FIREFIGHTER FATALITIES IN THE UNITED STATES – 2009

and

U.S. FIRE SERVICE FATALITIES IN STRUCTURE FIRES, 1977-2009

National Fire Protection Association
Fire Analysis and Research Division

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June 2010

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Abstract

In 2009, a total of 82 on-duty firefighter deaths occurred in the U.S. This is a sharp drop from the 105 on-duty deaths that occurred in the U.S. in 2008, and the lowest annual total since 79 deaths in 1993. The largest share of deaths occurred while firefighters were operating on the fire ground (27 deaths). Stress, exertion, and other medical-related issues, which usually result in heart attacks or other sudden cardiac events, continued to account for the largest number of fatalities. Of the 44 exertion- or medical-related fatalities in 2009, 35 were classified as sudden cardiac deaths and five were due to strokes.

Keywords: Firefighter fatality, statistics, heart attack, sudden cardiac death

Acknowledgements

This study is made possible by the cooperation and assistance of the United States fire service, the Public Safety Officers' Benefits Program of the Department of Justice, CDC's National Institute for Occupational Safety and Health, the United States Fire Administration, the Forest Service of the U.S. Department of Agriculture, and the Bureau of Indian Affairs and the Bureau of Land Management of the U.S. Department of the Interior. The authors would also like to thank Carl E. Peterson, recently retired from NFPA's Public Fire Protection Division, and Thomas Hales, MD, MPH, of CDC-NIOSH, for their assistance on the study.

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NFPA No. FFD09

2009 Experience

In 2009, a total of 82 on-duty firefighter deaths occurred in the U.S. This is a sharp drop from the 105 on-duty deaths that occurred in the U.S. in 2008, and the lowest annual total since 79 deaths in 1993.[1] The average number of deaths annually over the past 10 years is 98. Figure 1 shows firefighter deaths for the years 1977 through 2009, excluding the 340 firefighter deaths at the World Trade Center in 2001.

Of the 82 firefighters who died while on duty in 2009, 41 were volunteer firefighters, 31 were career firefighters, four were employees of federal land management agencies, four were contractors with federal land management agencies, one was an employee of a state land management agency, and one was a member of a race track fire safety crew.[2]

In 2009, there were six multiple-fatality incidents. Three firefighters were killed when their aircraft crashed while they were traveling to a wildland fire. The other five multiple-fatality incidents were all double-fatality cases. Two firefighters fell from an aerial platform while training. Two firefighters were killed when their apparatus crashed while they were operating on a wildland fire. The other six firefighters were killed during interior operations at three structure fires. More details will be presented throughout this report.

Analyses in this report examine the types of duty associated with firefighter deaths, the cause and nature of fatal injuries to firefighters, and the ages of the firefighters who died. They highlight deaths in intentionally-set fires and in motor vehicle-related incidents.[3] A 10-year analysis showing trends in deaths while operating inside structure fires is included. Finally, the study presents summaries of individual incidents that illustrate important problems or concerns in firefighter safety.

Introduction

Each year, NFPA collects data on all firefighter fatalities in the U.S. that resulted from injuries or illnesses that occurred while the victims were on-duty. The term *on-duty* refers to being at the scene of an alarm, whether a fire or non-fire incident; while responding to or returning from an alarm; while participating in other fire department duties such as training, maintenance, public education, inspection, investigation, court testimony or fund raising; and being on call or stand-by for assignment at a location other than at the firefighter's home or place of business.

On-duty fatalities include any injury sustained in the line of duty that proves fatal, any illness that was incurred as a result of actions while on duty that proves fatal, and fatal mishaps involving non-emergency occupational hazards that occur while on duty. The types of injuries included in the first category are mainly those that occur at a fire or other emergency incident scene, in training, or in crashes while responding to or returning from alarms. Illnesses (including heart attacks) are included when the exposure or onset of symptoms occurred during a specific incident or on-duty activity.

The victims include members of local career and volunteer fire departments; seasonal, full-time and contract employees of state and federal agencies who have fire suppression responsibilities as part of their job description; prison inmates serving on firefighting crews; military personnel performing assigned fire suppression activities; civilian firefighters working at military installations; and members of industrial fire brigades.

Fatal injuries and illnesses are included even in cases where death is considerably delayed. When the injury and the death occur in different years, the incident is counted in the year of the injury.

The NFPA recognizes that a comprehensive study of on-duty firefighter fatalities would include chronic illnesses (such as cancer or heart disease) that prove fatal and that arise from occupational factors. In practice, there is no mechanism for identifying fatalities that are due to illnesses that develop over long periods of time. This creates an incomplete picture when comparing occupational illnesses to other factors as causes of firefighter deaths. This is recognized as a gap the size of which cannot be identified at this time because of limitations in tracking the exposure of firefighters to toxic environments and substances and the potential long-term effects of such exposures.

The NFPA also recognizes that other organizations report numbers of duty-related firefighter fatalities using different, more expansive, definitions that include deaths that occurred when the victims were off-duty. (See, for example, http://www.usfa.dhs.gov/fireservice/fatalities/index.shtm and http://www.firehero.org.) Readers comparing reported losses should carefully consider the definitions and inclusion criteria used in any study.

Type of Duty

Figure 2 shows the distribution of the 82 deaths by type of duty. The largest share of deaths occurred while firefighters were operating on the fire ground (27 deaths). This total is well below the average 34 deaths per year on the fire ground over the past 10 years, and half the average number of deaths in the first 10 years of this study (69 deaths per year from 1977 through 1986). Eighteen of the 27 deaths occurred at 15 structure fires. Deaths in structure fires are discussed in more detail later in this report. There were seven deaths at six wildland-related incidents, one death at a vehicle fire and one at a dumpster fire involving combustible metals. Thirteen of the 27 fire ground victims were career firefighters and twelve were volunteer firefighters. The other two victims worked on state and federal wildland firefighting crews. The average number of career firefighter deaths on the fire ground over the past 10 years is 12 deaths per year, while the average for volunteer firefighters is 16 deaths per year.

Twenty firefighters died while responding to or returning from emergency calls. It is important to note that not all deaths in this category are the result of crashes. Ten of the 20 deaths occurred in eight collisions or rollovers and eight were due to sudden cardiac events or stroke. One firefighter fell from the back of a responding rescue vehicle, and one firefighter died as a result of complications from surgery after injuring his knee when he slipped on ice during an EMS response. Thirteen of the victims were volunteer firefighters, three were career firefighters, three were contractors for a federal land management agency and one was a member of a race track fire safety crew. All crashes, the fall from the rescue vehicle and sudden cardiac deaths are discussed in more detail later.

Eleven deaths occurred during training activities. Two firefighters fell from an elevated aerial platform during a training exercise to familiarize firefighters with the new equipment, three firefighters collapsed after training runs or other physical fitness activities, two died while attending seminars or training sessions, one collapsed during pump operation training, one suffered a stroke during fitness training at the station, one was struck by a falling tree during tree felling training, and one firefighter fell while rappelling from a helicopter.

Ten firefighters died at non-fire emergencies, including five at the scene of motor vehicle crashes, three at emergency medical calls, one during a water rescue at a frozen pond and one while clearing a fallen tree from the road.

The remaining 14 firefighters died while involved in a variety of non-emergency-related on-duty activities. These activities included normal administrative or station duties (nine deaths), community events (two deaths), patrolling for downed trees (one death), fuel reduction in a wildland area (one death) and a marijuana eradication project (one death).

Cause of Fatal Injury or Illness

Figure 3 shows the distribution of deaths by cause of fatal injury or illness. The term *cause* refers to the action, lack of action, or circumstances that resulted directly in the fatal injury.[4]

Deaths resulting from overexertion, stress and related medical issues made up the largest category of fatalities. Of the 44 deaths in this category, 35 were classified as sudden cardiac deaths (usually heart attacks), five were due to strokes, one due to complications from hypothermia, one to an aneurysm and one from a blood clot. See the section below for more detail on sudden cardiac deaths. In the remaining incident, a seizure caused a firefighter to fall, striking his head on the floor.

The second leading cause of fatal injury was being struck by an object or coming into contact with an object. The 22 firefighters killed included 14 in motor vehicle crashes and four struck by motor vehicles. Those deaths are discussed in more detail in a separate section of this report. Two firefighters were struck by falling trees. One firefighter was struck by debris when a dumpster exploded. One firefighter was electrocuted at a motor vehicle crash when he came into contact with a downed power line when he slipped or fell while trying to avoid walking into it.

Nine firefighters were killed in jumps or falls. Two fell through the floor at a structure fire, two fell from an elevated aerial platform during training, one fell on ice, one fell from the back of a responding rescue vehicle, one fell off a parked fire department vehicle after a parade, one fell while rapelling from a helicopter, and one jumped from a third-story window when trapped by intense fire conditions.

The next leading cause of fatal injury was being caught or trapped, resulting in six deaths. Four of the six firefighters were trapped by fire progress in two separate fires; two of them died of smoke inhalation and two died of burns. One firefighter became trapped in a silo and was asphyxiated. One became pinned between the top guardrail on an elevating platform the bay door header while doing maintenance at a fire station.

One firefighter was shot by an agitated patient at an EMS call.

Nature of Fatal Injury or Illness

The term *nature* refers to the medical process by which death occurred and is often referred to as *cause of death* on death certificates and in autopsy reports.

Figure 4 shows the distribution of deaths by nature of fatal injury or illness. The largest number of fatalities, 35 deaths, were due to sudden cardiac death. The other major categories were internal trauma (28 deaths), stroke (five deaths), and asphyxiation (five deaths). There were three deaths due to burns and two to blood clot or embolism. The remaining deaths included one each due to electrocution, gunshot wound, aneurysm and hypothermia.

Sudden Cardiac Deaths

Overall, sudden cardiac death is the number one cause of on-duty firefighter fatalities in the U.S. and almost always accounts for the largest share of deaths in any given year. (These are cases where the onset of symptoms occurred while the victim was on-duty and death occurred immediately or shortly thereafter.) The number of deaths in this category has fallen significantly since the early years of this study. From 1977 through 1986, an average of 60 on-duty firefighters a year suffered sudden cardiac deaths. The average fell to 44 a year in the 1990s and to under 40 in the past decade.   In spite of this reduction, sudden cardiac death still accounted for 39 percent of the on-duty deaths in the last five years, and 42 percent in 2009 alone.

