Computer and Computer Peripheral Fires with a Discussion of Batteries

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Abstract

During 1999-2003, computers and computer peripherals were involved in an estimated average of 360 reported structure fires per year, resulting in an annual average of nine civilian injuries and $16.6 million in direct property damage. Some type of short circuit arc, electrical failure or malfunction factored in 69% of these incidents. The U.S. Consumer Product Safety Commission (CPSC) has issued a number of recalls for computers, computer batteries and computer peripherals. The CPSC also issued a warning that household batteries can cause burns. The National Transportation Safety Board's (NTSB's) public hearing on a February 7, 2006 United Parcel Service airplane fire included a panel on the design, testing, and failure modes of lithium-ion batteries. The Federal Aviation Administration provided a list of aviation incidents involving a wide variety of battery types. The Institute of Electrical and Electronics Engineers (IEEE) has issued new standards for batteries for mobile computers and cell phones.

Keywords: fire statistics, computer fires, battery, computer batteries

Acknowledgements

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

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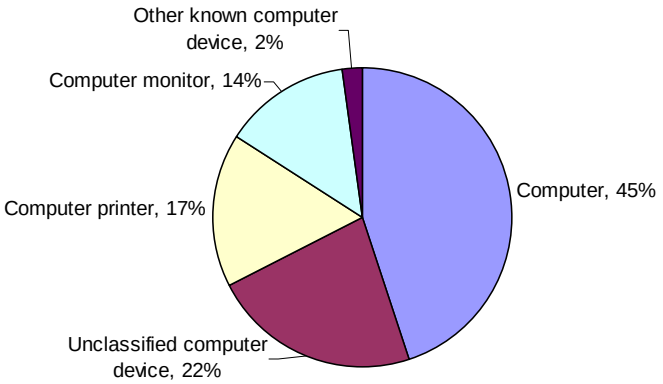
Computer and Computer Peripheral Fires with a Discussion of Batteries

Computers or related equipment were involved in an average of one reported structure fire a day in 1999-2003.

The two August 2006 announcements of voluntary recalls of 3.8 million notebook computer battery packs in the United States (and 2.1 million sold abroad) because of the possibility of overheating,[1,2] caused some interest in the number of fires in which computers and computer peripherals were involved. NFPA estimates that during 1999-2003, such equipment was involved in an annual average of 360 structure fires reported to U.S. fire departments. These fires resulted in an estimated average of nine civilian (non-firefighter) injuries and $16.6 million in direct property damage per year. No deaths from these fires were reported. These fires accounted for only 0.1% of the reported structure fires and associated injuries, and 0.2% of the direct property damage from structure fires. The statistics in this analysis are national estimates derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS), and the National Fire Protection Association's (NFPA's) annual fire department experience survey. Only Version 5.0 NFIRS data were used in this analysis.

The national fire data can identify categories of equipment but generally not specific parts of the equipment. (When cords or plugs, batteries, or battery chargers are listed as the equipment involved in ignition, information is not collected about the type of equipment these components support.) Figure 1 and Table 1 show that computers were involved in 45% of the computer-related structure fires, printers in 17%, and monitors in 14%.

Figure 1.
Types of Computer Equipment Involved in Non-Confined Structure Fires
1999-2003 Annual Averages



More than two thirds (69%) of the computer equipment fires were caused by the failure of the equipment or heat source. (See Table 2.) Table 3 shows that some type of short circuit arc, electrical failure or malfunction contributed to 69% of these ignitions. Unclassified mechanical failures or malfunctions were factors in 18%. The equipment or heat source was too close to combustibles in 4% of these incidents.

In 39% of these fires, the item first ignited was electrical wire or cable insulation. Appliance housing or casings were first ignited in 23%; unclassified items in 12%; and cabinetry, including built in cabinetry, in 5% of these incidents. (See Table 4.)

Not surprisingly, the heat sources in most of these ignitions came from equipment. In 45% of the fires, unclassified heat from powered equipment was the heat source; arcing provided the heat in 23%; heat was radiated or conducted from operating equipment in 15%; and sparks, embers or flames from operating equipment were the heat sources in 5%. Candles provided the heat in 4% of the fires. (See Table 5.)

Flame damage was confined to the object of origin in 43% of these fires. In an additional 40%, the flame damage was confined to the room where the fire began. Flame damage spread beyond the room of origin in only 17% of the fires. (See Table 6.)

