FIRES AT U.S. SERVICE STATIONS

Ben Evarts April 2011



National Fire Protection Association Fire Analysis and Research Division

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Abstract

According to the U.S. Census Bureau, there were 117,000 gasoline stations in the United States in 2007. During 2004-2008, an estimated average of 5,020 fires were reported in and around these properties per year, causing an annual average of two civilian deaths, 48 civilian fire injuries, and \$20 million in direct property damage. These fires include vehicle, structure, outside, and other fires. Most of the fires (61%) were vehicle fires, but the bulk of the property loss (59%) was a result of structure fires. These estimates are based on data from the U.S. Fire Administration's (USFA) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA) annual fire department experience survey.

Keywords: fire statistics, service station fires, gas station fires, non-residential fires

Acknowledgements

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

For more information about the National Fire Protection Association, visit <u>www.nfpa.org/</u> or call 617-770-3000. To learn more about the One-Stop Data Shop go to <u>www.nfpa.org/osds</u> or call 617-984-7443.

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National Fire Protection Association One-Stop Data Shop 1 Batterymarch Park Quincy, MA 02169-7471 www.nfpa.org/ e-mail: osds@nfpa.org phone: 617-984-7443

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Executive Summary

During the five-year period of 2004-2008, NFPA estimates that U.S. fire departments responded to an average of 5,020 in service or gas station properties per year. These fires caused an annual average of two civilian deaths, 48 civilian fire injuries, and \$20 million in direct property damage. The majority of the fires in this category were vehicle fires. Reported fires in this occupancy group fell 46% from 7,860 in 1980 to 4,280 in 2008.

According to the U.S. Census Bureau, there were 117,000 gasoline stations in the United States in 2007¹. Fires in these occupancies represent a variety of incidents, including structure fires, vehicle fires, outdoor fires and other fires. The majority of incidents are vehicle fires (61%), but the majority of the property damage (59%), results from structure fires. Outside trash or rubbish fires account for 12% of the fires reported to local fire departments at this type of property.

Twelve percent of fires reported to local fire departments in these properties were structure fires. The most common items first ignited in structure fires at service stations were flammable and combustible liquids and gases, piping or filter (22% of structure fires), followed by rubbish, trash, or waste (18%) and electrical wire or cable insulation (13%).

Most vehicle fires (82%) occurred in passenger vehicles, these fires accounted for nearly half of the total number of civilian injuries that occurred in service station fires of any kind (structure, vehicle, outside, other). The most common type of material first ignited in a vehicle fire was gasoline (28%).

Outside and other fires accounted for 15% of incidents at service stations. Natural vegetation fires accounted for 42% of these incidents. The most common heat source for outside fires was smoking materials (21%).

Twelve percent of fire incidents at service stations were outside trash or rubbish fires.

Individuals interested in keeping service stations safe from fire should consult <u>NFPA 30A – Code for Motor Fuel Dispensing Facilities and Repair Garages</u> for information about fire prevention in these properties.

¹ U.S. Census Bureau, Statistical Abstract of the United States: 2010, Table 740 "Economic Census Summary" (NAICS 2002 Basis): 2002 and 2007

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Fires at U.S. Service Stations

U. S. fire departments responded to an estimated average of **5,020** fires at service stations per year during 2004-2008. These fires caused annual averages of

- 2 civilian deaths
- **48** civilian fire injuries
- **\$20** million in direct property damage

Fires in service stations fell 46% from 7,860 in 1980 to 4,280 in 2008.

Fires in Service Stations by Type of Incident, 2004-2008

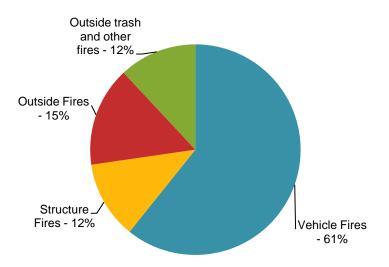
Facts:

Structure fires accounted for 12% of total incidents but 59% of the direct property damage.

In structure fires, heating equipment was the leading cause, followed by electrical distribution and lighting equipment.

The most common type of material first ignited in vehicle fires was gasoline.

Smoking materials provided the heat of ignition in 21% of outdoor and unclassified fires.



Special Considerations in These Properties

- Motorists should discharge static electricity by touching a metal part of their car door before fueling their vehicles.
- Most civilian injuries at service station fires occur in vehicle fires.
- The primary NFPA code addressing fire safety issues for service stations and motor fuel dispensing is NFPA 30A *Code for Motor Fuel Dispensing Facilities and Repair Garages.*

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Fires at U.S. Service Stations

This report contains information about structure service stations, gas stations. According to the U.S. Census Bureau, there were 117,000 gasoline stations in the United States in 2007.

5,020 fires, on average, were reported in these properties per year in 2004-2008.

These fires caused an annual average of two civilian deaths, 48 civilian fire injuries, and \$20 million in direct property damage. The table below provides a more detailed breakdown of losses by incident type. The majority of the fires in this category were in vehicles. (See Table A)

Table A. Fires in Service Stations 2004-2008 Annual Averages

Occupancy	Fir	es	Civi Dea		Civil Inju		Direc Property I (in Milli	Damage	
Vehicle fires Outside and other fires (excluding	3,050	61%	1	61%	29	61%	\$8	39%	
trash fires)	770	15%	0	7%	3	7%	\$1	3%	
Structure fires	600	12%	1	32%	15	32%	\$12	59%	
Outside trash or rubbish fires	600	12%	0	0%	0	0%	\$0	0%	
Total	5,020	100%	2	100%	48	100%	\$20	100%	
Source: NEIRS 5.0 and NEPA survey	7								

Source: NFIRS 5.0 and NFPA survey.

Since 1980, service station fires fell 46%.

Fires in this occupancy group fell 46% from 7,860 in 1980 to 4,280 in 2008. Version 5.0 of NFIRS was first introduced in 1999. Fire departments gradually adopted it. Estimates for the transition years of 1999-2001 are more volatile and should be viewed with caution. They are shown in Tables 1 and 2 but not in Figure 1.

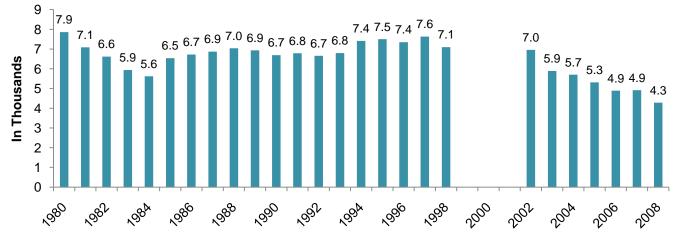


Figure 1. Reported Structure Fires in Service Stations by Year 1980-2008

Source: NFIRS and NFPA survey. See note for Table 1.

Data Sources, Definitions and Conventions Used in this Report

Unless otherwise specified, the statistics in this analysis are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. These estimates are projections based on the detailed information collected in Version 5.0 of the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS 5.0) and the National Fire Protection Association's (NFPA's) annual fire department experience survey. Except for property use and incident type, fires with unknown or unreported data were allocated proportionally in calculations of national estimates. In general, any fire that occurs in or in a structure is considered a structure fire, even if the fire was limited to contents and the building itself was not damaged.

Service stations were identified by NFIRS 5.0 property use code 571.

NFIRS 5.0 includes a category of structure fires collectively referred to as "confined fires," identified by incident type. These include confined cooking fires, confined chimney or flue fires, confined trash fires, confined fuel burner or boiler fires, confined commercial compactor fires, and confined incinerator fires (incident type 113-118). Losses are generally minimal in these fires, which by definition, are assumed to have been limited to the object of origin. Although causal data is not required for these fires, it is sometimes present. Vehicle fires are identified by incident type 130-139. Outside and other fires include fires outside involving property of value and unclassified fires, as well as outside rubbish and vegetation fires.

Confined and non-confined structure fires were analyzed separately and summed for Cause of Ignition, Heat Source, Factor Contributing to Ignition, Area of Origin, and Item First Ignited, as well as for the Detection and Automatic Suppression estimates. Non-confined fires were analyzed for Equipment Involved in Ignition. For that table, confined fires were not broken out further and were grouped by incident type with the non-confined fires.

Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Property damage has not been adjusted for inflation. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one and direct property damage to the nearest million (or thousand, in the case of outside fires). Due to the very small number of deaths, they have been omitted from trend and cause tables. Additional details on the methodology may be found in Appendix A and B.

Structure and outside and other fires have decreased over time.

Between 1980 and 2008, structure fires, and outdoor/other fires at service stations dropped by 70%, each (structure fires from 1,910 to 580, and outside/other fires from 4,010 to 1,200). Vehicle fires at these properties increased steadily until the late 1990s, and declined through the 2000's. Even with the recent decline, vehicle fires were still 29% higher in 2008 than they were in 1980 (2,510 in 2008 vs. 1,940 in 1980). See Figure 2 below and Table 2 for more information.

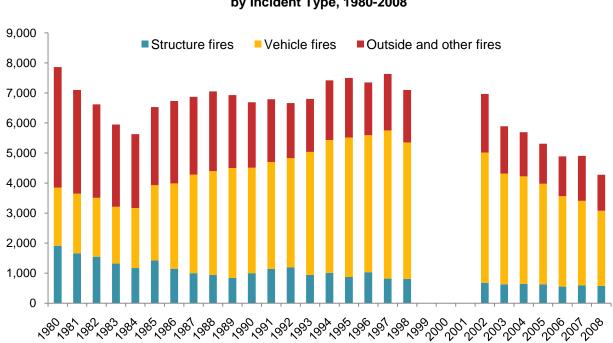


Figure 2. Reported Fires at Service Stations by Incident Type, 1980-2008

Structure Fires

Structure fires accounted for 12% of fire incidents at service stations between 2004 and 2008

Six hundred structure fires per year were reported at this property type, which caused one civilian death and 15 civilian injuries per year. These fires accounted for an average of \$12 million in property damage per year.

Combustible or flammable gases and liquids were the most common item first ignited in structure fires.

Table 3 shows the leading items first ignited in structure fires at service stations. The most common item was flammable or combustible liquids, gases, and associated piping or filter (22% of fires). Rubbish, trash, or waste was the item first ignited in 18% of these fires. However, most trash fires were not severe, as they caused only 7% of the property damage. Electrical cable or insulation was the item first ignited in 13% of incidents.

Many fires in service stations started in a cooking area, or in a lavatory or bathroom.

The most common area of origin for structure fires was an unclassified outside area (9% of fires). Eight percent of fires began in the kitchen or cooking area, another 8% started in the lavatory or bathroom. Four percent of fires began in a maintenance or paint shop area. Additional information about the area of origin in structure fires can be found in Table 4.

Fires at U.S. Service Stations, 4/11

Source: NFIRS 5.0 and NFPA survey.

Heating equipment was the most common type of equipment involved in structure fires in these properties.

Table 5 shows that heating equipment was involved in the ignition of 15% of structure fires in service stations. Electrical distribution and lighting equipment was involved in 13% and cooking equipment in 11%. The 4% of fires where a torch, burner, or soldering iron was involved in ignition caused 15% of the property damage.

Electrical failures or malfunctions and abandoned materials were leading factors contributing to the ignition of structure fires.

Table 6 shows that an electrical failure or malfunction was a factor in 25% of structure fires at service stations between 2004 and 2008. Abandoned or discarded materials were a factor in 15% of these incidents. A mechanical failure or malfunction was a factor in 12% of fires and a heat source being too close to combustibles was a contributing factor to ignition in 8% of fires.

Arcing was the most common type of heat source for structure fires.

Sixteen percent of structure fires in service stations were coded as having arcing as the heat source. Unclassified heat from powered equipment was the heat source in 13% of incidents, and smoking materials were involved in 10%. See Table 7 for additional information.