For 19 of the 35 victims of sudden cardiac events in 2009, post mortem medical documentation showed that eight had severe arteriosclerotic heart disease, five were hypertensive, two were diabetic, and eight were reported to have had prior heart problems -- such as prior heart attacks, bypass surgery or angioplasty/stent placement. (Some of the victims had more than one condition.) Other risk factors were represented among the victims of sudden cardiac death, including obesity, smoking and family history. Medical documentation was not available for the other 16 firefighters.

NFPA has several standards that focus on the health risks to firefighters. For example, NFPA 1582, *Comprehensive Occupational Medical Program for Fire Departments*, outlines for fire departments the procedures for screening candidate firefighters and handling health problems that might arise during an individual's fire service career. NFPA 1500, *Fire Department Occupational Safety and Health Program*, calls for fire departments to establish a firefighter health and fitness program based on NFPA 1583, *Health-Related Fitness Programs for Fire Fighters*, and requires that firefighters meet the medical requirements of NFPA 1582.

Information on developing a wellness-fitness program is available from other organizations, for example, the IAFC/IAFF Fire Service Joint Labor Management Wellness-Fitness Initiative (http://www.iafc.org/associations/4685/files/healthWell_WFI3rdEdition.pdf) and the National Volunteer Fire Council's Heart-Healthy Firefighter Program (http://www.healthy-firefighter.org). The Heart-Healthy Firefighter Program was launched in 2003 to address heart attack prevention for all firefighters and EMS personnel, through fitness, nutrition and health awareness.

An important part of this NVFC program includes health screenings that they make available annually at several fire service trade shows around the country. The purpose of the program is to lower the incidence of cardiac-related problems in the fire service by educating firefighters and their families about nutrition, fitness and heart disease prevention. While those screenings provide valuable information to the individuals tested, they've also collected data that provides a disturbing picture of the health status of many of the nation's firefighters. Since 2003, the program has screened almost 10,000 firefighters, both career and volunteer, for blood pressure, cholesterol, body fat and glucose.

- Cholesterol screening done from 2003 through 2007 found high or borderline-high levels (greater than or equal to 200 mg/dl) in 37.0 percent of the 7,904 firefighters tested.

- Blood pressure screenings from 2005 through 2007 found that 6.2 percent of the tested firefighters had Stage 2 hypertension; 28.9 percent had Stage 1 hypertension; and 48.0 percent were prehypertensive. Only 16.9 percent had normal blood pressure readings.
- Almost all of the 5,065 firefighters tested for glucose (non-fasting) in 2006 and 2007 were found to be in the desirable range (less than 140 mg/dl), with only 2.7 percent found to be diabetic (greater than or equal to 200 mg/dl) and 5.9 percent pre-diabetic (between 140 and 199 mg/dl).
- Of the almost 2,000 firefighters tested for body fat in 2005, 44.7 percent were found to be obese (defined as 25 percent or more of body fat for men and 32 percent or more for women).

Results of the testing in 2008 were reported in a slightly different format.

- Of the approximately 1,650 firefighters tested at four shows, 47.5 percent were determined to have a high overall coronary risk rating, based on the National Institute of Health's "National Cholesterol Education Program."
- Cholesterol screening showed that 5.8 percent of the tested firefighters were at high risk levels (greater than or equal to 240 mg/dl) and 21.4 percent were at moderate risk (200-239 mg/dl).
- Blood pressure screenings found that 27.9 percent of the tested firefighters had high blood pressure; and 49.6 percent were prehypertensive. The remaining 22.5 percent had desired or ideal blood pressure readings.
- Body fat was measured again in 2008, and 41.5 percent of the tested firefighters were found to be at high risk and another 25.1 were found to be overweight.

Only blood pressure was screened at a single show in 2009.

- Of the 137 firefighters tested there, 2.2 percent had Stage 2 hypertension; 20.4 percent had Stage 1 hypertension; and 54.0 percent were prehypertensive. Only 23.4 percent had normal blood pressure readings.

Through this program, many firefighters have been tested more than once, have come to understand their personal level of risk, and have adopted a more heart-healthy lifestyle.

Other efforts are in place in an attempt to address this health problem. The 2010 Fire/EMS Safety, Health and Survival Week was held in June, with the theme, "Fit for Duty." The event, co-sponsored by IAFF and IAFC, focused on nutrition and fitness, stress management, smoking and smokeless tobacco cessation, alcohol and other drugs, infectious diseases and suicide prevention.

Ages of Firefighters

The firefighters who died in 2009 ranged in age from 18 to 78, with a median age of 47 years. Three were over age 70. Figure 5 shows the distribution of firefighter deaths by age and whether the cause of death was sudden cardiac death or not.

Sudden cardiac death accounts for a higher proportion of the deaths among older firefighters, as might be expected. More than half of the firefighters over age 40 who died in 2009 died of heart attacks or other cardiac events. The youngest victim of sudden cardiac death was aged 24.

Figure 6 shows death rates by age, using career and volunteer firefighter fatality data for the five-year period from 2005 through 2009 and estimates of the number of career and volunteer firefighters in each age group from the NFPA's 2007 profile of fire departments (the mid-year in the range).[5]

The lowest death rates were for firefighters in their 20s. Their death rate was half the all-age average. Firefighters in their 30s had a death rate two-thirds the all-age average. The rate for firefighters aged 60 and over was 3-1/2 times the average. Firefighters aged 50 and over accounted for two-fifths of all firefighter deaths over the five-year period, although they represent only one-fifth of all career and volunteer firefighters in the U.S.

Fire Ground Deaths

Of the 27 fire ground fatalities, 11 were due to sudden cardiac death, seven to internal trauma, five to asphyxiation, two to burns and one each to stroke and aneurysm.

Figure 7 shows the distribution of the 27 fire ground deaths by fixed property use. Seven of the firefighters were killed on five wildland fires and one prescribed burn. Three of the victims suffered fatal cardiac events, two were killed in separate aircraft crashes over wildland fires, and two were killed when their fire department apparatus went off the road and overturned while they were trying to escape the fire.

Sudden cardiac death claimed the life of one firefighter during operations at a vehicle fire. One firefighter was killed outside a metal products manufacturing plant when water applied on a dumpster fire caused it to explode. A trainee firefighter died of an aneurysm while working at an outside fire involving debris from the demolition of a structure.

Nine of the 17 firefighter deaths at structure fires occurred in residential properties. Fires in one- and two-family dwellings killed seven of the nine and two died in fires in apartment buildings. Four firefighters were killed in fires in vacant houses. Two firefighters were killed in a fire in a delicatessen, one died at a restaurant fire and one was killed at a fire involving a grain silo.

None of the structures had an automatic fire suppression system.

To put the hazards of firefighting in various types of structures into perspective, the authors examined the number of fire ground deaths per 100,000 structure fires by property use. Estimates of the structure fire experience in each type of property were obtained from the NFPA's annual fire loss studies from 2004 through 2008 (the 2009 results are not yet available) and from the updated firefighter fatality data for the corresponding years. The results are shown in Figure 8.

This figure illustrates that, although many more firefighter deaths occur at residential structure fires than at fires in any other type of structure, fires in some nonresidential structures, such as mercantile, public assembly and manufacturing properties, are more hazardous to firefighters, on average. There were 7.7 fire ground deaths per 100,000 nonresidential structure fires from 2004 through 2008, compared to 3.8 deaths per 100,000 residential structure fires. The highest death rates over the five-year period occurred in stores and offices. This is a reflection, in part, of the nine deaths that occurred at a single store fire in 2007. The low rate in health care and correctional properties may reflect the fact that these occupancies are among the most regulated and most-frequently inspected and that their occupants are among the most likely to call the fire department to report fires while the fires are still in their early stages. The low rate in that five-year period for storage properties, which includes garages at dwellings, reflects the relatively small number of fatalities that have occurred in such structures in recent years. In contrast, the slightly higher rate in educational properties is a result of a single fatality over the five-year period in a type of property that has a very low occurrence of reported fires. (Fires in vacant structures are not shown separately in this analysis, as was done in previous years, because of changes in the methodology used to collect fire incident information. They are included in the category for the intended use of the structure; for example, deaths in vacant houses are included in the residential fire category.)

Vehicle-Related Incidents

In 2009, 14 firefighters died in 11 vehicle crashes (including five firefighters killed in three aircraft crashes). In addition to those deaths, four other firefighters were struck and killed by vehicles and two fell from moving apparatus.

Eight of the 14 firefighters were killed in six crashes while responding to incidents and two were killed while returning from incidents.

- Two pilots and a crew chief were killed when their aircraft crashed into a mountain in dense fog while they were traveling to a wildland fire.

- A firefighter responding to a grass fire in a wildland fire apparatus struck another responding vehicle head-on when smoke over the road caused the other driver to cross the center line. The victim was not wearing a seatbelt and was not ejected.
- A firefighter responding as passenger in a wildland fire apparatus was ejected and killed when the brakes failed and the driver of the 1964 vehicle was not able to stop at an intersection. He swerved to avoid traffic, causing the apparatus to overturn and strike a utility pole. The victim was not wearing a seatbelt. Factors cited in the crash included inadequate inspection, maintenance and testing of the vehicle, inadequate driver training and driver inexperience, and minimal safety features on the apparatus.
- A fire chief responding in his fire department vehicle at excessive speed in light rain was killed when his vehicle struck a tree as he swerved to avoid a vehicle that pulled out of an intersecting road. The other driver had stopped at the intersection, but the view of the other road was obstructed and the victim was not sounding his siren. He was wearing his seatbelt and was not ejected.
- A firefighter driving his personal vehicle to a car fire was killed when he struck a tree. Wet roads and speeding were cited as factors in the crash. He was not wearing a seatbelt and was ejected.
- A firefighter responding to a vehicle fire as passenger was killed when his rescue vehicle struck another vehicle and overturned. The driver of the other vehicle had appeared to pull over but then pulled in front of the rescue to make a left turn as the driver of the rescue attempted to pass. Seatbelt use was not reported, but the victim was not ejected.
- The officer in a ladder truck returning from an EMS call was killed when the truck's brakes failed on a hill and the truck crashed through a brick wall and into a building. The victim was not wearing a seatbelt and was not ejected.
- The driver of a water tender (tanker) struck a utility pole after he lost control of the vehicle on a steep hill while returning from a structure fire. There were no seatbelts in the 1970 apparatus, and the victim was ejected. Operator error or a medical emergency could have been the cause of the loss of control and crash.