As of 2001, 60 million U.S. households have personal computers. According to the U.S. Census Bureau, 60 million, or 56%, of the 107 million U.S. households possess and use personal computers.[3] Consequently, it is not surprising that 50% of the computer equipment fires occurred in one- and two-family dwellings and 9% occurred in apartments. Twelve percent occurred in banks, post offices or business offices, 3% occurred in elementary, middle or high schools, and 3% occurred in manufacturing or processing properties. (See Table 7.)

Roughly one of every five computer equipment fires originated in a bedroom. Table 8 shows that only 32% of computer equipment fires started in offices and 9% began in computer or control rooms or centers. Eighteen percent began in bedrooms and 9% started in living rooms, family rooms, dens or common rooms.

CPSC issued other recalls for computers, computer batteries and peripherals. The August 2006 recalls, mentioned earlier, were just two of many recalls of computer-equipment in recent years. The U.S. Consumer Product Safety Commission (CPSC) and various computer companies have issued nine[4-12] other recalls of computer batteries since January 1999. The risk of fire was a factor in all of these recalls.

Other types of computer-related equipment, including AC adapters,[13-15] modem power supplies,[16] computers,[17] laser printers,[18-20] monitors,[21-22] storage devices,[23] and networking cables and connections[24-25] were also recalled or retrofitted due to the risk of fire, fire spread, burns, or electrical shock.

Batteries fires are also a concern in aviation. On July 12-13, 2006, the National Transportation Board (NTSB) conducted a public hearing about a February 7, 2006 United Parcel Service Airline Flight 1307 fire at Philadelphia International Airport.[26] One panel addressed the design, testing and failure modes of lithium batteries. Jason Howard provided an overview of lithium-ion technology.[27] Rechargeable Li-ion batteries were first commercialized in 1991. He referenced H. Takeshita's estimate that more than 2 billion of these cells will be produced

for portable applications in 2006, with roughly 55% used in mobile telephones, 25% in notebook computers, and 20% in other electronic equipment. Howard reported that thermal runaway, "a sudden, rapid increase in cell temperature and pressure" could result from an overcharged unit, an excessively hot environment, or internal or external short circuits. The Federal Aviation Administration entered a list of aviations incidents involving batteries and battery-powered devices into the exhibits.[28] These incidents involved a wide variety of battery types, including lithium-ion, nickel metal hydride (NIMH), AA or AAA, C- and DD-cells, 9-volts and others.

CPSC recalled batteries for other purposes.
The CPSC has also issued recalls for a wide variety of batteries, battery packs and battery chargers for other purposes, including cell phones and other electronic products, toys, and tools. At the same time portable products have become smaller, industry has tried to reduce the size and weight of the batteries while increasing operating times. This has resulted in smaller, but higher energy batteries.[29] Many electronic devices today are not completely "off" even when turned off. A small amount of energy is consumed to maintain memory settings, time, etc. State of the art batteries, packing more energy storage capacity in a smaller volume, i.e. increased energy density (in Joules/m^3) get hotter faster in the event of a catastrophic failure. Standards for these batteries are relatively new. In a presentation on battery safety and recalls given at the July 2006 NTSB hearing, CPSC's Richard Stern divided the reasons for battery recalls (all types of batteries into two groups: design problems and quality control problems. Batteries with design problems tended to lack safety circuits, adequate overcharge protection or physical protection. Quality control problems included improper placement of leads, contaminants in the cell, and uneven forming of the cell.[30]

The IEEE issued standards for batteries for mobile computers and cell phones
In March, 2004, the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standards board approved the Livium™ mobile computer battery standard (also known as IEEE 1625™ "Standard for Rechargeable Batteries for Mobile Computers."[31] The IEEE Livium™ 1725, "Standard for Rechargeable Batteries for Cellular Telephones" was issued in April 2006.[32]

CPSC warned consumers that household batteries can cause burns.
According to the CPSC, household batteries can overheat and rupture when someone attempts to recharge a non-rechargeable battery or uses the wrong charger, when batteries are installed backwards, when old and new batteries are used together, or when alkaline and carbon-zinc batteries are used together. CPSC estimates that roughly 3,700 people are treated for battery-related chemical burns at hospital emergency rooms each year.[33]

Report unsafe consumer products to the CPSC.
The CPSC is the regulatory body that can issue recalls of unsafe consumer products (excluding vehicles, car seats, food, medicine, cosmetics and medical devices). Unsafe products may be reported on their website, http://www.cpsc.gov/. The same site provides details on product recalls.