Failure of equipment or a heat source was the cause of almost one-third of structure fires in service stations.

Unintentional fires accounted for 49% of incidents while a failure of equipment or heat source accounted for 30%. Twelve percent of fires were set intentionally. See Table 8 for additional information.

Vehicle Fires

3,050 fires, on average, were reported in vehicles at service stations per year in 2004-2008.

These fires caused an annual average of one civilian death, 29 civilian fire injuries, and \$8 million in direct property damage. The table below provides a more detailed breakdown of losses

Table B. **Vehicle Fires in Service Stations** 2004-2008 Annual Averages

Incident Type	Fi	res	Civiliar	n Deaths	Civilian	Injuries	Direct P Dan (in Mi	nage
Passenger vehicle fire Unclassified mobile property	2,500	(82%)	1	(100%)	23	(79%)	\$4.6	(58%)
(vehicle) fire	270	(9%)	0	(0%)	2	(8%)	\$0.5	(6%)
Road freight or transport vehicle fire	220	(7%)	0	(0%)	2	(7%)	\$2.5	(32%)
Camper or recreational vehicle (RV) fire	30	(1%)	0	(0%)	2	(5%)	\$0.2	(2%)
Off-road vehicle or heavy equipment fire	20	(1%)	0	(0%)	0	(0%)	\$0.0	(1%)
Other vehicles	10	(0%)	0	(0%)	0	(1%)	\$0.1	(1%)
Total	3,050	(100%)	1	(100%)	29	(100%)	\$7.8	(100%)

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Source: NFIRS 5.0 and NFPA survey.

Mechanical or electrical malfunctions and leaks are common factors contributing to vehicle fires at service stations.

Mechanical failures or malfunctions were a factor contributing to the ignition of 53% of vehicle fires. An electrical failure or malfunction was a factor in 24% of these incidents. A flammable liquid or gas being spilled was a factor in 4% of vehicle fires at service stations. Table 9 has additional information about factors contributing to ignition.

Heat from operating equipment within the vehicle provided the heat source for many fires.

Unclassified heat from powered equipment was the heat source in 23% of fires at service stations in vehicles, and radiated, conducted heat from operating equipment was the heat source in 21%. In 18% of incidents, the heat source was arcing. Spark, ember, or flame from operating equipment was the heat source 8% of the time. Table 10 has a more thorough accounting of heat sources.

Static electricity has been confirmed as a cause of refueling fires, but cellular phones have not. Three percent of vehicle fires at service stations between 2004 and 2008 were coded as having unclassified static discharge as the heat source (this coding excludes electrical arcs or sparks). According to a report by the Australian Transport Safety Bureau (ATSB), "between 1993 and 2004, there were 243 reports of fires breaking out at petrol stations due to mobile phones. However, according to Dr. Adam Burgess of the University of Kent, not one of these incidents occurred as a result of a sparking mobile phone. In fact, there is no evidence that any petrol station fire has been ignited from electrical equipment"¹. The Petroleum Equipment Institute echoes these findings via its "Stop Static." campaign. According to its website "So far, we have been unable to document any incidents that were sparked by a cellular telephone, In fact, many researchers have tried to ignite fuel

vapors with a cell phone and failed."²

Fires ignited by static occur during container refilling as well as vehicle refilling.

According to the same ATSB report, there is evidence that the condition most likely to lead to a spark discharge is filling an unearthed metal container or tank with fuel. An example of this condition is filling a metal container on a plastic-lined bed of a pick-up truck. In fact, of the twenty first-hand reports of fires involving the filling of portable fuel containers received by PEI between 1990 and 1995, seventeen involved the container being placed in the bed of a pick-up truck.

Fires during refueling have declined in recent years.

According to an article in PEI Journal, over the past 10 years (the article was published in January 2011), PEI has received 176 reports of fires/accidents attributable to static electricity, but only six since the beginning of 2007. The article attributes this drop to four probable factors: public awareness campaigns, warning signs at the dispenser (which was an amendment to NFPA's Code for Motor Fuel Dispensing Facilities and Repair Garages and Chapter 22 and to the International Fire Code in 2003), vapor recovery at the pump, and onboard refueling vapor recovery³.

¹ Static Fires at Retail Petrol Stations, Australian Transport Safety Bureau. June 2005.

http://www.esdjournal.com/static/Static_Fires.pdf. Accessed January 10, 2011

² Petroleum Equipment Institute.

http://www.pei.org/PublicationsResources/SafetyResources/StopStaticCampaign/tabid/121/Default.aspx. Accessed January 10, 2011.

³ "Why Are Vehicle Fires During Refueling Declining?" *PEI Journal*, First Quarter 2011. Renkes, Sunderhaus.

Fires that started with the ignition of flammable liquids or gas were most common and caused more property damage and more injuries, on average.

Twenty four percent of fires began when flammable liquids or gas specifically from an engine or burner was ignited (the most common type of flammable liquid or gas fire); these fires however, were responsible for 36% of the associated property losses. In 28% of the vehicle fires at service stations, electrical wire or cable insulation was the item first ignited, these incidents were responsible for 19% of the property damage. (See Table 11.)

Gasoline was the most common type of material first ignited in vehicle fires.

Twenty four percent of vehicle fires that occurred at service stations began when gasoline was ignited, these incidents caused nearly two thirds (62%) of civilian injuries. Plastic was the type of material first ignited in 16% of fires, these fires caused 30% of the property damage. (See Table 12)

The majority of vehicle fires at service station or gas station properties began in the engine area. The engine area, running gear, or wheel area was the area of origin for 74% of vehicle fires at these properties. The passenger area of the vehicle was the area of origin for 6% of fires, and 4% of fires originated in the fuel tank or fuel line of the vehicle. See Table 13 for more information.

Unintentional fires and failures of equipment or heat sources caused the bulk of vehicle fires. Unintentional fires accounted for 49% of incidents, while failure of equipment or heat source was responsible for causing 44% of fires. Only 1% of fires were intentionally set. See Table 14 for more information.

Outside and Other Fires (excluding trash or rubbish fires)

770 outside and other fires occurred at service stations per year between 2004 and 2008. These fires caused an average of three civilian injuries and \$0.6 million of property damage per year. Deaths rounded to less than one per year. A more detailed breakout of incident types is shown in Table C below.

Table C.Outside and Other Fires in Service Stations2004-2008 Annual Averages

Incident Type	Fire	es	Civilian D	eaths	Civilian	Injuries	Direct Prop Damag (in Millio	e
Natural vegetation Fire	320	(42%)	0	(0%)	0	(0%)	\$0.0	(1%)
Brush, or brush and grass mixture fire	140	(19%)) 0	(0%	i) (0 (0%)	\$0.0	(1%)
Natural vegetation fire, other	100	(13%)) 0	(0%) (0 (0%)	\$0.0	(0%)
Grass fire	70	(9%)) 0	(0%) (0 (0%)	\$0.0	(0%)
Forest, woods or wildland fire	0	(1%)) 0	(0%) (0 (0%)	\$0.0	(0%)
Special outside fire	240	(31%)	0	(0%)	2	(63%)	\$0.4	(67%)
Outside equipment fire	100	(13%)) 0	(0%) .	1 (16%)	\$0.3	(43%)
Special outside fire, other Outside gas or vapor combustion	70	(9%)) 0	(0%	i) (0 (5%)	\$0.0	(8%)
explosion	60	(7%)) 0	(0%) .	1 (41%)	\$0.1	(15%)
Outside storage fire	10	(2%)) 0	(0%) (0 (0%)	\$0.0	(1%)
Outside mailbox fire	0	(0%)) 0	(0%	i) (0 (0%)	\$0.0	(0%)

Direct Property

Table C. Outside and Other Fires in Service Stations 2004-2008 Annual Averages (Continued)

Incident Type	Fir	res	Civilian	Deaths	Civilian I	njuries	Direct Pro Damag (in Millio	ge
Other fire	200	(26%)	0	(100%)	1	(37%)	\$0.2	(32%)
Cultivated vegetation, crop fire Cultivated vegetation, crop fire, other	10 0	(1%) (1%)	0 0	(0%) (<i>0%)</i>	0	(0%) (0%)	\$0.0 <i>\$0.0</i>	(0%) (0%)
Cultivated trees or nursery stock fire	0	(0%)	0	(0%)	0	(0%)	\$0.0	(0%)
Total	770	(100%)	0	(100%)	3	(100%)	\$0.6	(100%)

Smoking materials were the most common heat source of outside fires at service stations.

Smoking materials were the heat source in 21% of outside fires at service station properties. Arcing was the heat source in 12% of incidents. Unclassified hot or smoldering objects and hot ember or ash were the heat source in 10% of fires each (See Table 15).

Gasoline was the type of material first ignited in nearly one third of outside and other fires at service stations.

Thirty one percent of these fires were coded as having gasoline as the type of material first ignited in the blaze. Wood chips, sawdust, or shavings where the item first ignited in 19% of fires. Other natural products, and plastic were the type of material first ignited in 10% of the fires each (see Table 16.)

Abandoned or discarded materials or products were the leading factor contributing to outside fires at gas or service station properties.

Twenty four percent of incidents listed abandoned or discarded materials or products as a factor contributing to the ignition of the fire, electrical failures or malfunctions were factors in 12%. A collision, knock down, run over or turnover was coded as a factor 9% of the time, however, these incidents caused 56% of the direct property damage. (See Table 17.)

Among outside and other fires where equipment was involved, electrical distribution and lighting equipment was most common.

Fifty-five percent of outside and other fires were coded as having no equipment involved in ignition. Twelve percent of fires involved some sort of electrical distribution or lighting equipment. Incidents involving a pump accounted for 8% of fires. See Table 18 for more information.

More than two thirds of outside and other fires at service stations were caused unintentionally. Sixty eight percent of fire incidents were coded as unintentional, and 11% were caused by the failure of equipment or heat source. Seven percent of fires were intentionally set. See Table 19 for more information.

Outside Trash or Rubbish Fires

600 outside trash or rubbish fires occurred at service stations per year between 2004 and 2008.

These fires caused an average of \$13,000 in property damage per year, on average. No civilian deaths were reported, and less that one civilian injury was reported per year. A more detailed breakout of incident types is shown in Table D below.

Table D. Outside Trash or Rubbish Fires in Service Stations 2004-2008 Annual Averages

Incident Type	Fi	res	Civilian	Injuries	Direct Pr Dama (in Thous	ige
Dumpster or other outside trash receptacle fire Outside rubbish, trash or waste	330	(55%)	0	(100%)	\$10	(77%)
fire	190	(32%)	0	(0%)	\$2	(15%)
Outside rubbish fire, other Garbage dump or sanitary landfill	70	(12%)	0	(0%)	\$1	(8%)
fire Outside stationary	0	(1%)	0	(0%)	\$0	(0%)
compactor/compacted trash fire Construction or demolition	0	(0%)	0	(0%)	\$0	(0%)
landfill fire	0	(0%)	0	(0%)	\$0	(0%)
Totals	600	(100%)	0	(100%)	\$13	(100%)

Nearly one third of outside trash or rubbish fires at service stations were set intentionally.

Sixty three percent of fires were unintentional, however 29% were intentionally set, a much higher proportion than structure, vehicle, or other outside fires. (See Table 20.)

Additional Resources for Fire Safety in Service Stations

The primary NFPA code that addresses fire safety issues for service stations and motor fuel dispensing is <u>NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*</u>. NFPA 30A addresses the following:

- storage of liquid motor fuels in tanks and containers
- special sitting requirements for aboveground motor fuel storage tanks
- the fuel dispensing system and its components
- building construction requirements for motor fuel dispensing facilities and repair garages
- electrical system area classification criteria for hazardous (classified) electrical equipment
- operating requirements for motor fuel dispensing

In addition, NFPA 30A includes chapters that address marine fueling operations; special requirements to be followed where alternative fuels are dispensed along with the more traditional gasoline and diesel fuels (e.g., compressed natural gas, liquefied natural gas, LP-gas, hydrogen); and special considerations for small quantity fuel storage and dispensing at farms and isolated sites.