The remaining three fatal crashes occurred on the scene at wildland fires:

- The driver and passenger in a fire department pickup truck died of traumatic injuries and smoke inhalation when they drove off the side of a mountain while trying to escape the fire. The pair had been attempting to set back fires when they were overrun and had to evacuate.

Investigators believe that obscured visibility may have been a factor in driving off the road. The passenger was not wearing a seatbelt and was ejected. It could not be determined if the driver was wearing a seatbelt, but he was not ejected.

- A state forestry pilot flying as air attack supervisor was killed when he crashed into a field. The probable cause of the crash was determined to be the pilot's failure to maintain adequate airspeed, resulting in a stall at low altitude.
- A contract pilot dropping retardant from his air tanker was killed when he crashed into rising terrain. No other details are available on this fire yet, either.

Of the nine deaths in road vehicles mentioned above, six of the victims were not wearing seatbelts (four were ejected and two were not ejected), one was wearing his seatbelt, and no information on seatbelt use was available for two of the victims (neither of whom was ejected). Excessive speed was a factor in at least two of the eight crashes. Other factors reported were driver inexperience, driver inattention, weather conditions, lack of maintenance of vehicles and minimal safety features on older apparatus.

Four firefighters were struck by vehicles.

- A firefighter was run over at a fire scene as he guided a pumper that was backing up. The area was well-lit and the victim was wearing turnout gear with reflective trim and lettering. The driver, who had been maintaining eye contact with the victim, may have been momentarily distracted by a passing vehicle. The victim might not have realized how close he was to the vehicle and might have lost his footing.
- In rain and poor visibility, a firefighter wearing a safety vest while clearing a tree from a roadway was struck by a car that came around a curve over a rise of a hill. The driver saw the headlights, flashers and yellow light on the firefighter's vehicle and slowed down but never saw the victim.
- A firefighter working at the scene of a motor vehicle crash collapsed for an unknown reason and was run over by a fire department apparatus that was backing up. No other details were reported.
- In the fourth incident, as a firefighter was assisting the victim of a crash, a truck crested the hill and could not stop on the ice, went off the road and struck him.

Two firefighters fell from moving vehicles. One of them fell from a helicopter during a rappel training exercise, due to improper rigging of the equipment. The other fell off the back of a race track safety vehicle as it responded to a crash on the track.

NFPA publishes several standards related to road safety issues. *NFPA 1002, Standard on Fire Apparatus Driver/Operator Professional Qualifications*, identifies the minimum job performance requirements for firefighters who drive and operate fire apparatus, in both emergency and nonemergency situations. *NFPA 1451, Standard for a Fire Service Vehicle Operations Training Program*, provides for the development of a written vehicle operations training program, including the organizational procedures for training, vehicle maintenance, and identifying equipment deficiencies. *NFPA 1911, Standard for the Inspection, Testing, Maintenance and Retirement of In-Service Automotive Fire Apparatus*, details a program to ensure that fire apparatus are serviced and maintained to keep them in safe operating condition. NFPA 1901, *Automotive Fire Apparatus,* addresses vehicle stability to prevent rollovers, and gives manufacturers options on how to provide it. New vehicles will have their maximum speed limited, based on their weight, and will have vehicle data recorders to monitor, among other things, acceleration and deceleration, and seatbelt use.

The provisions of NFPA 1500 include requirements that operators successfully complete an approved driver training program, possess a valid driver's license for the class of vehicle, and operate the vehicle in compliance with applicable traffic laws. All vehicle occupants must be seated in approved riding positions and secured with seatbelts before drivers move the apparatus, and drivers must obey all traffic signals and signs and all laws and rules of the road, coming to a complete stop when encountering red traffic lights, stop signs, stopped school buses with flashing warning lights, blind intersections and other intersection hazards, and unguarded railroad grade crossings. Passengers are required to be seated and belted securely and must not release or loosen seatbelts for any reason while the vehicle is in motion.

In related efforts, the USFA has formed partnerships with the IAFF, NVFC and IAFC to focus attention on safety while responding in emergency apparatus. Details can be found at www.usfa.dhs.gov/fireservice/research/safety/vehicle.shtm.

The focus of vehicle safety programs should not be exclusively on fire department apparatus, since, over the years, personal vehicles have been the vehicles most frequently involved in road crashes. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, includes a requirement that when members are authorized to respond to incidents or to fire stations in private vehicles, the fire department must establish specific rules, regulations, and procedures relating to the operation of private vehicles in an emergency mode.

Requirements are also in effect for emergency personnel operating on roadways. The 2009 version of the Federal Highway Administration’s Manual of Uniform Traffic Control Devices

(MUTCD) requires anyone working on a roadway to wear an ANSI 107-compliant high-visibility vest. An exemption was created for firefighters and others engaged on roadways that allows them to wear NFPA-compliant retroreflective turn-out gear when directly exposed to flames, heat and hazardous material. NFPA 1500 requires firefighters working on traffic assignments where they are endangered by motor vehicle traffic to wear clothing with fluorescent and retroreflective material. The 2009 edition of NFPA 1901 requires that ANSI 207-compliant breakaway high-visibility vests be carried on all new fire apparatus, and MUTCD 2009 allows emergency responders to use them in lieu of ANSI 107-compliant apparel. Advice on compliance with the updated Federal rules, including definition of the term 'safe-positioned' and use of temporary control devices, can be found at: http://www.respondersafety.com/ Articles/ 2009_Edition_of_the_Manual_on_Uniformed_Traffic_Control_Devices_MUTCD_Released _December_16_2009.aspx. NFPA 1901 also requires reflective striping for improved visibility on new apparatus and a reflective chevron on the rear of fire apparatus. Advice on how to improve visibility of existing apparatus can be found at: http://www.respondersafety.com/ MarkedAndSeen.aspx.

Career/Volunteer Comparison

The distribution of deaths of career and volunteer firefighters from local fire departments is shown in Figure 9. At 41, the number of deaths of volunteer firefighters in 2009 is the lowest it's been since 1994. Deaths among volunteers has tended to fluctuate between the mid-40s and the mid-60s. With the exception of 2007, when nine career firefighters were killed in a single incident, the number of on-duty deaths of career firefighters annually continues its plateau of approximately 30 deaths each year. (There were 31 in 2009.)

A breakdown of the fatality experience of the 72 career and volunteer firefighters killed in 2009 is shown in Table 1.

Other Findings

There were six deaths at five intentionally-set fires in 2009. Three were sudden cardiac deaths – two at fires in vacant houses and one at a grass fire. Two firefighters were killed in an apparatus crash on an intentionally-set wildland fire and one firefighter was run over by a fire department vehicle at the scene of a vacant house fire. From 2000 through 2009, 60 firefighters (6.1 percent of all on-duty deaths) died in connection with intentionally-set fires. The number of these deaths annually has been dropping since 1985.

Over the past 10 years, 29 firefighter deaths have resulted from false calls, including malicious false alarms and alarm malfunctions. In 2009, sudden cardiac death claimed the lives of two firefighters – one of them shortly after returning from a system malfunction at an apartment building and the other while returning from the false report of a motor vehicle crash.

Summary

There were 82 on-duty firefighter deaths in 2009; the lowest total since 1993 and the third lowest total since NFPA began this study in 1977. The sharp drop from the number of deaths in 2008 and 2007 is explained only in part by the presence in those years of single incidents that resulted in nine deaths.

Another promising development is the low number of deaths in road crashes in 2009. There were nine deaths in crashes of road vehicles in 2009. This is the lowest total since 1983, when there were only six. Over the past 10 years, the number of deaths in road vehicle crashes has averaged 15 a year, ranging from this year's low of nine to a high of 25 in 2003 and 2007.

Although a significant decline in the death total and in the category that regularly accounts for the second largest share of deaths (crashes) is a positive finding, a single year's results cannot be interpreted as a trend.

As in most years, the number one cause of on-duty firefighter fatalities was sudden cardiac death. The number of such deaths has been trending downwards since the late 1970s, but they have leveled off at under 40 deaths while on-duty each year and continue to account for approximately 40 percent of the deaths annually.

This study focuses on the fire deaths that are directly associated with specific on-duty activities, and does not track the effects of long-term exposure to toxic products that might occur during an individual's time in the fire service. The U.S. Fire Administration and NIOSH recently announced that NIOSH researchers will undertake a multi-year study to examine the cancer risk of firefighters, using health records of approximately 18,000 current and retired career firefighters from suburban and large city fire departments. More information about the project is available on the USFA and NIOSH websites.

References

1. The NFPA's files for firefighter on-duty fatal injuries are updated continually for all years.

2. For this report, the term *volunteer* refers to any firefighter whose principal occupation is not that of a full-time, paid member of a fire department. The term *career* refers to any firefighter whose occupation is that of a full-time, paid fire department member.

3. For this report, the term *motor vehicle-related incident* refers to motor vehicle collisions (including aircraft and boats) and rollovers, as well as to incidents such as falls from or struck by vehicles where the involvement of the vehicle played an integral role in the death.

4. The categories for cause of injury and nature of injury are based on the 1981 edition of NFPA 901, *Uniform Coding for Fire Protection*.

5. Michael J. Karter, Jr., "U.S. Fire Department Profile Through 2007," NFPA Fire Analysis and Research Division, Quincy, Massachusetts, November 2008.

Credits

This study is made possible by the cooperation and assistance of the United States fire service, the Public Safety Officers' Benefits Program of the Department of Justice, CDC's National Institute for Occupational Safety and Health, the United States Fire Administration, the Forest Service of the U.S. Department of Agriculture, and the Bureau of Indian Affairs and the Bureau of Land Management of the U.S. Department of the Interior. The authors would also like to thank Carl E. Peterson, retired from NFPA's Public Fire Protection Division, Thomas Hales, MD, MPH, of CDC-NIOSH, and Jack Sullivan, Emergency Responder Safety Institute (ERSI) Director of Training, for their assistance on the study.