Table 1.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Type of Equipment Involved
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Equipment Involved	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Computer	160	(45%)	0	(NA)	5	(55%)	$10.9	(66%)
Unclassified computer device	80	(22%)	0	(NA)	2	(23%)	$2.9	(18%)
Computer printer	60	(17%)	0	(NA)	2	(23%)	$0.8	(5%)
Computer monitor	50	(14%)	0	(NA)	0	(0%)	$1.9	(11%)
Other known computer device	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719). Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Sums may not equal totals due to rounding errors. Property damage has not been adjusted for inflation.

National estimates are projections. The Appendix describes how the initial scaling ratios are obtained by comparing the NFIRS totals to the estimated totals from NFPA's annual fire department experience survey and then applied to the NFIRS data. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire

An initial query was done to obtain all equipment involved types for non-confined structure fires originally collected in Version 5.0 only. Percents of the NFIRS 5.0 computer equipment fires were calculated for each type of equipment. The fires and associated losses with unknown or unreported equipment involved were allocated proportionally across fires with known equipment. The adjusted percents were then applied to the estimated total non-confined structure years for this period to develop national estimates.

Source: NFIRS and NFPA survey.

Table 2.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Cause
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Cause	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Failure of equipment or heat source	250	(69%)	0	(NA)	9	(100%)	$6.6	(40%)
Unintentional	90	(26%)	0	(NA)	0	(0%)	$10.0	(60%)
Act of nature	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Unclassified cause	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Intentional	0	(1%)	0	(NA)	0	(0%)	$0.0	(0%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Sums may not equal totals due to rounding errors. Property damage has not been adjusted for inflation.

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Source: NFIRS and NFPA survey.

Table 3.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Factor Contributing to Ignition
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Short circuit arc, electrical failure or malfunction, or arc or spark from operating equipment	250	(69%)	0	(NA)	4	(50%)	$6.3	(38%)
Unclassified mechanical failure or malfunction	70	(18%)	0	(NA)	4	(50%)	$10.1	(61%)
Heat source too close to combustibles	20	(4%)	0	(NA)	0	(0%)	$0.4	(2%)
Unclassified misuse of material or product	10	(4%)	0	(NA)	0	(0%)	$0.0	(0%)
Equipment not being operated properly	10	(3%)	0	(NA)	0	(0%)	$0.1	(1%)
Abandoned or discarded material or product	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Equipment overloaded	10	(2%)	0	(NA)	0	(0%)	$0.1	(0%)
Unintentionally turned on or not turned off	10	(2%)	0	(NA)	0	(0%)	$0.1	(0%)
Other known factor contributing	30	(7%)	0	(NA)	0	(0%)	$0.2	(1%)
Total*	360		0	(NA)	9		$16.6	

* Factors contributing to ignition can have multiple entries, which is why total entries can exceed total fires.

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation.

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Source: NFIRS and NFPA survey.

Table 4.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Item First Ignited
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical wire or cable insulation	140	(39%)	0	(NA)	3	(38%)	$1.9	(12%)
Appliance housing or casing	80	(23%)	0	(NA)	0	(0%)	$4.1	(25%)
Unclassified item	40	(12%)	0	(NA)	3	(31%)	$0.1	(0%)
Cabinetry, including built-in	20	(5%)	0	(NA)	0	(0%)	$8.4	(51%)
Multiple items first ignited	10	(3%)	0	(NA)	0	(0%)	$0.2	(1%)
Magazine, newspaper, writing paper or files	10	(3%)	0	(NA)	0	(0%)	$0.1	(1%)
Floor covering, rug, carpet, or mat	10	(3%)	0	(NA)	0	(0%)	$0.1	(0%)
Other known item first ignited	50	(13%)	0	(NA)	3	(31%)	$1.7	(10%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation.

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An initial query was done to obtain all equipment involved types for non-confined structure fires originally collected in Version 5.0 only. Percents of the NFIRS 5.0 computer equipment fires were calculated for each type of equipment. The fires and associated losses with unknown or unreported equipment involved were allocated proportionally across fires with known equipment. The adjusted percents were then applied to the estimated total non-confined structure years for this period to develop national estimates. Computer equipment fires in which the item first ignited was unknown or not reported were allocated proportionally among computer equipment fires of known item first ignited.