Numerous other NFPA codes and standards are referenced in NFPA 30A, the most important being:

- NFPA 30 Flammable and Combustible Liquids Code
- NFPA 51B Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
- <u>NFPA 70[®] National Electrical Code[®]</u>
- NFPA 385- Standard for Tank Vehicles for Flammable and Combustible Liquids

Also of interest are standards and recommended practices of other organizations.

The Petroleum Equipment Institute publishes a number of recommended practices for the motor fuel retailing industry:

- PEI/RP100 Installation of Underground Liquid Storage Systems
- PEI/RP200 Installation of Aboveground Storage Systems for Motor Fuel Dispensing
- PEI/RP300 Installation and Testing of Vapor Recovery Systems at Vehicle Fueling Sites
- PEI/RP400 Testing Electrical Continuity of Fuel-Dispensing Hanging Hardware
- PEI/RP500 Inspection and Maintenance of Motor Fuel Dispensing Equipment
- <u>PEI/RP600 Overfill Prevention for Shop-Fabricated Aboveground Tanks</u>
- PEI/RP700 Design and Maintenance of Fluid-Distribution Systems at Vehicle Maintenance Facilities
- PEI/RP800 Installation of Bulk Storage Plants
- <u>PEI/RP900 Inspection and Maintenance of UST Systems</u>
- <u>PEI/RP1000 Installation of Marina Fueling Systems</u>

PEI also offers standardized checklists for daily equipment inspection, monthly and annual system inspection, and post-incident inspection.

The Underwriters Laboratories publishes a number of standards that are directly related to motor fuel dispensing system components. The following are directly referenced in NFPA 30A:

- UL 87 Standard for Power-Operated Dispensing Devices for Petroleum Products
- UL 842 Standard for Valves for Flammable Fluids
- <u>UL 2080 Standard for Fire Resistant Tanks for Flammable and Combustible Liquids</u>
- UL 2085 Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids
- UL 2245 Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks

Table 1.Fires in Service or Gas Station Properties, by Year1980-2008

V F			Direct Property Damage (in Millions)			
Year	Fires	Civilian Injuries	As Reported	In 2008 Dollars		
1980	7,860	119	\$12	\$31		
1981	7,090	81	\$9	\$22		
1982	6,620	126	\$10	\$23		
1983	5,940	114	\$11	\$24		
1984	5,620	119	\$8	\$16		
1985	6,540	120	\$12	\$23		
1986	6,720	145	\$9	\$17		
1987	6,870	80	\$10	\$19		
1988	7,040	109	\$17	\$31		
1989	6,930	107	\$13	\$23		
1990	6,690	68	\$17	\$28		
1991	6,790	68	\$17	\$27		
1992	6,660	65	\$20	\$30		
1993	6,800	67	\$15	\$22		
1994	7,410	71	\$14	\$20		
1995	7,500	62	\$18	\$25		
1996	7,350	68	\$15	\$21		
1997	7,630	82	\$24	\$32		
1998	7,100	68	\$19	\$25		
1999	8,600	190	\$10	\$14		
2000	8,290	41	\$18	\$23		
2001	7,860	107	\$31	\$38		
2002	6,960	94	\$37	\$44		
2003	5,890	58	\$28	\$32		
2004	5,700	82	\$17	\$20		
2005	5,310	48	\$19	\$21		
2006	4,890	49	\$15	\$16		
2007 2008	4,910 4,280	38 25	\$23 \$28	\$24 \$28		

NFIRS 5.0 was first introduced in 1999, although participation was low. Estimates for 1999-2001 are considered particularly unstable and should be used with caution.

Note: NFPA estimates that a total of 130 civilian fire deaths were reported in these fires over a 29-year period. Due to the small number, annual estimates of civilian deaths are highly unstable and are therefore not shown. Inflation adjustments were based on the consumer price index found in the U.S. Census Bureau's *Statistical Abstract of the United States: 2010,* "Table 708, Purchasing Power of the Dollar."

Source: NFIRS and NFPA survey.

Fires at U.S. Service Stations, 4/11

Table 2.Fires in Service or Gas Station Properties, by Incident Type and Year1980-2008

Year	Structure Fires	Vehicle Fires	Outside and Other Fires
1980	1,910	1,940	4,010
1981	1,660	1,990	3,450
1982	1,550	1,960	3,110
1983	1,320	1,890	2,740
1984	1,170	2,000	2,460
1985	1,420	2,510	2,600
1986	1,150	2,840	2,740
1987	1,000	3,280	2,590
1988	940	3,460	2,650
1989	840	3,660	2,430
1990	1,000	3,510	2,180
1991	1,140	3,560	2,090
1992	1,200	3,630	1,830
1993	940	4,100	1,760
1994	1,010	4,420	1,990
1995	870	4,650	1,980
1996	1,030	4,560	1,760
1997	820	4,930	1,880
1998	810	4,540	1,750
1999	810	5,170	2,620
2000	900	5,540	1,850
2001	860	4,800	2,200
2002	680	4,330	1,950
2003	630	3,690	1,580
2004	640	3,580	1,470
2005	630	3,350	1,340
2006	550	3,010	1,330
2007	590	2,820	1,500
2008	580	2,510	1,200

Source: NFIRS 5.0 and NFPA survey.

Table 3. Structure Fires in Service or Gas Station Properties, by Item First Ignited 2004-2008 Annual Averages

Item First Ignited	Fires		Civilian Injuries		Direct Property Damage (in Millions)	
Flammable and combustible						
liquids and gases, piping and filter	130	(220/)	10	$(\boldsymbol{\epsilon}\boldsymbol{\epsilon}\boldsymbol{0})$	\$3.5	(29%)
	130 60	(22%) (11%)		(66%) (66%)	\$3.5 \$3.4	(29%)
Non-confined fire	70	(11%)		(00%)	\$3.4 \$0.0	(29%)
Confined fire		. ,		(10%)	\$0.0 \$0.8	. ,
Rubbish, trash, or waste	110 20	(18%)	2	. ,	\$0.8 \$0.8	(7%)
Non-confined fire	20 90	(3%)	0	(3%)	\$0.8 \$0.0	(7%)
<i>Confined fire</i> Electrical wire or cable	90	(15%)	1	(7%)	\$0.0	(0%)
insulation	80	(13%)	0	(3%)	\$1.6	(13%)
Non-confined fire	70	(12%)	0	(3%)	\$1.6	(13%)
Confined fire	0	(1%)	0	(0%)	\$0.0	(0%)
Unclassified item first ignited	50	(8%)	0	(0%)	\$0.9	(8%)
Non-confined fire	20	(4%)	0	(0%)	\$0.9	(8%)
Confined fire	20	(4%)	0	(0%)	\$0.0	(0%)
Structural member or framing	20	(4%)	1	(6%)	\$0.9	(7%)
Non-confined fire	20	(4%)	1	(6%)	\$0.9	(7%)
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)
Box, carton, bag, basket or						
barrel	20	(3%)	0	(0%)	\$0.7	(6%)
Non-confined fire	10	(2%)	0	(0%)	\$0.7	(6%)
Confined fire	10	(1%)	0	(0%)	\$0.0	(0%)
Exterior wall covering or finish	20	(3%)	0	(0%)	\$0.1	(1%)
Non-confined fire	20	(3%)	0	(0%)	\$0.1	(1%)
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)
Multiple items first ignited	10	(2%)	0	(3%)	\$0.8	(7%)
Non-confined fire	10	(2%)	0	(3%)	\$0.8	(7%)
Confined fire	0	(1%)	0	(0%)	\$0.0	(0%)
Exterior roof covering or finish	10	(2%)	0	(0%)	\$0.1	(1%)
Non-confined fire	10	(2%)	0	(0%)	\$0.1	(1%)
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)
Magazine, newspaper, writing	10	(20)	0	(201)	\$ 0.4	(1.04)
paper	10	(2%)	0	(3%)	\$0.1	(1%)
Non-confined fire	10	(2%)	0	(3%)	\$0.1	(1%)
Confined fire	0	(1%)	0	(0%)	\$0.0	(0%)
Interior ceiling cover or finish	10	(2%)	0	(0%)	\$0.1	(1%)
Non-confined fire	10	(2%)	0	(0%)	\$0.1	(1%)
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)

Note: Sums may not equal totals due to rounding errors. Source: NFIRS 5.0 and NFPA survey.

Table 3. Structure Fires in Service or Gas Station Properties, by Item First Ignited 2004-2008 Annual Averages (continued)

Item First Ignited	Fires Civilian Injuries		Injuries	Direct Property Damage (in Millions)		
Interior wall covering.						
excluding drapes	10	(2%)	0	(0%)	\$0.3	(2%)
Non-confined fire	10	(2%)	0	(0%)	\$0.3	(2%)
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)
Other known item first ignited	110	(19%)	1	(9%)	\$2.2	(18%)
Non-confined fire	100	(17%)	1	(9%)	\$2.1	(18%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Total	600	(100%)	15	(100%)	\$11.9	(100%)
Non-confined fire	380	(64%)	14	(93%)	\$11.9	(100%)
Confined fire	220	(36%)	1	(7%)	\$0.0	(0%)

Table 4. Structure Fires in Service or Gas Station Properties, by Area of Origin 2004-2008 Annual Averages

Area of Origin	Fires		Civilian	Civilian Injuries		Direct Property Damage (in Millions)		
Unclassified outside area	50	(9%)	2	(16%)	\$0.4	(3%)		
Non-confined fire	10	(2%)		2 (16%)	\$0.4	(3%)		
Confined fire	40	(7%)		0 (0%)	\$0.0	(0%)		
Kitchen or cooking area	50	(8%)	0	(2%)	\$0.3	(3%)		
Non-confined fire	10	(2%)	6) (2%)	\$0.3	(3%)		
Confined fire	40	(6%)	6) (0%)	\$0.0	(0%)		
Lavatory, bathroom, locker								
room or check room	50	(8%)	1	(5%)	\$0.3	(3%)		
Non-confined fire	30	(6%)	1	(5%)	\$0.3	(3%)		
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)		
Unclassified area of origin	40	(6%)	0	(0%)	\$1.6	(14%)		
Non-confined fire	10	(2%)	0	(0%)	\$1.6	(14%)		
Confined fire	30	(4%)	0	(0%)	\$0.0	(0%)		
Trash or rubbish chute, area or								
container	40	(6%)	1	(9%)	\$0.0	(0%)		
Non-confined fire	0	(0%)	0	()	\$0.0	(0%)		
Confined fire	30	(6%)	1	(7%)	\$0.0	(0%)		
Unclassified equipment or service area	30	(5%)	0	(2%)	\$0.6	(5%)		
	30 20	(3%)	0		\$0.0 \$0.6			
Non-confined fire		, ,		. ,		(5%)		
<i>Confined fire</i> Maintenance or paint shop or	10	(1%)	0	(0%)	\$0.0	(0%)		
area	30	(4%)	4	(26%)	\$1.0	(8%)		
Non-confined fire	20	(4%)	. 4		\$1.0	(8%)		
Confined fire	0	(1%)	0	. ,	\$0.0	(0%)		
Office	20	(4%)	1	(5%)	\$0.8	(7%)		
Non-confined fire	20	(3%)	1		\$0.8	(7%)		
Confined fire	0	(0%)	0		\$0.0	(0%)		
Exterior roof surface	20	(3%)	0	(0%)	\$0.3	(3%)		
Non-confined fire	20	(3%)	0		\$0.3	(3%)		
Confined fire	20	(1%)	0	. ,	\$0.0	(0%)		
Exterior wall surface	20	(3%)	0	(0%)	\$0.0	(0%)		
Non-confined fire	20	(3%)	0		\$0.0	(0%)		
Confined fire	0	(0%)	0		\$0.0	(0%)		
Storage room, area, tank, or bin	20	(3%)	0	(2%)	\$0.9	(8%)		
Non-confined fire	20	(3%)	0		\$0.9 \$0.9	(8%)		
Confined fire	20 0	(3%) (0%)	0		\$0.9 \$0.0	(0%)		
Conjinea jire	0	(0%)	0	(0%)	\$0.0	(0%)		