U.S. Department of Justice Death, Disability and Educational Benefits for Public Safety Officers and Survivors

Line of duty deaths: The Public Safety Officers' Benefits (PSOB) Act, signed into law in 1976, provides a federal death benefit to the survivors of the nation's federal, state, local and tribal law enforcement officers, firefighters, and rescue and ambulance squad members, both career and volunteer, whose deaths are the direct and proximate result of a traumatic injury sustained in the line of duty. The Act was amended in 2000 to include FEMA employees performing official, hazardous duties related to a declared major disaster or emergency. Effective December 15, 2003, public safety officers are covered for line-of-duty deaths that are a direct and proximate result of a heart attack or stroke, as defined in the Hometown Heroes Survivors' Benefits Act of 2003.

A 1988 amendment increased the amount of the benefit from $50,000 to $100,000 and included an annual cost-of-living escalator. On October 1 of each year, the benefit changes as a result. The enactment of the USA PATRIOT bill in 2001 increased the benefit to $250,000. The current benefit is $311,810, tax free.

A decedent's spouse and minor children usually are the eligible beneficiaries. Generally, in cases in which the public safety officer had no surviving spouse or eligible children, the death benefit is to be awarded to either the individual most recently designated as beneficiary for PSOB benefits with the officer's public safety agency, organization, or unit, or, if there is no designation of beneficiary of PSOB benefits on file, then to the individual designated as beneficiary under the most recently executed life insurance policy on file at the time of death. (*See* 42 U.S.C. § 3796(a)(4) for specific details.) If no individuals qualify under 42 U.S.C. § 3796(a)(4), then the benefit is paid to the public safety officer's surviving parents.

Line of duty disability: In 1990, Congress amended the PSOB benefits program to include permanent and total disabilities that occur on or after November 29, 1990. The amendment covers public safety officers who are permanently unable to perform any gainful employment in the future. PSOB is intended for those few, tragic cases where an officer survives a catastrophic, line of duty injury. Only then, in the presence of the program's statutory and regulatory qualifying criteria, will PSOB's disability benefit be awarded. The bill's supporters anticipated that few PSOB disability claims would be eligible annually.

Public Safety Officers' Educational Assistance Program (PSOEA): An additional benefit, signed into law in October 1996 and amended in 1998, provides an educational assistance allowance to the spouse and children of public safety officers whose deaths or permanent and total disabilities qualify under the PSOB Act. This benefit is provided directly to dependents who attend a program of education at an eligible education institution and are the children or spouses of covered public safety officers. It is retroactive to January 1, 1978, for beneficiaries who have received or are eligible to receive the PSOB death benefit. Students may apply for PSOEA funds for up to 45 months of full-time classes. As of October 1, 2009, the maximum benefit a student may receive is $925 per month of full-time attendance.

Further benefits information: To initiate a claim for death benefits, to receive additional information on filing a disability claim or to receive additional information about coverage, call, email, or write the Public Safety Officers' Benefits Office, Bureau of Justice Assistance, Office of Justice Programs, U.S. Department of Justice, 810 7th Street, N.W., Washington DC 20531. The telephone number is (888) 744-6513 and the email address is ASKPSOB@usdoj.gov. PSOB death claims can now be filed online as well, at: https://www.psob.gov. Please note that the PSOB Office "Call Center" is now available to take calls Monday through Friday from 7:00 AM until 7:00 PM.

Table 1.
Comparison of On-Duty Deaths Between
Career and Volunteer Firefighters, 2009*

	Career Firefighters		Volunteer Firefighters	
	Number of Deaths	**Percent of Deaths**	**Number of Deaths**	**Percent of Deaths**
Type of duty				
Operating at fire ground	13	42 %	12	29 %
Responding to or returning from alarms	3	10	13	32
Operating at non-fire emergencies	0	0	10	24
Training	6	19	3	7
Other on-duty	9	29	3	7
TOTALS	31	100 %	41	100 %
Cause of fatal injury				
Exertion/stress/other related	18	58 %	25	61 %
Struck by or contact with object	5	16	9	22
Fell/jumped	6	19	1	2
Caught or trapped	2	6	4	10
Assault	0	0	1	2
Exposure to electricity	0	0	1	2
TOTALS	31	100 %	41	100 %
Nature of fatal injury				
Sudden cardiac death	12	39 %	22	54 %
Internal trauma	10	32	10	24
Stroke/aneurysm	3	10	3	7
Asphyxiation (including smoke inhalation)	2	6	3	7
Burns	2	6	0	0
Blood clot/embolism	1	3	1	2
Hypothermia	1	3	0	0
Gunshot wounds	0	0	1	2
Electrocution	0	0	1	2
TOTALS	31	100 %	41	100 %
Rank				
Firefighter	20	65 %	26	63 %
Company officer	10	32	3	7
Chief officer	1	3	12	29
TOTALS	31	100 %	41	100 %

Table 1.
Comparison of On-Duty Deaths Between
Career and Volunteer Firefighters, 2009* (Continued)

	Career Firefighters Number of Deaths	Career Firefighters Percent of Deaths	Volunteer Firefighters Number of Deaths	Volunteer Firefighters Percent of Deaths
Ages of Firefighters				
All deaths				
20 and under	0	0 %	1	2 %
21 to 25	2	6	1	2
26 to 30	2	6	2	5
31 to 35	3	10	3	7
36 to 40	5	16	1	2
41 to 45	8	26	6	15
46 to 50	4	13	3	7
51 to 55	4	13	6	15
56 to 60	3	10	7	17
61 to 65	0	0	5	12
66 to 70	0	0	3	7
Over 70	0	0	3	7
TOTALS	31	100 %	41	100 %
Ages of Firefighters				
Sudden cardiac deaths only				
21 to 25	1	8 %	0	0 %
31 to 35	1	8	0	0
36 to 40	1	8	0	0
41 to 45	5	42	3	14
46 to 50	1	8	2	9
51 to 55	2	17	4	18
56 to 60	1	8	6	27
61 to 65	0	0	4	18
over 70	0	0	3	14
TOTALS	12	100 %	22	100 %
Fire ground deaths by fixed property use				
Dwellings and apartments	6	46 %	3	25 %
Wildland/prescribed burns	3	23	2	17
Vacant dwellings	2	15	2	17
Stores	2	15	0	0
Outside fires	0	0	2	17
Storage	0	0	1	8
Restaurant	0	0	1	8
Vehicle	0	0	1	8
TOTALS	13	100 %	12	100 %

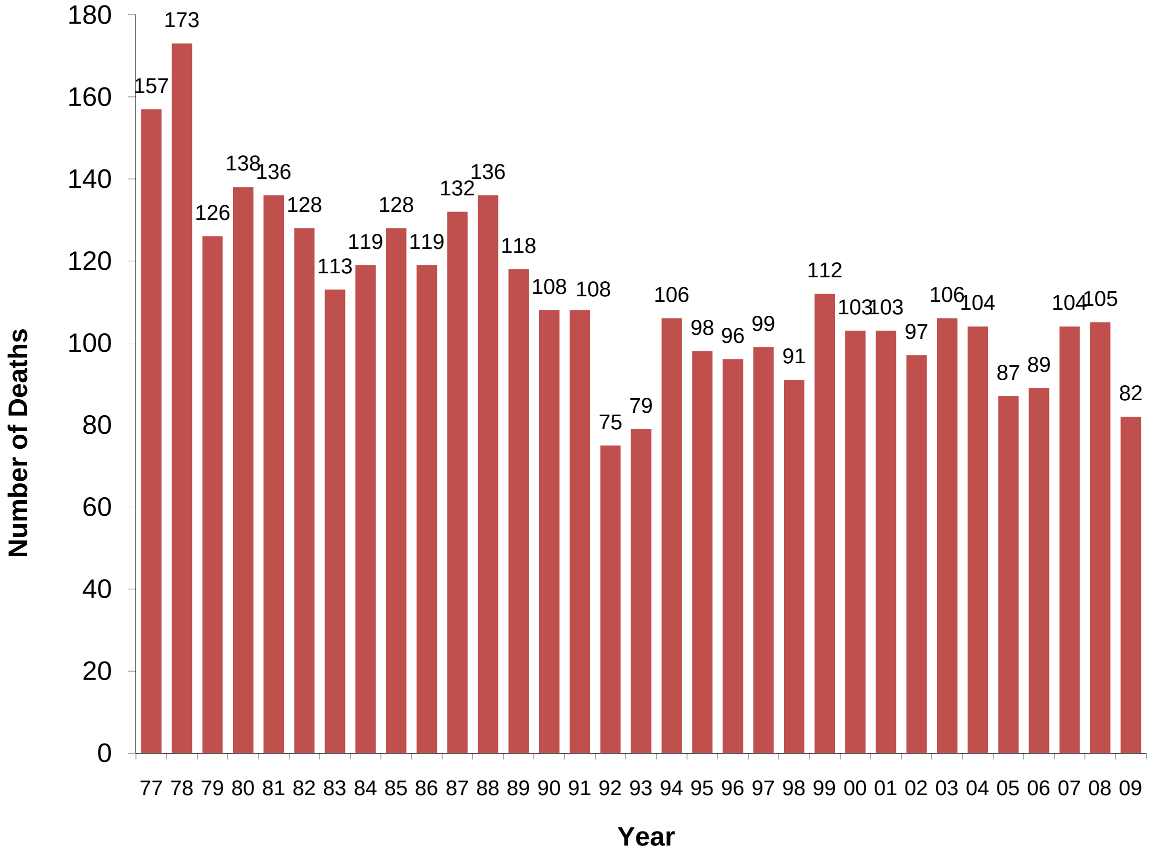
Table 1.
Comparison of On-Duty Deaths Between
Career and Volunteer Firefighters, 2009* (Continued)

	Career Firefighters		Volunteer Firefighters	
	Number of Deaths	**Percent of Deaths**	**Number of Deaths**	**Percent of Deaths**
Years of service				
5 or less	7	23 %	9	22 %
6 to 10	4	13	5	12
11 to 15	4	13	4	10
16 to 20	3	10	4	10
21 to 25	5	16	2	5
26 to 30	7	23	6	15
over 30	1	3	9	22
Not reported	0	0	2	5
TOTALS	31	100 %	41	100 %
Attributes of fire ground deaths**				
Intentionally-set fires	3		3	
Search and rescue operations	4		1	
Motor vehicle crashes	4		5	
False alarms	1		1	

* This table does not include the 10 victims who were employees of or contractors for state or federal land management agencies, or members of private firefighting crews.