Source: NFIRS and NFPA survey.

Table 5.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Heat Source
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Heat Source	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified heat from powered equipment	160	(45%)	0	(NA)	6	(69%)	$10.1	(61%)
Arcing	80	(23%)	0	(NA)	3	(31%)	$1.3	(8%)
Radiated or conducted heat from operating equipment	60	(15%)	0	(NA)	0	(0%)	$4.1	(24%)
Spark, ember, or flame from operating equipment	20	(5%)	0	(NA)	0	(0%)	$0.5	(3%)
Candle	20	(4%)	0	(NA)	0	(0%)	$0.3	(2%)
Unclassified heat source	10	(2%)	0	(NA)	0	(0%)	$0.1	(1%)
Other known heat source	20	(5%)	0	(NA)	0	(0%)	$0.1	(1%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation.

National estimates are projections. The Appendix describes how the initial scaling ratios are obtained by comparing the NFIRS totals to the estimated totals from NFPA's annual fire department experience survey and then applied to the NFIRS data. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire.

An initial query was done to obtain all equipment involved types for non-confined structure fires originally collected in Version 5.0 only. Percents of the NFIRS 5.0 computer equipment fires were calculated for each type of equipment. The fires and associated losses with unknown or unreported equipment involved were allocated proportionally across fires with known equipment. The adjusted percents were then applied to the estimated total non-confined structure years for this period to develop national estimates. Computer equipment fires in which the heat source was unknown or not reported were allocated proportionally among computer equipment fires of known heat source.

Source: NFIRS and NFPA survey.

Table 6.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Extent of Flame Damage
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Extent of Flame Damage	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Confined to object of origin	150	(43%)	0	(NA)	4	(50%)	$0.4	(2%)
Confined to room of origin	150	(40%)	0	(NA)	2	(27%)	$12.0	(72%)
Confined to floor of origin	20	(5%)	0	(NA)	0	(0%)	$0.8	(5%)
Confined to building of origin	40	(10%)	0	(NA)	2	(23%)	$2.1	(13%)
Extended beyond building of origin	10	(2%)	0	(NA)	0	(0%)	$1.3	(8%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation.

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An initial query was done to obtain all equipment involved types for non-confined structure fires originally collected in Version 5.0 only. Percents of the NFIRS 5.0 computer equipment fires were calculated for each type of equipment. The fires and associated losses with unknown or unreported equipment involved were allocated proportionally across fires with known equipment. The adjusted percents were then applied to the estimated total non-confined structure years for this period to develop national estimates.

Source: NFIRS and NFPA survey.

Table 7.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Property Use or Occupancy
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Property Use or Occupancy	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
One- or two-family dwelling	180	(50%)	0	(NA)	7	(77%)	$4.0	(24%)
Bank, post office, or business office	40	(12%)	0	(NA)	0	(0%)	$0.1	(1%)
Apartment	30	(9%)	0	(NA)	2	(23%)	$1.5	(9%)
Elementary, middle or high school	10	(3%)	0	(NA)	0	(0%)	$0.1	(1%)
Manufacturing or processing	10	(3%)	0	(NA)	0	(0%)	$0.1	(1%)
Hospital or hospice	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Grocery or convenience store	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Personal service, recreational, or home repair store	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Mental retardation or substance abuse center	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Other known property use	50	(14%)	0	(NA)	0	(0%)	$4.0	(24%)
Undetermined or unclassified property use	0	(1%)	0	(NA)	0	(0%)	$6.7	(41%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation.

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An initial query was done to obtain all equipment involved types for non-confined structure fires originally collected in Version 5.0 only. Percents of the NFIRS 5.0 computer equipment fires were calculated for each type of equipment. The fires and associated losses with unknown or unreported equipment involved were allocated proportionally across fires with known equipment. The adjusted percents were then applied to the estimated total non-confined structure years for this period to develop national estimates.

Source: NFIRS and NFPA survey.