Table 4. Structure Fires in Service or Gas Station Properties, by Area of Origin 2004-2008 Annual Averages (Continued)

Area of Origin	Fir	es	Civilian Injuries		Direct Pro Damage (in	
Unclassified storage area	20	(3%)	0	(0%)	\$0.7	(6%)
Non-confined fire	10	(2%)	(\$0.7	(6%)
Confined fire	0	(1%)	() (0%)	\$0.0	(0%)
Awning	10	(2%)	0	(2%)	\$0.0	(0%)
Non-confined fire	10	(2%)	() (2%)	\$0.0	(0%)
Confined fire	0	(0%)	() (0%)	\$0.0	(0%)
Heating equipment room	10	(2%)	0	(2%)	\$0.0	(0%)
Non-confined fire	0	(1%)	(0 (2%)	\$0.0	(0%)
Confined fire	10	(2%)	(0 (0%)	\$0.0	(0%)
Garage or vehicle storage area	10	(2%)	0	(3%)	\$0.8	(7%)
Non-confined fire	10	(2%)		0 (3%)	\$0.8	(7%)
Confined fire	0	(0%)		0 (0%)	\$0.0	(0%)
On or near highway, public way						
or street	10	(2%)	0	(0%)	\$0.0	(0%)
Non-confined fire	0	(1%)		0 (0%)	\$0.0	(0%)
Confined fire	10	(2%)		0 (0%)	\$0.0	(0%)
Unclassified service facility	10	(2%)	0	(3%)	\$0.4	(3%)
Non-confined fire	10	(2%)		0 (3%)	\$0.4	(3%)
Confined fire	0	(0%)		0 (0%)	\$0.0	(0%)
Storage of supplies or tools or	10	(20)	0	(00)	\$6.2	(20)
dead storage	10	(2%)	0	(0%)	\$0.3	(2%)
Non-confined fire	10	(2%)		0 (0%)	\$0.3	(2%)
Confined fire	0	(0%)		0 (0%)	\$0.0	(0%)
Sales or showroom area	10	(2%)	0	(0%)	\$0.1	(1%)
Non-confined fire	10	(2%)		0 (0%)	\$0.1	(1%)
Confined fire	0	(0%)		0 (0%)	\$0.0	(0%)
Ceiling/floor assembly or concealed space	10	(2%)	0	(0%)	\$0.3	(2%)
Non-confined fire	10	(2%)		0 (0%)	\$0.3	(2%)
Confined fire	10 0	(170) (0%)		0 (0%) 0 (0%)	\$0.5 \$0.0	(276) (0%)
Engine area, running gear or	0	(0/0)		0 (070)	\$0.0	(070)
wheel area vehicle	10	(2%)	0	(0%)	\$0.1	(1%)
Non-confined fire	10	(2%)		0 (0%)	\$0.1	(1%)
Confined fire	0	(0%)		0 (0%)	\$0.0	(0%)
Attic or ceiling/roof assembly or		()		()		
concealed space	10	(2%)	0	(2%)	\$0.6	(5%)
Non-confined fire	10	(2%)		0 (2%)	\$0.6	(5%)
Confined fire	0	(0%)		0 (0%)	\$0.0	(0%)

Table 4. Structure Fires in Service or Gas Station Properties, by Area of Origin 2004-2008 Annual Averages (Continued)

Area of Origin	Fires	Civilian Injuries	Direct Property Damage (in Millions)
Wall assembly or concealed			
space	10 (2%)	0 (0%)	\$0.1 (1%)
Non-confined fire	10 (1%)	0 (0%)	\$0.1 (1%)
Confined fire	0 (0%)	0 (0%)	\$0.0 (0%)
Other known area of origin	100 (17%)	3 (20%)	\$2.2 (19%)
Non-confined fire	80 (13%)	3 (20%)	\$2.2 (19%)
Confined fire	30 (4%)	0 (0%)	\$0.0 (0%)
Total	600 (100%)	15 (100%)	\$11.9 (100%)
Non-confined fire	380 (64%)	14 (93%)	\$11.9 (100%)
Confined fire	220 (36%)	1 (7%)	\$0.0 (0%)

Table 5. Structure Fires in Service or Gas Station Properties, by Equipment Involved in Ignition 2004-2008 Annual Averages

Equipment Involved	Fir	es		ilian uries	Direct Property Damage (in Millions)	
Contained trash or rubbish fire	120	(19%)	1	(5%)	\$0.0	(0%)
No equipment involved	110	(18%)	7	(45%)	\$3.0	(25%)
Heating equipment	90	(15%)	0	(0%)	\$0.2	(2%)
Confined fuel burner or boiler fire	40	(7%)	0) (0%)	\$0.0	(0%)
Fixed or portable space heater	20	(4%)	0) (0%)	\$0.2	(2%)
Water heater	10	(1%)	0) (0%)	\$0.0	(0%)
Confined chimney or flue fire	10	(1%)	(0 (0%)	\$0.0	(0%)
Central heating equipment Other heating equipment in non-confined	10		C			(0%)
<i>fire</i> Electrical distribution and lighting	0	(0%)	0	0 (0%)	\$0.0	(0%)
equipment	70	(13%)	1	(9%)	\$0.2	(2%)
Lamp, bulb or lighting	50) (8%)	() (0%)	\$0.0	(0%)
Wiring and related equipment Other electrical distribution and lighting	30) (4%)	(0%)	\$0.1	(1%)
equipment in non-confined fire	0) (1%)	ļ	l (9%)	\$0.0	(0%)
Cooking equipment	60	(11%)	() (2%)	\$1.6	(14%)
Confined cooking fire	50) (8%)	() (2%)	\$0.0	(0%)
Portable cooking or warming equipment Other cooking equipment in non-confined	0	()		0 (0%)		
fire	10) (0%)		. ,
Shop tools and industrial equipment	50	(8%)	4	(28%)	\$2.6	(22%)
Torch, burner or soldering iron	20	()		2 (10%)		
Pump	10			2 (10%)		. ,
Air compressor	0	()		l (9%)		. ,
Power sander, grinder, buffer, polisher	0			$0 \qquad (0\%)$		
Motor - separate	0	()		$\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 $. ,
Other shop tools and industrial equipment	10	()		0 (0%)		. ,
Fan Clethes dever	40	(7%) (2%)	0	(0%)	\$0.2 \$0.1	(2%)
Clothes dryer Unclassified equipment involved in ignition	10 10	(2%)	2 0	(10%) (0%)	\$0.1 \$1.3	(1%)
Refrigerator, refrigerator/freezer	10	(2%) (2%)	0	(0%)	\$1.3 \$0.1	(11%) (1%)
Air conditioner	0	(2%)	0	(0%)	\$0.1 \$0.0	(1%) (0%)
Vending machine	0	(1%)	0	(0%)	\$0.0 \$0.2	(0%)
vending machine	0	(1%)	0	(0%)	\$0.2	(1%)
Other known equipment in non-confined fires	10	(2%)	0	(0%)	\$2.4	(20%)
Other confined fires defined by incident type	0	(1%)	0	(0%)	\$0.0	(0%)
Total	600	(100%)	15	(100%)	\$11.9	(100%)

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Table 5. Structure Fires in Service or Gas Station Properties, by Equipment Involved in Ignition 2004-2008 Annual Averages (Continued)

The estimates for equipment involved in ignition did not break out the confined fires further.

Note: Non-confined fires in which the equipment involved in ignition was unknown or not reported have been allocated proportionally among fires with known equipment involved. Fires in which the equipment involved in ignition was entered as none but the heat source indicated equipment involvement or the heat source was unknown were also treated as unknown and allocated proportionally among fires with known equipment involved. Non-confined fires in which the equipment was partially unclassified (i.e., unclassified kitchen or cooking equipment, unclassified heating, cooling or air condition equipment, etc.) were allocated proportionally among fires that grouping (kitchen or cooking equipment; heating, cooling or air conditioning equipment, etc.). Sums may not equal totals due to rounding errors.

Note: Sums may not equal totals due to rounding errors. Source: NFIRS 5.0 and NFPA survey.

Table 6. Structure Fires in Service or Gas Station Properties, by Factor Contributing to Ignition 2004-2008 Annual Averages

Factor Contributing to Ignition	F	ires	Civilian In	juries	Direct Property Damage (in Millions)		
Electrical failure or malfunction	150	(25%)	2 (1	1%)	\$3.9	(33%)	
Non-confined fire	140	(23%)	2	(11%)	\$3.9	(33%)	
Confined fire	20	(3%)	0	(0%)	\$0.0	(0%)	
Abandoned or discarded		. ,		. ,			
materials or products	90	(15%)	1 ((3%)	\$1.0	(8%)	
Non-confined fire	30	(4%)	1	(3%)	\$1.0	(8%)	
Confined fire	60	(11%)	0	(0%)	\$0.0	(0%)	
Mechanical failure or	- 0	<i></i>			* • •	(0)	
malfunction	70	(12%)		(7%)	\$1.1	(9%)	
Non-confined fire	50	(8%)	1	(7%)	\$1.1	(9%)	
Confined fire	20	(4%)	0	(0%)	\$0.0	(0%)	
Heat source too close to combustibles.	50	(90/)	3 (1	70()	\$2.2	(100/)	
	30 30	(8%)	5 (1 3	(17%)	\$2.2 \$2.2	(19%)	
Non-confined fire		(6%) (2%)		(17%)		(19%)	
<i>Confined fire</i> Unclassified misuse of material	10	(2%)	0	(0%)	\$0.0	(0%)	
or product, other	40	(6%)	1 ((3%)	\$0.3	(2%)	
Non-confined fire	20	(3%)	1	(3%)	\$0.3	(2%)	
Confined fire	20	(4%)	0	(0%)	\$0.0	(0%)	
Unclassified factor contributed	20	(170)	0	(0)0)	φ0.0	(070)	
to ignition	40	(6%)	1 ((8%)	\$0.6	(5%)	
Non-confined fire	20	(3%)	1	(8%)	\$0.6	(5%)	
Confined fire	20	(3%)	0	(0%)	\$0.0	(0%)	
Exposure fire	30	(5%)	0 ((0%)	\$0.3	(2%)	
Non-confined fire	30	(5%)	0	(0%)	\$0.3	(2%)	
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)	
Failure to clean	20	(4%)	0 ((0%)	\$0.1	(1%)	
Non-confined fire	10	(1%)	0	(0%)	\$0.1	(1%)	
Confined fire	20	(3%)	0	(0%)	\$0.0	(0%)	
Flammable liquid or gas spilled	20	(3%)	1 ((7%)	\$1.1	(10%)	
Non-confined fire	10	(2%)	1	(7%)	\$1.1	(10%)	
Confined fire	0		0	(0%)	\$0.0	(0%)	
Improper container or storage	10	(2%)		0%)	\$0.5	(5%)	
Non-confined fire	10	(1%)	2	(10%)	\$0.5	(5%)	
Confined fire	0	(1%)	0	(0%)	\$0.0	(0%)	
Cutting, welding too close to	0	(1/0)	0	(0/0)	$\psi 0.0$	(0/0)	
combustible	10	(2%)	1 ((4%)	\$1.6	(14%)	
Non-confined fire	10	(2%)	1	(4%)	\$1.6	(14%)	
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)	

Note: Sums may not equal totals due to rounding errors. Confined structure fires (NFIRS incident type 113-118) were analyzed separately from non-confined structure fires (incident type 110-129, except 113-118). See Appendix A for details.