** Because these attributes are not mutually exclusive, totals and percentages are not shown.

Figure 1
On-Duty Firefighter Deaths - 1977-2009



* excluding the 340 firefighter deaths at the World Trade Center

Figure 2
Firefighter Deaths by Type of Duty - 2009

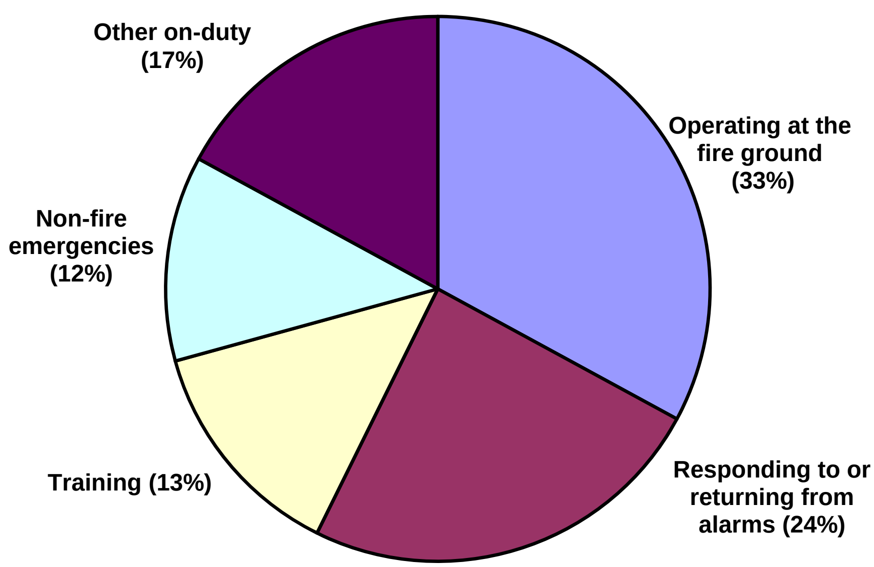


Figure 3
Firefighter Deaths by Cause of Injury -- 2009

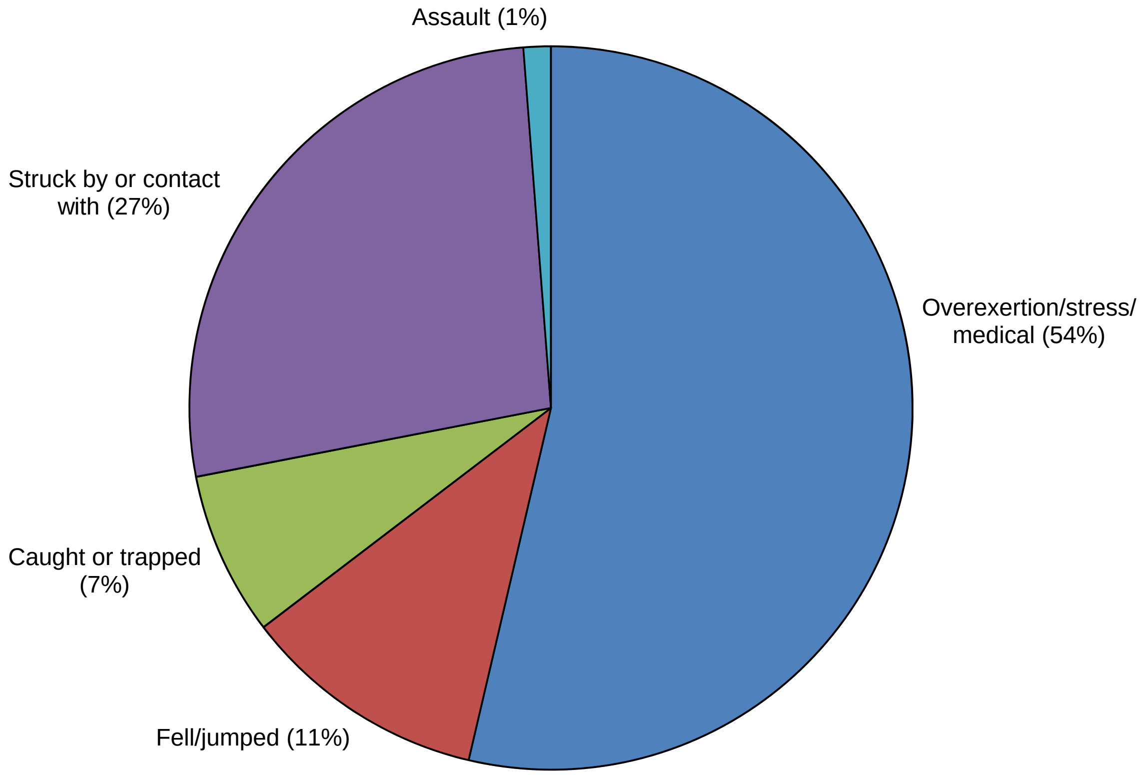


Figure 4
Firefighter Deaths by Nature of Injury -- 2009

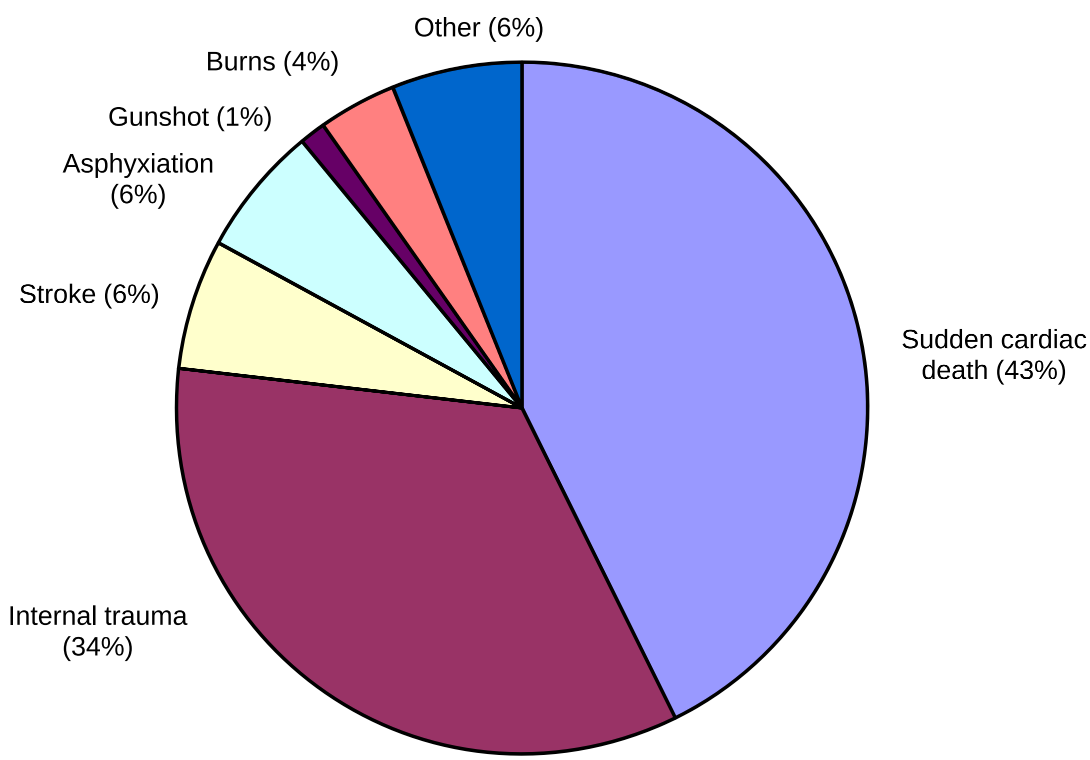


Figure 5
Firefighter Deaths by Age and Cause of Death -- 2009

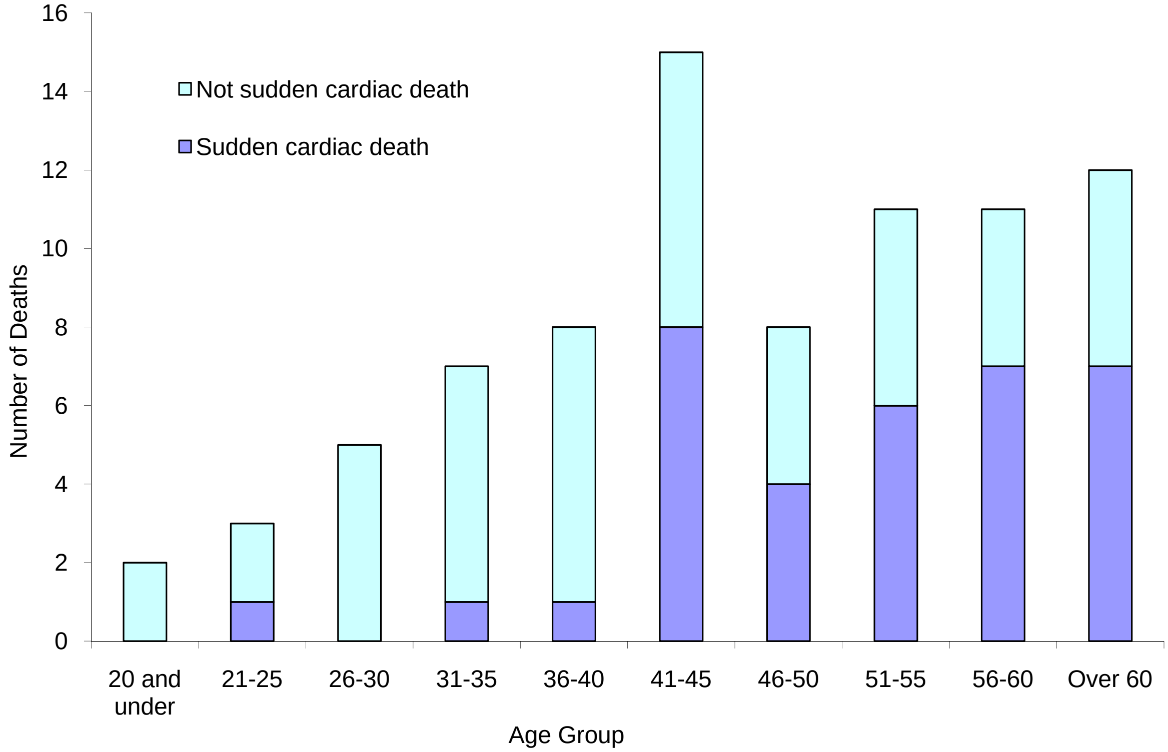


Figure 6
On-Duty Death Rates per 10,000 Career and Volunteer Firefighters 2005-2009

