the fire will drop into the intentional bucket, regardless of any other factors. See *Children Playing with Fire* from the Fire Analysis and Research Division for more information on this topic.

Smoking materials

Incidents in which the form of heat was some form of lighted tobacco product are captured here. (Cigarettes and pipes can be based on other materials, like marijuana, but these form a negligible share of total fires.) This category does not capture incidents in which a match or lighter used to light a cigarette started a fire. Prior to Version 5.0 these were captured by form of heat of ignition 30–39. In Version 5.0, smoking material fires are identified by heat source 61-63. Code 60 – “heat from other open flame or smoking materials” is grouped with “other heat source” because of the lack of specific information. See also *U.S. Smoking-Material Fire Problem* from the Fire Analysis and Research Division.

Heating equipment

Incidents in which some form of heating equipment (central heating units, hot water heaters, fixed or portable space heaters, fireplaces, chimneys, heat transfer equipment such as hot air ducts or hot water pipes, or other heating equipment) was involved in the ignition are said to be caused by heating equipment. This category includes both equipment that functioned properly and equipment that malfunctioned. Prior to Version 5.0, this was identified by equipment involved 10–19. Confined chimney fires, confined fuel burner or boiler fires (incident types 114 or 116, respectively,) or equipment involved 100 or 120-152 identify heating equipment fires in Version 5.0. See also *U.S. Home Heating Fire Patterns and Trends* from the Fire Analysis and Research Division.

Cooking equipment

Incidents in which some form of cooking equipment (Ranges, ovens or microwave ovens, food warming appliances, fixed or portable cooking appliances, deep fat fryers, open fired charcoal or gas grills, grease hoods or ducts, or other cooking appliances) was involved in the ignition are said to be caused by cooking equipment. Food preparation devices that do not involve heating, such as can openers or food processors, are not included here. This category includes equipment that functioned properly and equipment that malfunctioned. Incidents in which food or cooking materials were the material first ignited are included only when cooking equipment was identified; if the equipment involved was undetermined, unreported, not applicable or unclassified, the fire would not be captured here. Prior to Version 5.0, cooking equipment fires were identified by equipment involved 20-29). In Version 5.0, cooking equipment fires are identified by confined cooking fires (incident type 113), or equipment involved 631-647, 652, or code 600 when it had been converted from earlier versions. See also *U.S. Home Cooking Fire Patterns and Trends* from the Fire Analysis and Research Division.

Electrical distribution equipment

Incidents in which some form of electrical distribution or related lighting equipment (fixed wiring, transformers, associated overcurrent or disconnect equipment such as fuses or circuit breakers, meters, meter boxes, power switch gear, switches, receptacles, outlets, light fixtures, ballasts, signs, cords, plugs, lamps, light bulbs or other electrical distribution equipment) was involved in ignition or in which the form of heat was a fluorescent light ballast or an electric lamp or light bulb are captured in this category. Prior to Version 5.0, these were identified by equipment involved 40-49 or form of heat of ignition 28 or 54. In Version 5.0, these are identified by factor contributing to ignition 37 or equipment involved 200-263, except 224, 225, 228 and 229. See also *U.S. Home Product Report (Appliances and Equipment)* from the Fire Analysis and Research Division.

Appliances or air conditioning or refrigeration equipment

Incidents in which the equipment involved was coded as some form of air conditioning or refrigeration equipment (central or local air conditioning or refrigeration equipment, water cooling devices or towers, dehumidifiers, or other air conditioning or refrigeration equipment) or appliances that are not classified elsewhere (televisions, radios, stereos, VCR's, cable boxes, washers, dryers, floor care equipment, hand tools, portable appliances designed to produce heat, portable appliances not designed to produce heat, or other appliances or tools) are captured in this category. Prior to Version 5.0, these were identified by equipment involved 30-39, 50-54, or 56-59. In 5.0, these are identified by equipment involved 111-117, 310-316, 318, 345, 445, 611-623, 651-653, 655, 656, 730-759, 800-871, 874-897 or equipment involved 872 and equipment power is not between 20-39 or equipment involved = 600 and the data was originally collected in the Version 5.0 format and not converted. See also *U.S. Home Product Report (Appliances and Equipment)* from the Fire Analysis and Research Division.