Source: NFIRS 5.0 and NFPA survey.

Table 6. Structure Fires in Service or Gas Station Properties, by Factor Contributing to Ignition 2004-2008 Annual Averages (Continued)

Factor Contributing to Ignition	F	ïres	Civilian	Injuries		Property (in Millions)
Equipment unattended	10	(2%)	0	(0%)	\$0.0	(0%)
Non-confined fire	0	(1%)	0	(0%)	\$0.0	(0%)
Confined fire	10	(1%)	0	(0%)	\$0.0	(0%)
Outside/open fire for debris or						
waste disposal	10	(2%)	0	(0%)	\$0.0	(0%)
Non-confined fire	0	(0%)	0	(0%)	\$0.0	(0%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Playing with heat source	10	(2%)	1	(3%)	\$0.0	(0%)
Non-confined fire	0	(0%)	1	(3%)	\$0.0	(0%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Design deficiency	10	(2%)	0	(0%)	\$0.1	(1%)
Non-confined fire	0	(0%)	0	(0%)	\$0.1	(1%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Collision, knock down, run						
over, turn over	10	(2%)	0	(0%)	\$1.2	(10%)
Non-confined fire	10	(2%)	0	(0%)	\$1.2	(10%)
Confined fire	0	(0%)	0	(0%)	\$0.0	(0%)
Other factors contributing to non-confined fires Other factors contributing to	30	(6%)	5	(30%)	\$0.8	(7%)
confined fires	10	(2%)	0	(0%)	\$0.0	(0%)
Total Factors*	620	(104%)	16	(103%)	\$14.9	(125%)
Non-confined fire	400	(67%)	16	(103%)	\$14.9	(125%)
Confined fire	220	(37%)	0	(0%)	\$0.0	(0%)
Total Fires	600	(100%)	15	(100%)	\$11.9	(100%)
Non-confined fire	380	(64%)	14	(93%)	\$11.9	(100%)
Confined fire	220	(36%)	1	(7%)	\$0.0	(0%)

Note: Sums may not equal totals due to rounding errors. Confined structure fires (NFIRS incident type 113-118) were analyzed separately from non-confined structure fires (incident type 110-129, except 113-118). See Appendix A for details.

*More than one factor can be reported per fire

Source: NFIRS 5.0 and NFPA survey.

Table 7. Structure Fires in Service or Gas Station Properties, by Heat Source 2004-2008 Annual Averages

Heat Source	F	ïres	Civilian Injuries		Direct Property Damage (in Millions)	
Arcing	100	(16%)	2	(13%)	\$2.2	(18%)
Non-confined fire	90	(15%)	2	(13%)	\$2.2	(18%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Unclassified heat from powered equipment	80	(13%)	1	(9%)	\$1.2	(10%)
Non-confined fire	60	(10%)	1	(9%)	\$1.2	(10%)
Confined fire	20	(3%)	0	(0%)	\$0.0	(10%)
Smoking materials	60	(10%)	2	(11%)	\$0.2	(2%)
Non-confined fire	20	(3%)	- 1	(4%)	\$0.2	(2%)
Confined fire	40	(7%)	1	(7%)	\$0.2 \$0.0	(0%)
Spark, ember or flame from	40	(770)	1	(770)	φ0.0	(070)
operating equipment	60	(10%)	6	(38%)	\$2.0	(17%)
Non-confined fire	40	(7%)	6	(38%)	\$2.0	(17%)
Confined fire	20	(4%)	0	(0%)	\$0.0	(0%)
Radiated or conducted heat from						
operating equipment	60	(10%)	1	(4%)	\$0.6	(5%)
Non-confined fire	30	(5%)	1	(4%)	\$0.6	(5%)
Confined fire	30	(4%)	0	(0%)	\$0.0	(0%)
Unclassified heat source	50	(9%)	0	(0%)	\$1.5	(13%)
Non-confined fire	30	(5%)	0	(0%)	\$1.5	(13%)
Confined fire	30	(4%)	0	(0%)	\$0.0	(0%)
Hot ember or ash	40	(6%)	0	(0%)	\$0.2	(2%)
Non-confined fire	10	(2%)	0	(0%)	\$0.2	(2%)
Confined fire	20	(4%)	0	(0%)	\$0.0	(0%)
Unclassified hot or smoldering						
object	40	(6%)	1	(4%)	\$0.7	(6%)
Non-confined fire	20	(3%)	1	(4%)	\$0.7	(6%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Cigarette lighter	20	(4%)	0	(0%)	\$0.1	(1%)
Non-confined fire	10	(2%)	0	(0%)	\$0.1	(1%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Match	20	(3%)	0	(0%)	\$0.1	(1%)
Non-confined fire	10	(1%)	0	(0%)	\$0.1	(1%)
Confined fire	10	(2%)	0	(0%)	\$0.0	(0%)
Backfire from internal						
combustion engine	10	(2%)	0	(0%)	\$0.4	(4%)
Non-confined fire	0	(1%)	0	(0%)	\$0.4	(4%)
Confined fire	10	(1%)	0	(0%)	\$0.0	(0%)

Table 7. Structure Fires in Service or Gas Station Properties, by Heat Source 2004-2008 Annual Averages

Heat Source	Fires	Civilian Injuries	Direct Property Damage (in Millions)
Heat or spark from friction	10 (2%)	1 (4%)	\$0.3 (2%)
Non-confined fire	10 (2%)	1 (4%)	\$0.3 (2%)
Confined fire	0 (0%)	0 (0%)	\$0.0 (0%)
Other known heat sources in non-confined fire	50 (8%)	3 (17%)	\$2.5 (21%)
Other known heat sources in confined fire	10 (1%)	0 (0%)	\$0.0 (0%)
Total	600 (100%)	15 (100%)	\$11.9 (100%)
Non-confined fire	380 (64%)	14 (93%)	\$11.9 (100%)
Confined fire	220 (36%)	1 (7%)	\$0.0 (0%)

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Table 8. Structure Fires in Service or Gas Station Properties, by Cause of Ignition 2004-2008 Annual Averages

ause of Ignition	Fires	Civilian Injuries	Direct Property Damage (in Millions)
Unintentional	290 (49%)	11 (73%)	\$7.9 (66%)
Non-confined fire	170 (29%)	11 (73%)	\$7.9 (66%)
Confined fire	120 (19%)	0 (0%)	\$0.0 (0%)
Failure of equipment or heat source	180 (30%)	2 (12%)	\$1.8 (15%)
Non-confined fire	130 (22%)	2 (12%)	\$1.8 (15%)
Confined fire	40 (7%)	0 (0%)	\$0.0 (0%)
Intentional	70 (12%)	1 (8%)	\$1.6 (13%)
Non-confined fire	30 (6%)	1 (8%)	\$1.6 (13%)
Confined fire	40 (6%)	0 (0%)	\$0.0 (0%)
Unclassified cause	50 (9%)	0 (0%)	\$0.6 (5%)
Non-confined fire	30 (6%)	0 (0%)	\$0.6 (5%)
Confined fire	20 (3%)	0 (0%)	\$0.0 (0%)
Act of nature	0 (1%)	0 (0%)	\$0.0 (0%)
Non-confined fire	0 (1%)	0 (0%)	\$0.0 (0%)
Confined fire	0 (0%)	0 (0%)	\$0.0 (0%)
Total	600 (100%)	14 (93%)	\$11.9 (100%)

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Table 9. Vehicle Fires at Service or Gas Station Properties, by Factor Contributing to Ignition 2004-2008 Annual Averages

Factor Contributing to Ignition	Fi	res	Civilia	n Injuries	Dire Property I (in Mill	Damage
Mechanical failure or malfunction	1,630	(53%)	7	(26%)	\$3.3	(43%)
Electrical failure or malfunction	730	(24%)	2	(8%)	\$1.5	(19%)
Unclassified factor contributed to ignition	130	(4%)	3	(9%)	\$0.3	(4%)
Flammable liquid or gas spilled	110	(4%)	2	(8%)	\$0.6	(8%)
Heat source too close to combustibles	80	(3%)	2	(6%)	\$0.1	(2%)
Improper fueling technique	80	(3%)	5	(17%)	\$0.2	(2%)
Unclassified misuse of material or product	60	(2%)	3	(9%)	\$0.1	(1%)
Exposure fire	50	(2%)	1	(4%)	\$1.3	(17%)
Unclassified operational deficiency	50	(2%)	1	(2%)	\$0.1	(1%)
Other known factor contributing to ignition	250	(8%)	7	(22%)	\$0.7	(8%)
Total Fires	3,050	(100%)	29	(100%)	\$7.8	(100%)
Total Factors*	3,170	(104%)	32	(111%)	\$8.2	(105%)

Note: Sums may not equal totals due to rounding errors.

Source: NFIRS 5.0 and NFPA survey.

*More than one factor can be reported per fire

Table 10. Vehicle Fires at Service or Gas Station Properties, by Heat Source 2004-2008 Annual Averages

Heat Source	Fi	res	Civilian	Injuries	Dire Property (in Mil	Damage
Unclassified heat from powered equipment Radiated or conducted heat from operating	690	(23%)	3	(9%)	\$1.3	(16%)
equipment	630	(21%)	1	(4%)	\$1.5	(19%)
Arcing Spark, ember or flame from operating	540	(18%)	3	(11%)	\$1.2	(15%)
equipment	250	(8%)	9	(30%)	\$0.5	(6%)
Unclassified heat source	230	(8%)	1	(2%)	\$0.4	(5%)
Unclassified hot or smoldering object	200	(7%)	1	(3%)	\$1.3	(17%)
Heat or spark from friction	150	(5%)	1	(4%)	\$0.3	(4%)
Backfire from internal combustion engine	100	(3%)	2	(6%)	\$0.1	(2%)
Unclassified static discharge	90	(3%)	4	(15%)	\$0.1	(2%)
Other heat source	180	(6%)	5	(16%)	\$1.2	(15%)
Total	3,050	(100%)	29	(100%)	\$7.8	(100%)

Note: Sums may not equal totals due to rounding errors. Source: NFIRS 5.0 and NFPA survey.

Table 11. Vehicle Fires at Service or Gas Station Properties, by Item First Ignited 2004-2008 Annual Averages

Item First Ignited	Fire	es (Civilian	Injuries	Direc Property I (in Milli	Damage
Flammable liquid or gas	1,200	(39%)	24	(83%)	\$4.3	(55%)
Flammable liquid/gas (fuel) in or escaping						
from combustion engines.	740	(24%)		7 (23%	5) \$2.8	3 (36%)
Flammable liquid/gas, uncontained.	1.40	(50.0)		c	() ()	
Includes accelerants	140	(5%)		6 (20%	<i>\$0.3</i>	3 (4%)
Flammable liquid/gas in or escaping from						
container or pipe. Excludes engines,	140	(5%)		9 (29%	5) \$0. 7	7 (9%)
burners, and their fuel systems Flammable liquid/gas in or escaping from	140	(3%)		9 (29%)	ϕ) ϕ ().	(9%)
final container or pipe before engine or						
burner. Includes piping between the						
engine and the burner	80	(3%)		2 (8%	5) \$ <i>0</i> .4	4 (5%)
Liquids, piping, filters, other	70	(2%)		1 (2%	5) \$0.0	
Other flammable liquid or gas	30	(1%)		1 (2%	5) \$0. 1	! (1%)
Electrical wire or cable insulation	850	(28%)	1	(3%)	\$1.5	(19%)
Unclassified item first ignited	450	(15%)	1	(3%)	\$1.0	(12%)
Multiple items first ignited	110	(4%)	0	(0%)	\$0.4	(5%)
Tire	110	(4%)	1	(2%)	\$0.3	(4%)
Upholstered furniture or vehicle seat	60	(2%)	1	(2%)	\$0.1	(2%)
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Other item first ignited	260	(8%)	2	(5%)	\$0.2	(3%)
Total	3,050	(100%)	29	(100%)	\$7.8	(100%)

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Note: Sums may not equal totals due to rounding errors. Source: NFIRS 5.0 and NFPA survey.