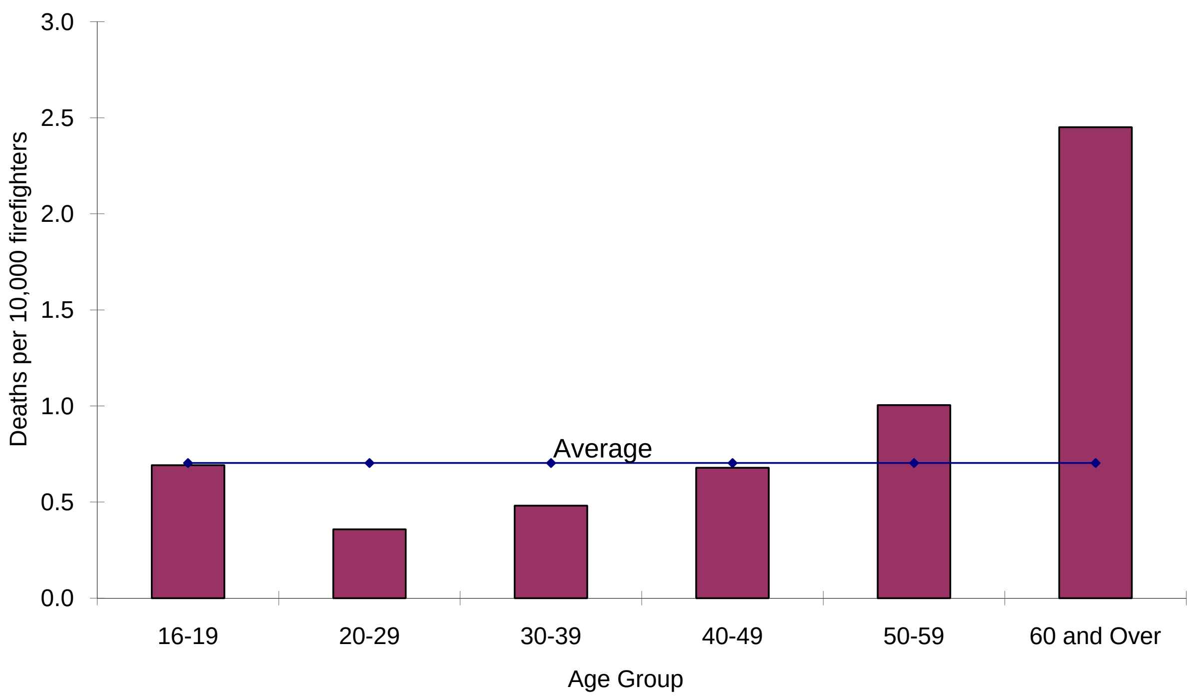
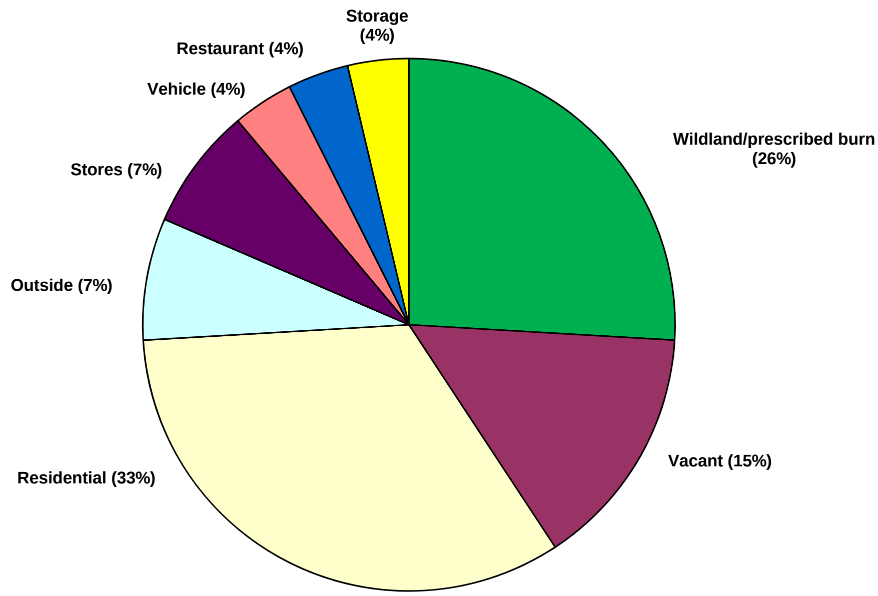


Figure 7
Fire Ground Deaths by Fixed Property Use -- 2009*



*** There were 27 deaths on the fire ground in 2009.**

Figure 8
On-Duty Fire Ground Deaths
per 100,000 Structure Fires
2004-2008

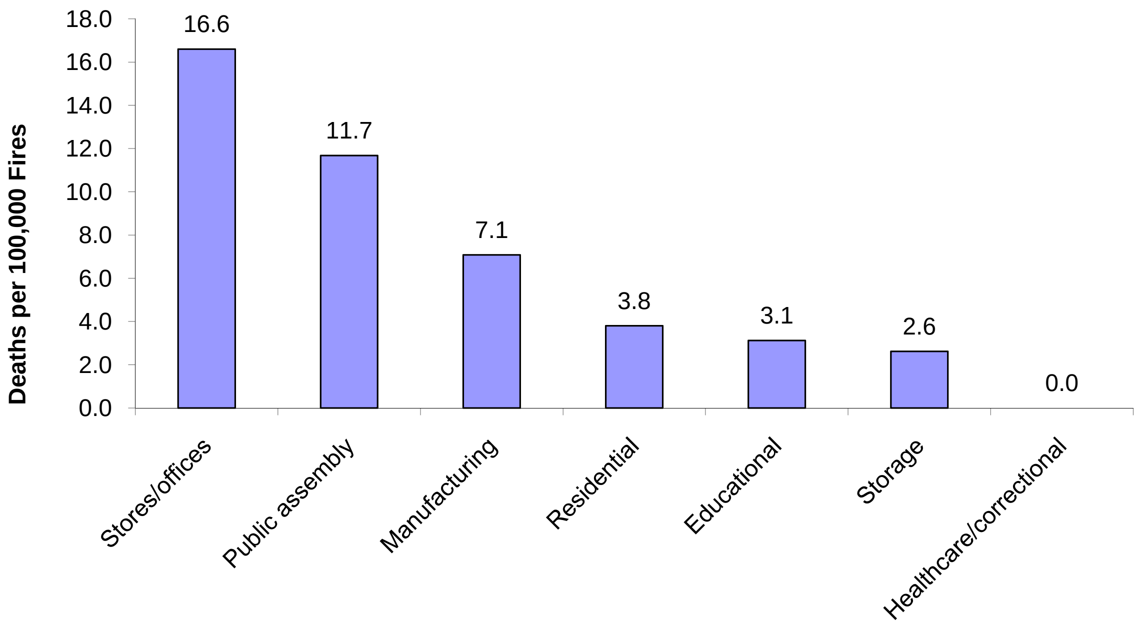
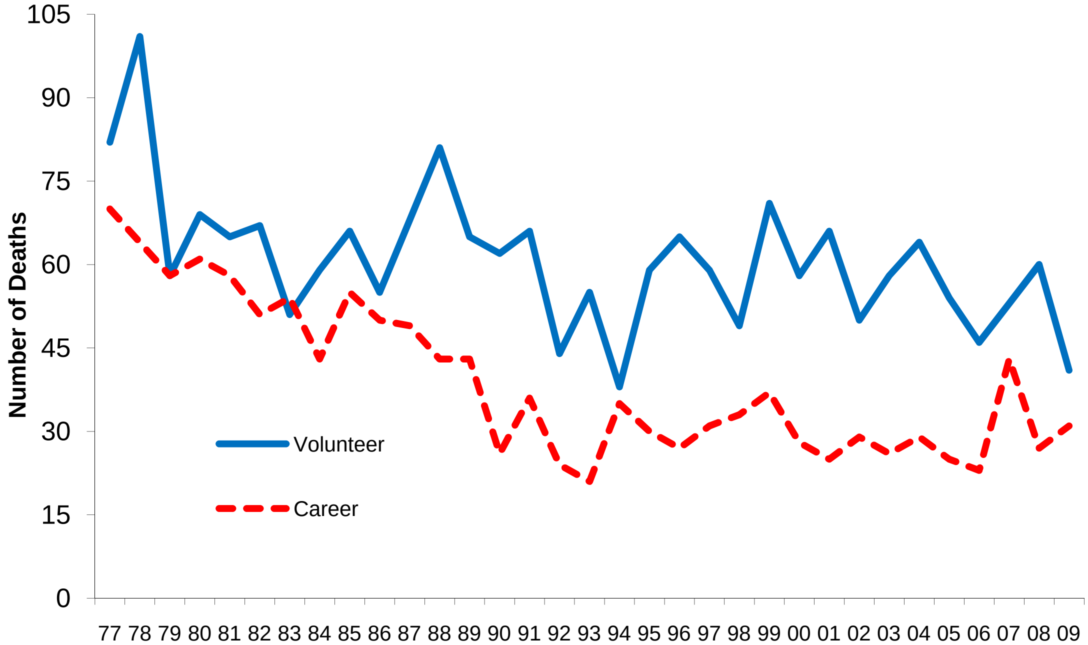


Figure 9
Career and Volunteer Firefighter Deaths
1977 - 2009*



* excluding the 340 firefighter deaths at the World Trade Center in 2001

SELECTED FIREFIGHTER FATALITY INCIDENTS

Dumpster explosion involving combustible metals

On an evening of below freezing temperatures, a member of the sheriff's department on patrol observed an orange glow with white smoke coming from a dumpster in the parking lot of a manufacturing plant. The plant produced aluminum automobile parts and other parts by sand casting aluminum alloy materials. When the parts are finished, they are extracted from the molds and the excess material is removed. These shavings are collected and put into an outside dumpster for sale to an aluminum recycling company.