Open flame, ember or torch

Incidents involving torches (coded as equipment involved; or coded as form of heat of ignition: cutting, welding, or other torch operation; or coded under ignition factor: thawing, or cutting or welding too close), candles, matches, lighters, open fires, embers, or rekindles are said to be caused by open flames, embers or torches. Prior to Version 5.0, these were identified by equipment involved 87 or form of heat 41 - 47, 53, or 55; or ignition factor 32 or 35. In Version 5.0, these are identified by equipment involved 331-334 or 873, or factor contributing to ignition 13 or 72, or heat source 43 or 64-67, or equipment involved = 872 and equipment power 20-29. See also *Torch Fires in the United States* and *Candle Fires in U.S. Homes and Other Occupancies* from the Fire Analysis and Research Division.

Other heat, flame or spark

Incidents in which the form of heat of ignition was fireworks or explosives (explosives, blasting agents, fireworks, sparklers, paper caps, party poppers, model rockets, or unknown-type heat from explosives or fireworks); unclassified or unknown-type open flame or spark; or heat or spark from friction, molten hot metal, or unclassified or unknown-type hot object. Prior to Version 5.0, these were identified by form of heat of ignition 40, 49-52, 59, or 60-65. In Version 5.0, these are identified by heat source 40-42, 50-60, 69, and 80-84. See also *Fireworks-Related Injuries, Deaths, and Fires in the U.S.* from the Fire Analysis and Research Division.

Other equipment

Incidents in which the equipment involved in ignition was coded as special equipment, processing equipment, service equipment, vehicles, engines, or unspecified equipment are said to be caused by other equipment. These include the following more specific types of equipment: motors; generators; electronic equipment such as telephones or computers; vending machines; drinking fountains; office machines; biomedical equipment; pumps; compressors; internal combustion engines; conveyors; printing presses; unclassified and unknown-type special equipment; furnaces; ovens; kilns; casting, molding; or forging equipment; heat treating equipment; working or shaping machines; coating machines; painting equipment; chemical process equipment; waste recovery equipment; and unclassified or unknown-type processing equipment. Fires in which the form of heat indicates some type of fuel-powered or electrical equipment, but no type of equipment is specified in equipment involved in ignition, were also captured here prior to Version 5.0. These latter fires include fires contradictorily coded as "no equipment" under equipment involved and "equipment involved" under form of heat. Unfortunately, these fires often dominated the "other equipment" category. Prior to Version 5.0, other equipment fires were identified by equipment involved 55, 60-79, or 96; or form of heat 10-19, 20, 29, 56, or 57. In Version 5.0, these are identified by either incident type 115 (incinerator overload or malfunction) or by equipment involved 224, 225, 228 229, 300, 317, 320-329, 340-344, 346-349, 351-365, 371-377, 400-434, 441-444, 446, 450, 451, 500-599, 700, 710-729, or heat source 68, or mobile property 2 or 3 (involved in ignition) and mobile property was not equal to 15-17. See also *U.S. Vehicle Fire Trends and Patterns* from the Fire Analysis and Research Division.

Natural causes

Incidents in which the ignition factor was lightning or the form of heat was a natural source (sun's heat, spontaneous ignition, chemical reaction, lightning discharge, static discharge, or unclassified or unknown-type heat from a natural source) are said to be caused by natural causes. Prior to Version 5.0, these were identified by ignition factor 84 or form of heat 70–79. In Version 5.0, these are identified by cause 4 (act of nature) and either heat source 70-74 or factor contributing 65. It was felt that some of the items listed under “act of nature,” such as animals or some weather conditions, could be more accurately described as contributing factors. Due to a conversion glitch, many of the form of heat of ignition codes in the seventies and eighties did not convert into the appropriate specific heat source code. Consequently, lightning and spontaneous ignition or chemical reaction do not appear as any of the leading types of natural causes in the 1999 data.

Exposure

Incidents that are caused by the spread of or from another fire are said to be caused by exposures. These include fires in which the exposure number is greater than 0; the ignition factor is property too close; or the form of heat is heat spreading from another fire via direct flame or convection current; radiated heat; heat from flying brand, ember or spark; conducted heat; or unclassified or unknown-type heat. Prior to Version 5.0, these were identified by exposure number greater than zero, ignition factor 65 or form of heat 80-89. In Version 5.0, these incidents are identified by exposure number greater than zero or factor contributing to ignition 70, 71 or 73-75.

Unknown

All remaining fires are grouped under unknown. In this analysis, fires in which the cause was unknown were allocated proportionally among fires of known cause.