Table 12. Vehicle Fires at Service or Gas Station Properties, by Type of Material First Ignited 2004-2008 Annual Averages

Type of Material First Ignited	Fi	res	Civiliar	n Injuries	Diro Property (in Mil	Damage
Gasoline	750	(24%)	18	(62%)	\$2.0	(25%)
Plastic	500	(16%)	1	(4%)	\$2.3	(30%)
Unclassified type of material first ignited Unclassified flammable or combustible	270	(9%)	0	(1%)	\$0.7	(8%)
liquid	240	(8%)	1	(4%)	\$0.4	(5%)
Multiple types of material	180	(6%)	2	(5%)	\$0.5	(6%)
Flammable gas, other	170	(6%)	1	(3%)	\$0.4	(5%)
Cooking oil, transformer or lubricating oil	160	(5%)	0	(0%)	\$0.1	(2%)
Rubber, excluding synthetic rubbers	100	(3%)	0	(0%)	\$0.1	(2%)
Fabric, fiber, cotton, blends, rayon, wool	70	(2%)	1	(2%)	\$0.1	(2%)
Material compounded with oil, other	60	(2%)	0	(0%)	\$0.1	(1%)
Other known type of material first ignited	170	(6%)	4	(13%)	\$0.5	(6%)
Not required	380	(12%)	1	(4%)	\$0.6	(8%)
Total	3,050	(100%)	29	(100%)	\$7.8	(100%)

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Note: Sums may not equal totals due to rounding errors. Source: NFIRS 5.0 and NFPA survey.

Table 13. Vehicle Fires at Service or Gas Station Properties, by Area of Origin 2004-2008 Annual Averages

Area of Origin	Fir	es	Civilian	Injuries	Dire Property I (in Mill	Damage
Engine area, running gear or wheel area vehicle	2,250	(74%)	8	(29%)	\$5.0	(64%)
Passenger area of vehicle	190	(6%)	4	(13%)	\$0.8	(10%)
Unclassified vehicle area	170	(6%)	3	(10%)	\$0.9	(11%)
Fuel tank or fuel line of vehicle	110	(4%)	7	(22%)	\$0.3	(4%)
Cargo or trunk area of vehicle	100	(3%)	3	(12%)	\$0.3	(4%)
Exterior surface of vehicle	80	(3%)	1	(5%)	\$0.3	(4%)
Unclassified area of origin	50	(2%)	0	(0%)	\$0.0	(1%)
Other area of origin	100	(3%)	3	(9%)	\$0.2	(3%)
Total	3,050	(100%)	29	(100%)	\$7.8	(100%)

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Note: Sums may not equal totals due to rounding errors Source: NFIRS 5.0 and NFPA survey.

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Table 14. Vehicle Fires at Service or Gas Station Properties, by Cause of Ignition 2004-2008 Annual Averages

Cause of Ignition	Fii	es	Civilian	Injuries	Dire Property I (in Mill	Damage
Unintentional	1,500	(49%)	19	(65%)	\$3.3	(42%)
Failure of equipment or heat source	1,330	(44%)	7	(22%)	\$2.5	(32%)
Unclassified cause	160	(5%)	2	(5%)	\$1.8	(24%)
Intentional	40	(1%)	1	(4%)	\$0.2	(2%)
Act of nature	20	(1%)	1	(4%)	\$0.0	(0%)
Total	3,050	(100%)	29	(100%)	\$7.8	(100%)

Note: Sums may not equal totals due to rounding errors Source: NFIRS 5.0 and NFPA survey.

Table 15. Outside and Other Fires (Excluding Outside Rubbish Fires) at Service or Gas Station Properties by Heat Source 2004-2008 Annual Averages

Heat Source	Fi	res	Civilian	Injuries	Diro Property (in Thou	Damage
Smoking materials	160	(21%)	0	(9%)	\$9	(1%)
Arcing	90	(12%)	1	(31%)	\$70	(12%)
Unclassified hot or smoldering object	70	(10%)	0	(0%)	\$6	(1%)
Hot ember or ash	70	(10%)	0	(0%)	\$0	(0%)
Unclassified heat source Spark, ember or flame from	60	(7%)	0	(0%)	\$66	(11%)
operating equipment Unclassified heat from powered	50	(7%)	0	(12%)	\$214	(36%)
equipment	50	(7%)	0	(13%)	\$26	(4%)
Unclassified static discharge	40	(5%)	0	(8%)	\$28	(5%)
Heat or spark from friction Radiated, conducted heat from	30	(4%)	0	(0%)	\$59	(10%)
operating equipment	30	(4%)	0	(0%)	\$49	(8%)
Cigarette lighter	20	(3%)	0	(13%)	\$6	(1%)
Lightning	10	(2%)	0	(0%)	\$9	(2%)
Other known heat source	70	(9%)	0	(13%)	\$47	(8%)
Total	770	(100%)	3	(100%)	\$589	(100%)

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Note: Sums may not equal totals due to rounding errors Source: NFIRS 5.0 and NFPA survey.

Table 16. Outside and Other Fires (Excluding Outside Rubbish Fires) at Service or Gas Station Properties by Type of Material First Ignited 2004-2008 Annual Averages

Type of Material First Ignited	Material First Ignited Fires		Civilian	Injuries	Direct Property Damag ries (in Thousands)		
Gasoline	240	(31%)	2	(61%)	\$363	(62%)	
Wood chips, sawdust, shavings	140	(19%)	0	(0%)	\$0	(0%)	
Natural product, other	80	(10%)	0	(0%)	\$4	(1%)	
Plastic	70	(10%)	0	(9%)	\$10	(2%)	
Type of material first ignited, other	50	(7%)	0	(10%)	\$94	(16%)	
Flammable gas, other	40	(5%)	0	(10%)	\$34	(6%)	
Wood pulp	20	(2%)	0	(0%)	\$0	(0%)	
Multiple types of material Fabric, fiber, cotton, blends, rayon,	10	(2%)	0	(0%)	\$17	(3%)	
wool	10	(2%)	0	(11%)	\$1	(0%)	
Other known type of material	100	(13%)	0	(0%)	\$65	(11%)	
Total	770	(100%)	3	(100%)	\$589	(100%)	

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Note: Sums may not equal totals due to rounding errors

Source: NFIRS 5.0 and NFPA survey.

Table 17. Outside and Other Fires (Excluding Outside Rubbish Fires) at Service or Gas Station Properties by Factor Contributing to Ignition 2004-2008 Annual Averages

Factor Contributing to Ignition	Fires		Civilian	Injuries	Direct Property Damage (in Thousands)	
Abandoned or discarded material or product	180	(24%)	0	(0%)	\$8	(1%)
Electrical failure or malfunction Collision, knock down, run over or	90	(12%)	1	(25%)	\$25	(4%)
turn over	70	(9%)	0	(0%)	\$331	(56%)
Other factor contributed to ignition	70	(9%)	0	(11%)	\$75	(13%)
Mechanical failure or malfunction	50	(7%)	0	(0%)	\$25	(4%)
Natural condition, other	40	(6%)	0	(0%)	\$13	(2%)
Improper fueling technique Unclassified misuse of material or	40	(5%)	0	(11%)	\$41	(7%)
product	40	(5%)	0	(0%)	\$13	(2%)
Flammable liquid or gas spilled Heat source too close to	30	(4%)	0	(14%)	\$85	(14%)
combustibles	20	(3%)	1	(28%)	\$1	(0%)
Exposure fire	20	(3%)	0	(0%)	\$44	(8%)
Storm	20	(2%)	0	(0%)	\$13	(2%)
Playing with heat source Cutting or welding too close to	20	(2%)	0	(11%)	\$4	(1%)
combustible Outside or open fire for debris or	10	(2%)	0	(0%)	\$0	(0%)
waste disposal	10	(2%)	0	(0%)	\$0	(0%)
Other known factors contributing to ignition	70	(9%)	0	(11%)	\$58	(10%)
Total Fires	770	(100%)	3	(100%)	\$589	(100%)
Total Factors*	800	(105%)	4	(110%)	\$738	(125%)

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Note: Sums may not equal totals due to rounding errors Source: NFIRS 5.0 and NFPA survey.

*More than one factor can be reported per fire

Table 18. Outside and Other Fires (Excluding Outside Rubbish Fires) at Service or Gas Station Properties by Equipment Involved in Ignition 2004-2008 Annual Averages

Equipment Involved	Fires		Civiliar	n Injuries	Direct Property Damage (in Thousands)		
No equipment involved	420	(55%)	2	(59%)	\$63	(11%)	
Electrical distribution and lighting equipment	100	(12%)	0	(11%)	\$40	(7%)	
Lamp, bulb or lighting	60) (8%))	0 (0%)	\$38	(7%)	
Wiring and related equipment	30) (4%))	0 (11%)	\$1	(0%)	
Transformers and power supplies	10) (1%))	0 (0%)	\$1	(0%)	
Unclassified equipment involved in ignition	70	(9%)	1	(16%)	\$226	(38%)	
Pump	60	(8%)	0	(0%)	\$216	(37%)	
Heating equipment	20	(2%)	0	(0%)	\$7	(1%)	
Water heater	10	0 (1%)	0 (0%)) \$2	(0%)	
Fixed or portable space heater	(0 (1%)	0 (0%) \$5	(1%)	
Vending machine	10	(2%)	0	(0%)	\$5	(1%)	
Torch, burner or soldering iron	10	(2%)	0	(0%)	\$0	(0%)	
Lawn mower	10	(1%)	0	(0%)	\$0	(0%)	
Radio	10	(1%)	0	(0%)	\$0	(0%)	
Video game - electronic	10	(1%)	0	(0%)	\$7	(1%)	
Wet/dry vacuum (shop vacuum)	0	(1%)	0	(0%)	\$0	(0%)	
Motor - separate	0	(1%)	0	(0%)	\$3	(1%)	
Other known equipment involved	40	(5%)	0	(15%)	\$22	(4%)	
Total	770	(100%)	3	(100%)	\$589	(100%)	

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Note: Sums may not equal totals due to rounding errors Source: NFIRS 5.0 and NFPA survey.

Table 19. Outside and Other Fires (Excluding Outside Rubbish Fires) at Service or Gas Station Properties by Cause of Ignition 2004-2008 Annual Averages

Cause of Ignition	Fir	es	Civilian	Injuries	Dire Property I (in Thou	Damage
Unintentional	520	(68%)	2	(72%)	\$466	(79%)
Failure of equipment or heat source	80	(11%)	1	(21%)	\$45	(8%)
Unclassified cause	70	(9%)	0	(0%)	\$47	(8%)
Intentional	50	(7%)	0	(8%)	\$21	(4%)
Act of nature	50	(6%)	0	(0%)	\$10	(2%)
Total	770	(100%)	3	(100%)	\$589	(100%)

Note: Sums may not equal totals due to rounding errors

Source: NFIRS 5.0 and NFPA survey.