The officer determined that there was no one on site and that the plant was closed. He further investigated the contents of the dumpster and observed that it contained at least two 55-gallon (208-liter) drums that contained aluminum dross (slag), lying on top of scrap metal and metal shavings. There was snow on top of the shavings. He further observed a 55-gallon (208-liter) drum at one end of the dumpster that had orange flames coming from it. The officer called for the fire department at 7:32 p.m., moved his patrol car, and turned on and positioned the dash-mounted video camera.

One of the first firefighters to arrive was the fire chief, who observed a cherry red circular pattern, 18 inches (46 cm) in diameter at the end of the dumpster. The chief placed a ladder against the dumpster, climbed up and saw one barrel in the dumpster that appeared to be very hot. He also saw aluminum shavings burning. A blue-green flame appeared when a water stream was directed into the dumpster. He then instructed the engine company to apply foam on the fire. He observed the fire intensify as the foam was applied and as he climbed down the ladder, he ordered that the application of foam stopped. An explosion occurred that extinguished the fire as the chief turned away.

The explosion caused the dumpster to rotate 25 degrees and ripped one side of the dumpster back. One firefighter died from multiple traumatic injuries; his body was found 60 feet (18 meters) from where he was working. Eight other firefighters suffered various non-fatal injuries.

An investigation into the explosion identified seven materials that are used in the manufacturing process. They are: Aluminum Casting Alloy #535, Aluminum Casting Alloy #319, Aluminum Casting Alloy #356, ALpHSASET9010, ALpHACURE110, RF118 Aluminum Flux and SYNTILO AL 20. According to Material Safety Data Sheets for these materials, in case of fire, three of the seven, Aluminum Casting Alloys #535, #319 and #356, should be extinguished using Class D extinguishing agents. No water or moist sand should be used and no water should be used on molten metal as it will explode.

To prevent similar injuries and deaths, fire departments should survey their districts to identify occupancies that have special hazards and address and mitigate those hazards through code enforcement, pre-fire planning and ensuring their Standard Operating Procedures or Guidelines properly address fires involving such hazards. NFPA 484, *Standard for Combustible Metals*, specifically addresses the safe handling of combustible metals and requirements for fire prevention, fire protection, and emergency response involving combustible metals.

The full report can be found at: http://www.doj.state.wi.us/news/files/StAnnaFirefighterDeath.pdf

Brake failure

A 1995 aerial ladder apparatus was involved in a single-vehicle crash that killed the officer and injured his crew of three firefighters, a permanent driver and two detailed firefighters. The ladder company was returning to the fire station from a medical call, following a route that took them down a long, steep hill. As they started down the hill, the vehicle's brake system failed.

The apparatus quickly gained speed as it descended. Thoughts of crashing into parked vehicles or buildings on the hill were not acted upon because there were pedestrians on the sidewalks on both sides of the street. The officer turned on the siren and operated the air horn as they approached a T-shaped intersection at the bottom of the hill. The intersecting street was a main street usually busy with traffic and used by the public transit authority's trolleys. Miraculously, there was no activity on the street as the apparatus went through the intersection. The truck crashed into a parked vehicle, then knocked down a section of brick wall between two brick stanchions just far enough apart for the apparatus to pass between them and finally crashed into the first level of a high-rise apartment building housing an after-school computer learning center.

One of the firefighters riding in the back seat used a portable radio to notify fire dispatch of the crash and they immediately sent fire companies and medical personnel to the scene. The 52-year-old fire lieutenant died on the scene, minutes after the crash, from blunt force trauma to the head. A nurse going to work stopped and rendered aid and is credited with saving the 24-year-old driver's life. He had received severe lacerations to the head and had to be extricated. One of the firefighters sitting in the rear jump seat sustained a fractured leg and the other firefighter suffered severe sprains to his neck area. Four children and one adult from the learning center were transported to local hospitals with non-life threatening injuries. The only occupant of the apparatus wearing a seatbelt was the firefighter in the rear seat behind the driver, who buckled his seatbelt just before the collision.

Improper maintenance of the apparatus was cited as a cause of the brake failure. As a result of the crash, the fleet maintenance division was reorganized.

See NIOSH's report at: http://www.cdc.gov/niosh/fire/reports/face200905.html

Contact with power line

On a misty morning at 2:30 a.m., a pick-up truck with two occupants left the road, went airborne and struck a utility pole, causing the pole to snap. The pick-up truck continued rotating clockwise, overturning, and hitting some mailboxes and a wire fence before coming to stop in the upright position. The crash caused a power line to come down and others to hang above the ground. A deputy from the county sheriff's office witnessed the crash and reported it by radio. The deputy instructed the vehicle occupants to stay in the vehicle because of the downed power lines. When the initial dispatch was issued to the fire and ems responders on a different frequency, power line involvement was not mentioned.

The deputy escorted the first firefighter on scene along the only safe route to the pick-up. Additional deputies arrived and blocked the opposite approaches to the scene. In total, eight firefighters, two emergency medical personnel and four deputy sheriffs were on scene. Deputies attempted to warn arriving personnel to go around and not under the power lines. Interviews established that not everyone received or complied with warnings. A 60-year-old fire captain entered the scene from the wrong side. He brought medical equipment requested by personnel working on the crash victims.

After dropping off the equipment, he then started walking back up an embankment to his apparatus. As he approached the down and hanging lines, he tried to walk through them. He lost his footing and fell onto the live power lines hanging four to five feet above the roadway and was electrocuted. An additional ALS (Advanced Life Support) ambulance was summoned to the scene and on its arrival, the crew found the captain's injuries were fatal.

An investigation into the incident highlighted two findings: First, there was no incident command and on-scene agencies operated independently and without effective coordination. Secondly, information regarding the downed power lines and safety messages were not immediately communicated by dispatch to the emergency responders. The use of different radio frequencies by the fire department and the deputy sheriffs also complicated communications.

Fall during training

At 2:00 p.m., two firefighters participating in a training exercise died when they fell 83 feet (25 meters) from the platform of a brand new elevated platform apparatus. The purpose of the training session was to familiarize the firefighters with the 95-foot (29-meter) mid-mount aerial platform before it could be placed in service. The training was conducted at an eight-story building. The exercise consisted of setting up the apparatus for operation by extending and setting the stabilizers, leveling the aerial platform, and then raising the platform to the roof of the building.

The first two groups operated the aerial platform without difficulty. The third and last group of firefighters to perform the exercise consisted of four firefighters dressed in station uniforms. After setting up the apparatus, the four firefighters entered the bucket and decided who would operate the controls. No ladder belts were used. The operator raised the platform to the roof and observed that the inclinometer read 71 degrees as he directed the platform over the roof. He instructed the other three firefighters to stay in the bucket because he thought it was too high to exit safely. As he lowered the platform, firefighters on the ground and the firefighter in the platform heard a scraping sound followed by a bang. The operator observed the bucket resting on the top of the parapet wall and instructed the firefighters again to stay in the bucket until he raised it off the wall. He attempted to raise and move the platform but it would not move. Investigators would learn later that a lifting eye on the underside of the bucket was caught on the inner surface of the parapet wall. He attempted to move the bucket a second and third time. On the third try, the top inside part of the parapet wall broke with no warning, causing the platform to lurch away from the building and then swing back and forth violently. The force of the movement caused one victim to be ejected through the door on the right side of the bucket and the second victim to be ejected through the door on the left side. These doors are designed to swing in only but failed when the fire fighters were thrown against them.

The firefighters on the ground immediately provided first aid to control the bleeding and cardiopulmonary resuscitation (CPR) on both victims. Medical assistance was summoned and both victims were transported to the hospital where they were pronounced dead as a result of blunt force injuries. One of the firefighters standing on the cab of the aerial platform apparatus fractured his left heel when he jumped down to render aid.

The National Institute for Occupational Safety and Health conducted an investigation into this incident and cited the following as contributing factors: 1. Unfamiliarity with the controls of a new fire apparatus, 2.Training in a high risk situation without adequate familiarization with the fire apparatus, 3. No fall restraint devices in use during training at height and 4. Design of the lifting eyes (one of which snagged the parapet wall) and platform doors which sprung outward during the incident.

To see the full NIOSH report go to: http://www.cdc.gov/niosh/fire/reports/face200906.html

Gunshot
At 11:34 p.m., the fire department was called to an emergency medical situation, a 25-year-old male complaining of chest pains at an apartment building. On arrival to the fire station, firefighters observed that the ambulance's right front tire was flat. They notified dispatch of the problem and that three fire fighters would be responding in their personal vehicles. When the fire fighters arrived at the scene, they started evaluating the patient in the living room.

As they were taking his vital signs, the patient became severely disturbed and went into a nearby bedroom. The firefighters could hear sounds that turned out to be the patient loading a high-powered rifle. The crew tried to leave the apartment quickly, but before they could exit, the patient got two shots off, with one striking one of the firefighters. The firefighter in charge followed the fleeing patient who still had the rifle and subdued him and held him until the police arrived. The other firefighter called dispatch and reported the shooting and then began working on the injured firefighter. The victim was transported to the hospital by an ambulance where he was pronounced dead as a result of a loss of blood.