Table 8.
Non-Confined Structure Fires
in which Computer Equipment Was Involved in the Ignition,
by Area of Origin
1999-2003 Annual Averages
(Percents Based Only on Fires Reported in NFIRS Version 5.0)

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Office	110	(32%)	0	(NA)	2	(27%)	$8.4	(51%)
Bedroom	70	(18%)	0	(NA)	4	(50%)	$2.0	(12%)
Living room, family room, den, or common room	30	(9%)	0	(NA)	2	(23%)	$1.3	(8%)
Computer room or control room or center	30	(9%)	0	(NA)	0	(0%)	$0.3	(2%)
Unclassified function area	30	(7%)	0	(NA)	0	(0%)	$0.2	(1%)
Classroom or assembly area for less than 100 people	10	(3%)	0	(NA)	0	(0%)	$0.0	(0%)
Unclassified technical processing area	10	(2%)	0	(NA)	0	(0%)	$0.2	(1%)
Laboratory	10	(2%)	0	(NA)	0	(0%)	$3.3	(20%)
Kitchen	10	(2%)	0	(NA)	0	(0%)	$0.1	(1%)
Unclassified equipment or service area	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Processing or manufacturing area or workroom	10	(2%)	0	(NA)	0	(0%)	$0.1	(0%)
Substructure area or crawl space	10	(2%)	0	(NA)	0	(0%)	$0.2	(1%)
Sales area or showroom	10	(2%)	0	(NA)	0	(0%)	$0.0	(0%)
Other known area	30	(8%)	0	(NA)	0	(0%)	$0.4	(2%)
Total	360	(100%)	0	(NA)	9	(100%)	$16.6	(100%)

NA – Not applicable because no cases were reported with the cited characteristic known.

Note: This table shows the estimated number of non-confined structure fires (incident type 110-129, except 113-118) in which computer equipment was involved in ignition (equipment involved 710-719) by cause. Fires are rounded to the nearest ten, civilian deaths, and civilian injuries are rounded to the nearest one; direct property damage is rounded to the nearest hundred thousand dollars. Property damage has not been adjusted for inflation.

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An initial query was done to obtain all equipment involved types for non-confined structure fires originally collected in Version 5.0 only. Percents of the 132 NFIRS 5.0 computer equipment fires were calculated for each type of equipment. The fires and associated losses with unknown or unreported equipment involved were allocated proportionally across fires with known equipment. The adjusted percents were then applied to the estimated total non-confined structure years for this period to develop national estimates.

Source: NFIRS and NFPA survey.

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Appendix A.
How National Estimates Statistics Are Calculated

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

Databases Used

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

The strength of NFIRS is that it provides the most detailed incident information of any national 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. (The NFPA survey separates fewer than 20 of the hundreds of property use categories defined by NFPA 901 and solicits no cause-related information except for incendiary and suspicious fires.) NFIRS also captures information on the avenues and extent of flame spread and smoke spread and on the performance of detectors and sprinklers. For more information about NFIRS visit http://www.usfa.fema.gov/nfirs.

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

The NFPA survey begins with the NFPA Fire Service Inventory, a computerized file of about 30,000 U.S. fire departments, which is the most complete and thoroughly validated such listing in existence. The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural

communities protect fewer people per department and are less likely to respond to the survey, so a large number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate. The results of the survey are published in the annual report Fire Loss in the United States. To download a free copy of the report visit http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.

Projecting NFIRS to National Estimates

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

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

For example, the scaling ratio for 2002 civilian deaths in residential structures is equal to the total number of 2002 civilian deaths in residential structure fires reported to fire departments, according to the NFPA survey (2,695), divided by the total number of 2002 civilian deaths in residential structure fires reported to NFIRS (1,029). Therefore, the scaling ratio is 2,695/1,029 = 2.62.

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

community, resulting in severity-per-fire ratios characteristic only of the oversampled regions or community sizes.

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

Calculating National Estimates of Particular Types of Fires

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

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

Consequently, most national estimates analyses allocate unknowns. This is done by using scaling ratios defined by NFPA survey estimates of totals divided by only those NFIRS fires for which the dimension in question was known and reported. This approach is equivalent to assuming that the fires with unreported characteristics, if known, would show the same proportions as the fires with known characteristics. For example, it assumes that the fires with unknown item first ignited contain the same relative share of fires beginning with: cooking materials or food; rubbish, trash or waste; upholstered furniture; structural members or framing; and so forth, as are found in the fires where the item first ignited was reported.

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