Table 20.Outside Trash or Rubbish Fires at Service or Gas Station Properties
by Cause of Ignition
2004-2008 Annual Averages

Cause of Ignition	Fir	es	Property Damage (in Thousands)		
Unintentional	380	(63%)	\$4.7	(35%)	
Intentional	170	(29%)	\$8.4	(63%)	
Unclassified cause	40	(7%)	\$0.2	(1%)	
Failure of equipment or heat source	10	(1%)	\$0.2	(1%)	
Act of nature	0	(1%)	\$0.0	(0%)	
Total	600	(100%)	\$13.4	(100%)	

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Note: Sums may not equal totals due to rounding errors Source: NFIRS 5.0 and NFPA survey.

Appendix A. How National Estimates Statistics Are Calculated

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

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit <u>http://www.nfirs.fema.gov/</u>. Copies of the paper forms may be downloaded from http://www.nfirs.fema.gov/documentation/design/NFIRS Paper Forms 2008.pdf.

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

Methodology may change slightly from year to year.

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

NFPA's fire department experience survey provides estimates of the big picture.

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

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

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

Projecting NFIRS to National Estimates

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

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

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission developed the specific basic analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates. A copy of the article is available online at <u>www.nfpa.org/osds</u> or through NFPA's One-Stop Data Shop.

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

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

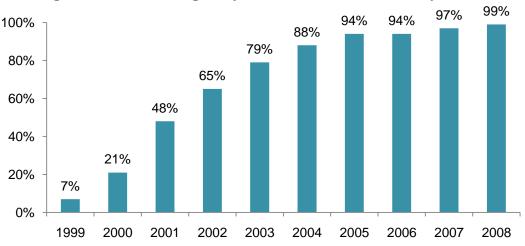


Figure A.1. Fires Originally Collected in NFIRS 5.0 by Year

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

<u>NFPA survey projections</u> NFIRS totals (Version 5.0)

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

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

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

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases. Some analyses, particularly those that examine cooking equipment, heating equipment, fires caused by smoking materials, and fires started by playing with fire, may examine the confined fires in greater detail. Because the confined fire incident types describe certain scenarios, the distribution of unknown data differs from that of all fires. Consequently, allocation of unknowns must be done separately. Table A.1 shows the breakdown of these fires. Figure A.1 shows the percentage of the different confined fires and of non-confined fires for all homes, one-and two-family homes (including manufactured homes), and apartments.

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Table A.1. Confined and Non-Confined Reported Structure Fires in Service Station or Gas Station properties 2004-2008 Annual Averages

Type of Fire	Fir	•es	-	ivilian Juries	Pr D	Direct operty amage Willions)	
All Confined Fires	220	(36%)	0 (7%	6) \$	0 (0%)
Contained trash or rubbish fire		120	(19%)	0	(5%)	\$0	(0%)
Confined cooking fire		50	(8%)	0	(2%)	\$0	(0%)
Confined fuel burner or boiler fire	е	40	(7%)	0	(0%)	\$0	(0%)
Confined chimney or flue fire		10	(1%)	0	(0%)	\$-	(0%)
Confined commercial compactor fire		0	(0%)	0	(0%)	\$0	(0%)
Confined incinerator overload or malfunction fire		0	(0%)	0	(0%)	\$0	(0%)
Non-Confined Fires	380	(64%) 0	(93%)	\$12	(100%)	
Total	600	(100%) 0	(100%)	\$12	(100%)	

Source: NFIRS 5.0 and NFPA survey.

Some analyses of structure fires show only non-confined fires. In these tables, percentages shown are of non-confined structure fires rather than all structure fires. This approach has the advantage of showing the frequency of specific factors in fire causes, but the disadvantage of possibly overstating the percentage of factors that are seldom seen in the confined fire incident types and of understating the factors specifically associated with the confined fire incident types.

Other analyses include entries for confined fire incident types in the causal tables and show percentages based on total structure fires. In these cases, the confined fire incident type is treated as a general causal factor.

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

In the formulas that follow, the term "all fires" refers to all fires in NFIRS on the dimension studied. The percentages of fires with known or unknown data are provided for non-confined fires and associated losses, and for confined fires only.

Cause of Ignition: This field is used chiefly to identify intentional fires. "Unintentional" in this field is a specific entry and does not include other fires that were not intentionally set: failure of equipment or heat source, act of nature, or "other" (unclassified)." The last should be used for exposures but has been used for other situations as well. Fires that were coded as under

investigation and those that were coded as undetermined after investigation were treated as unknown. For non-confined structure fires in office properties, the cause was known in 74% of the fires, 69% of the civilian injuries, and 53% of the direct property damage. For confined fires, the cause was known in 12% of the fires.

Factor Contributing to Ignition: In this field, the code "none" is treated as an unknown and allocated proportionally. For Human Factor Contributing to Ignition, NFPA enters a code for "not reported" when no factors are recorded. "Not reported" is treated as an unknown, but the code "none" is treated as a known code and not allocated. Multiple entries are allowed in both of these fields. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Although Factor Contributing to Ignition is only required when the cause of ignition was coded as: 2) unintentional, 3) failure of equipment or heat source; or 4) act of nature, data is often present when not required. Consequently, any fire in which no factor contributing to ignition was entered was treated as unknown.

In some analyses, all entries in the category of mechanical failure, malfunction (factor contributing to ignition 20-29) are combined and shown as one entry, "mechanical failure or malfunction." This category includes:

- 21. Automatic control failure;
- 22. Manual control failure;
- 23. Leak or break. Includes leaks or breaks from containers or pipes. Excludes operational deficiencies and spill mishaps;
- 25. Worn out;
- 26. Backfire. Excludes fires originating as a result of hot catalytic converters;
- 27. Improper fuel used; Includes the use of gasoline in a kerosene heater and the like; and
- 20. Mechanical failure or malfunction, other.

Entries in "electrical failure, malfunction" (factor contributing to ignition 30-39) may also be combined into one entry, "electrical failure or malfunction." This category includes:

- 31. Water-caused short circuit arc;
- 32. Short-circuit arc from mechanical damage;
- 33. Short-circuit arc from defective or worn insulation;
- 34. Unspecified short circuit arc;
- 35. Arc from faulty contact or broken connector, including broken power lines and loose connections;
- 36. Arc or spark from operating equipment, switch, or electric fence;
- 37. Fluorescent light ballast; and
- 30. Electrical failure or malfunction, other.

The factor contributing to ignition was coded as none, undetermined or left blank in 43% of the non-confined structure fires in office properties, 41% of the associated injuries, 61% of the associated direct property damage and 93% of the confined fires.

Heat Source. In NFIRS 5.0, one grouping of codes encompasses various types of open flames and smoking materials. In the past, these had been two separate groupings. A new code was added to NFIRS 5.0, which is code 60: "Heat from open flame or smoking material, other." NFPA treats this code as a partial unknown and allocates it proportionally across the codes in the

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61-69 range, shown below.

- 61. Cigarette;
- 62. Pipe or cigar;
- 63. Heat from undetermined smoking material;
- 64. Match;
- 65. Lighter: cigarette lighter, cigar lighter;
- 66. Candle;
- 67 Warning or road flare, fuse;
- 68. Backfire from internal combustion engine. Excludes flames and sparks from an exhaust system, (11); and
- 69. Flame/torch used for lighting. Includes gas light and gas-/liquid-fueled lantern.

In addition to the conventional allocation of missing and undetermined fires, NFPA multiplies fires with codes in the 61-69 range by

All fires in range 60-69 All fires in range 61-69

The downside of this approach is that heat sources that are truly a different type of open flame or smoking material are erroneously assigned to other categories. The grouping "smoking materials" includes codes 61-63 (cigarettes, pipes or cigars, and heat from undetermined smoking material, with a proportional share of the code 60s and true unknown data.

In non-confined structure fires in office properties, code 60: "heat from open flame or smoking material, other" was entered for 3% of the fires and 1% of the direct property damage and civilian injuries. The heat source was undetermined in 29% of the non-confined office property structure fires, 19% of the civilian injuries, and 56% of the direct property damage. The heat source was known in 11% of the confined fires, including less than 1% with heat source code 60.

Equipment Involved in Ignition (EII). NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment malfunctioned or was used improperly. In 2006, the definition was modified to "the piece of equipment that provided the principal heat source to cause ignition." However, much of the data predates the change. Individuals who have already been trained with the older definition may not change their practices. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

To allocate unknown data for EII, the known data is multiplied by

All fires	
(All fires – blank – undetermined – [fires in which EII =NNN and heat source <>40-99])	

In addition, the partially unclassified codes for broad equipment groupings (i.e., code 100 - heating, ventilation, and air conditioning, other; code 200 - electrical distribution, lighting and power transfer, other; etc.) were allocated proportionally across the individual code choices in their respective broad groupings (heating, ventilation, and air conditioning; electrical distribution, lighting and power transfer, other; etc.). Equipment that is totally unclassified is not allocated further. This approach has the same downside as the allocation of heat source 60 described above. Equipment that is truly different is erroneously assigned to other categories.

In some analyses, various types of equipment are grouped together.

Code Grouping Central heat	EII Code 132	NFIRS definitions Furnace or central heating unit
	133	Boiler (power, process or heating)
Fixed or portable space heater	131	Furnace, local heating unit, built-in
	123	Fireplace with insert or stove
	124	Heating stove
	141	Heater, excluding catalytic and oil-filled
	142	Catalytic heater
	143	Oil-filled heater
Fireplace or chimney	120	Fireplace or chimney
	121	Fireplace, masonry
	122	Fireplace, factory-built
	125	Chimney connector or vent connector
	126	Chimney – brick, stone or masonry
	127	Chimney-metal, including stovepipe or flue
Wiring, switch or outlet	210	Unclassified electrical wiring
	211	Electrical power or utility line
	212	Electrical service supply wires from utility
	214	Wiring from meter box to circuit breaker
	216	Electrical branch circuit
	217	Outlet, receptacle
	218	Wall switch
Power switch gear or overcurrent protection device	215	Panel board, switch board, circuit breaker board
	219	Ground fault interrupter
	222	Overcurrent, disconnect equipment
	227	Surge protector
Lamp, bulb or lighting	230	Unclassified lamp or lighting
	231	Lamp-tabletop, floor or desk
	232	Lantern or flashlight
	233	Incandescent lighting fixture
	234	Fluorescent light fixture or ballast
	235	Halogen light fixture or lamp
	236	Sodium or mercury vapor light fixture or lamp
	237	Work or trouble light
	238	Light bulb
	241	Nightlight
	242	Decorative lights – line voltage
	243	Decorative or landscape lighting – low
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	244	voltage Sign
Cord or plug	260	Unclassified cord or plug
	261	Power cord or plug, detachable from appliance
	262	Power cord or plug- permanently attached
	263	Extension cord
Torch, burner or soldering iron	331	Welding torch
	332	Cutting torch
	333	Burner, including Bunsen burners
	334	Soldering equipment
Portable cooking or warming equipment	631	Coffee maker or teapot
	632	Food warmer or hot plate
	633	Kettle
	634	Popcorn popper
	635	Pressure cooker or canner
	636	Slow cooker
	637	Toaster, toaster oven, counter-top broiler
	638	Waffle iron, griddle
	639	Wok, frying pan, skillet
	641	Breadmaking machine

The equipment involved in ignition was undetermined, not reported, or coded as no equipment with a heat source code outside the range of 40-99 (non-equipment related heat sources) in 76% of the non-confined fires, 65% of the injuries, 78% of the direct property damage. Equipment was not analyzed separately for confined fires. Instead, each confined fire incident type was listed with the equipment or as other known equipment.

Item First Ignited. In most analyses, mattress and pillows (item first ignited 31) and bedding, blankets, sheets, and comforters (item first ignited 32) are combined and shown as "mattresses and bedding." In many analyses, wearing apparel not on a person (code 34) and wearing apparel on a person (code 35) are combined and shown as "clothing." In some analyses, flammable and combustible liquids and gases, piping and filters (item first ignited 60-69) are combined and shown together. The item first ignited was undetermined or unreported in 30% of the non-confined structure fires, 23% of the associated injuries, 52% of the direct property damage, and in 88% of the confined structure fires.

Area of Origin. Two areas of origin: bedroom for more than five people (code 21) and bedroom for less than five people (code 22) are combined and shown as simply "bedroom." Chimney is no longer a valid area of origin code for non-confined fires. The area of origin was unknown or not reported in 8% of non-confined structure fires in Office properties, 6% of associated injuries, and 23% of the direct property damage. It was also unknown in 86% of confined fires excluding those confined to the chimney or flue which were all assumed to have begun in the chimney or flue.

Detection Equipment. Detection equipment presence was known in 75% of the non-confined fires and 3% of the non-confined fires.

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

In this analysis, when estimates were derived solely from the NFPA survey, fires were rounded to the nearest 500, civilian deaths were rounded to the nearest five, civilian injuries were rounded to the nearest 25, and direct property damage was rounded to the nearest million dollars. For estimates derived from NFIRS and the NFPA survey, fires were rounded to the nearest hundred, civilian deaths and injuries were rounded to the nearest ten, and direct property damage was rounded to the nearest million dollars.

Inflation. Property damage estimates are not adjusted for inflation unless so indicated. In this analysis, inflation adjusted damage estimates are provided in Table 1, 1A and 1B.

Appendix B Selected Published Incidents

The following are selected published incidents involving office properties. Included are short articles from the "Firewatch" or "Bi-monthly" columns in *NFPA Journal* or it predecessor *Fire Journal* and incidents from either the large-loss fires report or catastrophic fires report. If available, investigation reports or NFPA Alert Bulletins are included and provide detailed information about the fires.

It is important to remember that this is anecdotal information. Anecdotes show what can happen; they are not a source to learn about what typically occurs.

NFPA's Fire Incident Data Organization (FIDO) identifies significant fires through a clipping service, the Internet and other sources. Additional information is obtained from the fire service and federal and state agencies. FIDO is the source for articles published in the "Firewatch" column of the *NFPA Journal* and many of the articles in this report.

Fire Heavily Damages Convenience Store and Gas Station, Pennsylvania

After smelling something burning at a 24-hour convenience store/gas station, occupants discovered a fire near a walk-in cooler. Employees evacuated the store and shut off electrical power to the cooler and the fuel pumps before leaving. A passerby saw the fire and called 911 at 6:37 p.m.

The wooden-frame, single-story building measured 120 feet (36 meters) by 30 feet (9 meters). Exterior walls were wood framing over a concrete slab with wooden roof trusses creating a flat roof covered by a rubberized surface. The building did not have a fire detection system or sprinklers.

The fire burned 20 to 30 minutes before detection. It started in a wall where a 200-amp electrical service entered the building. An undetermined malfunction occurred within the electrical wiring and ignited structural wood-frame members behind the walk-in cooler. Flames spread vertically into the attic/roof void and externally through a large hole burned through the outside walls.

From 15 blocks away, heavy smoke could be seen coming from the store. Firefighters arrived within three minutes of the 911 call and observed fire coming from the left rear corner of the building. Smoke was pushing out of the façade but no other fire was visible. Two crews advancing hose lines into the building found little smoke or heat and quickly made it to the back of the store. Using a thermal imaging camera crews observed extreme fire involvement of the void space and upon pulling ceilings and applying water into the space, it had no effect and they retreated. Command ordered everyone from the building as roof crews reported the roof sagging as all crews were accounted for before commencing a defensive attack. Large master streams were used to control the fire, but the roof collapsed 10 minutes after arrival.

Valued at \$375,000 with contents of \$345,000, the building and contents were total losses. One firefighter received minor injury after being struck by a hose line.

Kenneth J. Tremblay, 2007, "Firewatch", NFPA Journal, September/October, 31-32.

Mississippi Date, Time of Alarm, Number of Deaths August, 1:00 a.m., Five

Setting: Service station; construction not reported, operating

Detection and Suppression Systems: Not reported.

Fire Origin and Path:

While a tanker truck operator was filling the service station's underground storage tanks, he removed the cap from a dipping lid to speed the process, inadvertently bypassing the normal venting and overfill protections. Nearly 750 gallons (2,839 liters) of gasoline spilled onto an adjacent road, where an undetermined source ignited it. The ensuing fire engulfed three vehicles. The tanker truck and a nearby restaurant suffered radiant heat damage.

Contributing Factors:

The five occupants of the three vehicles died when flames engulfed them. The two male victims were 58 and 18 years old, and the three female victims were 56, 40, and 20 years old.

Kenneth J. Tremblay, 1999, "The Catastrophic Fires of 1998" NFPA Journal, September/October 55.

Two Die in Garage Fire, Colorado

Two men died and two others were burned when gasoline vapors ignited a blaze in a garage where they were repairing a vehicle.

The single-story detached garage, which measured 28 by 20 feet, was constructed of concreteblock walls and a wood-framed roof covered with asphalt shingles. The building, which had been used for years as a shelter in which to paint vehicles, was insulated with cardboard. It didn't contain any detectors or sprinklers. At the time of the incident, the temperature was below freezing.

The four men had removed a partially filled fuel tank from a vehicle and emptied the gasoline into a bucket, spilling some in the process. They then installed a new fuel tank and used a garden hose to pour the gasoline from the bucket into the new tank. Without the proper equipment, however, they were unable to hold the tank's clapper valve open, and they spilled more gasoline, which mixed with melting snow and flowed down the sloped floor toward an operating, propane-fired space heater. The vapors ignited, and flames flashed back toward the men. Paint residue inside the garage further intensified the flames.

Two men, ages 20 and 26, died from their burns and from inhaling superheated gases. The other two sustained second-degree burns. Damage to the garage, valued at \$5,000, was estimated at \$2,000. The contents, valued at \$5,000, were a total loss.

Kenneth J. Tremblay, 1997, "Firewatch," NFPA Journal, January/February, 26.

Vehicle Accident Triggers Fuel Storage Fire, South Carolina

The 41-year-old driver of a pickup truck died when his vehicle careened off the roadway, struck the piping of two 4,000-gallon aboveground fuel storage tanks at a convenience store, and burst into flames.

The collision broke off the piping that conveyed gasoline from the tanks to the pumps in front of the store, and gasoline began pouring from the pipe. Somehow, the gasoline and the truck ignited, and the truck kept rolling into a nearby shed, where it came to rest, setting the shed on fire.

News accounts said that scores of firefighters converged on the scene and that they had the fire under control within 90 minutes, using foam as their primary extinguishing agent. The same accounts said that a private firm was called in to clean up the spill under the auspices of the appropriate state agency because the gasoline might present an environmental hazard.

Damage estimates were not available.

Kenneth J. Tremblay, 1991, "Firewatch," NFPA Journal, March/April, 32.

Wind Blows Extinguishment Away from Fire, Michigan

An automobile backed into three fuel pumps at this gas station and knocked them over, creating a spark that ignited the spilled gasoline. Fortunately, the emergency shut-off valves at the base of each gas pump functioned properly and shut down the flow of gasoline.

When the fire erupted, the dry-chemical fire extinguishing system that protected the service island activated, and the potassium bicarbonate was discharge through four nozzles. However, a 5- to 10-mile-per-hour breeze carried the extinguishing agent away from the area before it could completely quell the burning pool of fuel.

Fortunately, one of the service station crew had notified the fire department as soon as the fire began at 11:06 am. Firefighters arrived within five minutes and extinguished the blaze with a single hoseline.

No injuries were reported, and loss estimates were not available.

Kenneth J. Tremblay, 1989, "Firewatch," Fire Journal, July/August, 17.

Fast-Spreading Fire Destroys Building, Virginia

An accidental fire ripped through this three-bay gas station, completely destroying the structure. The building was of ordinary construction with a concrete floor, concrete-block walls, and a wood roof assembly covered with tar and gravel. It measured 75-feet long, 50-feet wide, and 15-feet high.

The volunteer fire department responded to the alarm four minutes after they received the telephone report at 12:37 pm, but the building was fully involved by the time they arrived, and they were unable to save it. The \$250,000 service station was deemed a total loss.

The fire started in the middle service bay where an employee was draining gasoline from the fuel tank of a vehicle he was repairing. Evidently, the gasoline vapors ignited, and the flames quickly spread throughout the service area. The employees used portable dry chemical extinguishers on the fire, but were unable to control it. The source of ignition was undetermined.

Kenneth J. Tremblay, 1989, "Firewatch," Fire Journal, January/February, 17-18.

Gasoline Used for Cleaning Kills Attendant, Illinois

A 21-year-old attendant cleaning the floor in the service bays of this gas station was killed when a flash fire engulfed the area. Another attendant and two by-standers were injured.

The one-story service station had concrete-block walls and measured 57 by 30 feet. It was equipped with portable fire extinguishers.

The fire occurred as three employees were preparing to close the station for the day. One was at the gas pumps servicing customers, while the other two started removing grease and oil from the service area floor using gasoline as a solvent. They had poured about two gallons onto the floor and had scrubbed the soiled areas with brooms for about seven or eight minutes when a flash fire swept through the building.

The fire department was notified of the fire at 5:10 pm by a home-based citizens' band radio operator who had received an emergency radio call from a passerby who witnessed the fire.

One of the men was able to escape from the building and was treated for first-and second-degree burns to his face and left hand. However, the other was found on the floor of the service area, burning. The ambulance attendant who was the first rescuer on the scene snuffed out the flames with a garden hose, and the victim was transported to the hospital, where he died the next morning. He had suffered second- and third-degree burns over his entire body. Two bystanders also suffered minor burns, but they did not require medical treatment.

The two men had reportedly been aware of the potential fire danger that the inappropriate use of gasoline as a solvent presented, and they had made sure that cigarette. They had also turned off all the electrical components in the area, including a compressor. Unfortunately, they forgot about the gas-fired water heater located at ground-level in a store room just five feet from the repair bay. Investigators believe that the fire began when the flammable gasoline vapors came in contact with the heater's pilot light.

Property damage amounted to an estimated \$5,000. The owner of the station was fined by the Occupational Safety and Health Administration for safety violations.

Kenneth J. Tremblay, 1987, "Firewatch," Fire Journal, November/December, 19.

Spark Ignites Gasoline Vapors, Florida

A potentially dangerous fire erupted early one morning when a spark ignited gasoline being delivered to this combination gas station and convenience store.

A 9,050-gallon-capacity gasoline tank truck was filling the store's underground storage tanks when the fire began. Apparently, the driver of the truck leaned against its exterior metal battery

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box, causing the battery terminals to come in contact with the top of the box. This resulted in an electrical arc, which ignited the gasoline vapor present in the atmosphere around the truck. The driver immediately closed the emergency shut-off valves, and fire officials credit his prompt action with helping reduce the potential for disaster.

Firefighters responding to the fire at 7:47 am noticed flames licking at the underside of the tanker and at the underground tanks fill connections. Evidently, heat from the fire had damaged the gaskets in the tankers valve assembly, and leaking gasoline was fueling the fire. Firefighters called for the fire districts hazardous materials unit, then began advancing a 30-inch hoseline equipped with a fog nozzle toward the tanker.

When they had effectively controlled the blaze, the firefighters manually closed the tankers valves and allowed members of the haz-mat unit to apply absorbent materials to the runoff gasoline.

Once the situation was declared under control, the remaining 1,800 gallons of fuel were unloaded under the watchful eye of the fire department, and the proper environmental agencies were asked to investigate the impact of the gasoline on the soil and groundwater in the area.

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No one was hurt in the fire, and damages were considered to be minor.

Kenneth J. Tremblay, 1987, "Firewatch," Fire Journal, May/June, 22.