Caught in a manufactured home
At 10:00 p.m., the fire department was called to a camper fire that was in close proximity to a manufactured home with an addition built on to it. Arriving firefighters observed wind spreading the fire from the camper to the home. Occupants of the camper and the home had evacuated prior to the arrival of the fire department personnel. The initial attack line was directed to the exterior of the camper and the home.
The second attack line, a charged 1.5-inch (38-mm) line of hose, was advanced into the home by an 11-year veteran fire lieutenant with excessive facial hair and a firefighter with seven months service, both dressed in full turnout clothing including self-contained breathing apparatus (SCBA) but without either an integrated or stand alone personal alert safety system device (PASS). A short time later, the pump operator sounded an evacuation alarm when he noticed that his tank water was low. The two firefighters did not exit the building. Firefighters outside tried to communicate with them by radio and shouting but neither the lieutenant nor the firefighter had a department radio with them. The fire chief pulled on the line of hose a number of times with no response. The line of hose became free and was pulled entirely out of the building. The chief then directed search teams into the home. On the fourth search, the bodies of the 49-year-old lieutenant and the 26-year-old firefighter were found in the living room. Neither had their face pieces on and both face pieces were covered inside and outside with soot. The remote gauge read zero. The air cylinder gauges were damaged and unreadable. The firefighter's face piece was missing the harness fastener on the lower left side. Both were pronounced dead at the scene. The cause of death for both firefighters was smoke inhalation. The carboxyhemoglobin (COHb) levels were 63% for the lieutenant and 64% for the firefighter.

The state fire marshal's office investigated this fire and listed the cause as undetermined. It also cited a number of factors in the fire fighter deaths including:

- No integrated or separately attached PASS devices located on the individual Self Contained Breathing Apparatus.
- No documented program within the department regarding the testing, maintenance and care of department owned and provided self contained breathing apparatus and air cylinders.
- No fire ground incident safety officer assigned.
- No Rapid Intervention team (RIT) established prior to any interior fire suppression operations.
- The incident commander did not properly account for the activities and locations of all the firefighters present.
- The incident commander did not maintain overall scene command while becoming physically involved with multiple fire ground operations.
- The department command staff did not mandate proper firefighter grooming standards with regards to facial hair and the use of self contained breathing apparatus.
- The firefighters did not secure personal communication using department issued handheld radios.

See NIOSH's report at: http://www.cdc.gov/niosh/fire/reports/face200907.html

Trapped in Grain Bin

A fire chief died and five firefighters were injured during suppression activities at a grain bin fire. Contractors who were hired to off load the product because of a clogged auger in the bin ignited a small grass fire when they cut a hole in one of the bin's doors. The fire department responded and extinguished the fire. Not seeing any smoke coming from the bin, they returned to the fire station.

An hour later, they were called for a second fire at the bin. The bin was constructed of steel with a diameter of 72 feet (22 meters) and a height of 61 feet (18 meters) with a capacity of 250,000 bushels (8,810m^3). Two firefighters dressed in full protective clothing including self-contained breathing apparatus (SCBA) climbed up the exterior ladder and then down the interior ladder of the bin and operated a 1.5-inch (38 mm) hose line, while breathing from their SCBA's the entire time. A short time later, they requested two additional air cylinders and two were dropped down to them. As they were changing their cylinders, two more firefighters dressed in full protective clothing including SCBA's entered the bin. The second firefighter to change his cylinder completely ran out of air and became light headed. At this time, the fire chief sounded the evacuation for the men in the bin.

The first firefighter in was the first to climb the ladder to the roof of the bin. The second firefighter got halfway up and stopped when he became weak and dizzy. The fire chief without a SCBA climbed down to help the firefighter and one of the firefighters started climbing up to help also. As they tried to help the firefighter, he fell head first into the soybeans and was buried up to his waist. The fire chief continued down and assisted with getting the firefighter out from under the soybeans. During this time, the fire chief and the firefighters were having trouble breathing. Firefighters from another fire department operating from an aerial tower platform cut a hole into the bin but the hole was too high. They cut a second hole and were able to remove the fire chief and firefighter who were unconscious.

The fire chief never regained consciousness and was pronounced dead at the hospital. The cause of death was asphyxia. The five firefighters were treated and recovered.

Aircraft crash

At 10:00 a.m., two pilots and a crew chief were killed when the aircraft they were flying crashed into a mountain. The pilots, ages 66 and 59, and crew chief, age 32, were responding to a 19,000-acre (7,700-hectare) wildland fire in a different state when the aircraft crashed. The tanker they were flying was a retrofitted military aircraft owned by a private company and contracted by the United States Forest Service. Visibility at that time was reported to be 100 feet (30.5 meters) in the vicinity of the crash.

Local authorities were alerted to the crash by people on the ground, who called and reported the sound of a low flying aircraft with the sound of a crash. Poor visibility prevented the people on the ground from seeing the impact and slowed the search for the crash site. The sheriff's office was notified that a plane was reported missing and once the weather lifted the crash site became visible. The identification number located on its tail wing verified that the plane that crashed was the missing plane. No radio transmissions were reported prior to the crash.

The National Transportation Safety Board is conducting an investigation into the crash. To see their preliminary report go to: http://www.ntsb.gov/ntsb/brief.asp?ev_id=20090425X65240&key=1

Fire Station

A 40-year old firefighter/paramedic with seven years service was working an overtime night shift. At 2:30 a.m., she and her company responded to a call for a fire alarm going off and returned to the fire station and retired for the night. At 6:00 a.m., she collapsed in the lavatory. Her collapse was not witnessed but was heard and first aid was immediately given to her by the rest of her crew. She was transported to the hospital where she underwent 11 hours of surgery. She died at approximately 4:30 p.m. as a result of a stroke caused by a clot in the carotid artery.

Rappelling from helicopter

At 10:30 a.m., a 20-year-old firefighter died on scene after falling from a helicopter while rappelling. The firefighter, with two years service, was participating in a proficiency training exercise held every other week. The firefighter had participated in 15 prior such exercises with no problems. Witnesses stated that it appeared that the firefighter was not connected to the rappelling rope properly and that he tried to hold on to the rope as he fell 200 feet (61 meters) in what looked like a free fall. He landed on an area of fine gravel that was several inches (centimeters) deep.

During a buddy check of their equipment prior to the exercise, one of the rappellers informed the firefighter that a clip used to stop the hook from slipping around the triangular connector was broken. It was replaced with an authorized rubber “O” ring by a spotter trainee. Three other people, including the firefighter, inspected the connection prior to the rappel.

An investigator who examined the firefighter’s rappelling equipment determined that nothing was defective or broken. The investigator did observe that a metal hook that was supposed to connect a braking device connected to the rappelling rope to a metal, triangular shaped connector attached to the harness that the firefighter was wearing was connected only to the braking device and not the harness connector. The investigator believed that the metal hook was improperly connected to the triangular connector attached to the harness. The investigation report mentioned that the improper rigging may have gone unidentified because of a lack of awareness that improper rigging was possible with the use of an O-ring.
The cause of death was listed as multiple blunt force trauma.

To see the United States Forest Service preliminary investigation report refer to:
http://www.wildfirelessons.net/documents/Willow_CA_Final_2009.pdf

To see the National Transportation Safety Board’s Factual report in regards to the incident go to:
http://www.ntsb.gov/ntsb/brief2.asp?ev_id=20090720X02055&ntsbno=WPR09TA356&akey=1

Crash while returning At 1:11 p.m., a firefighter returning to the fire station after a structure fire was killed in a single vehicle crash. The firefighter, the sole occupant of the tanker/pumper, was traveling down a steep hill. Near the bottom of the hill he the lost control and went off the road, striking a telephone pole, snapping it in two. The tanker/pumper rolled and came to a stop in the woods. The firefighter was ejected from the 1971 tanker that was not equipped with seatbelts and pronounced dead on scene. Witnesses stated that the tanker/pumper was traveling at a high rate of speed down the steep hill before it crashed. The apparatus was inspected after the crash and the inspection did not reveal any failures to critical components prior to the crash. The investigation concluded that the crash was caused either by operator error or a medical emergency, as the driver had a history of seizure symptoms. The cause of death was listed as massive head trauma.

Struck by tree
At 11:55 a.m., a firefighter was killed instantly when a dead tree fell, striking him on the head. He was unable to get out of the way after a warning was shouted out. The 52-year-old firefighter was participating in a marijuana eradication project at the time of his death and was loading bundles of marijuana into sling loads that were taken away by helicopter.

The 30-year veteran, certified in helicopter long line operations, assisted in hooking up a bale of marijuana and walked to the edge of the field where some dead trees were standing as the helicopter took off. Investigators believe the “rotor wash” from the helicopter toppled the dead tree. The tree snapped off at the base, fell and struck the firefighter. An OSHA investigation cited the department with several safety violations. The main violation was not identifying and removing the dead trees prior to the operation. The cause of death was listed as head trauma.

Floor collapse

A 22-year veteran fire lieutenant and a 10-year veteran firefighter died as a result of a partial floor collapse at a structure fire. The building was a two-story structure of ordinary construction with a flat roof that ran 40 feet (12 meters) from the front of the building and changed to a gable roof for the remaining 45 feet (13 meters). It contained 2,295 square feet (213 sq. meters) of ground floor area. The first level in the front housed a delicatessen/convenience store with an unoccupied apartment at the rear. The second level contained two apartments with only the rear apartment occupied. Two street level doors to the delicatessen were secured by locked metal gates. One of these doors was located at the front of the building. The other was on the left side of the building and could not be used because of the placement of floor coolers on the inside. A third street-level door located at the front of the building led to a stairway to the second-level apartments. The basement was also heavily secured. All of the window openings were filled in with concrete and steel bars. The two doors to the basement were also heavily secured. One was an exterior below-grade steel barred door at the rear of the left side and the second was a heavily secured wooden door accessed through the delicatessen.

At 3:51 a.m., fire companies were dispatched to the fire with an alert reporting that people were trapped inside. A civilian was on site to meet the first arriving company and stated that he heard trapped people calling for help. He directed the company to the below grade entrance and this became the focus of the operation. Additional resources arriving at the scene were used for a simultaneous primary search on the second level due to more information suggesting possible trapped people. The first engine company and other first arriving companies reported that the fire was in the basement but access to the basement was limited due to the metal barred door. Firefighters searched for an entrance to the basement from inside the delicatessen. When the general location of the door was found, a line of hose was stretched there. Because the companies were unable to gain access to the basement in the rear and conditions were deteriorating, all companies were ordered out of the building.

At approximately 4:22 a.m., the members of the rescue company entered the delicatessen to make sure all firefighters had evacuated. Structural members supporting the first level at the rear of the delicatessen collapsed less than two minutes after they entered. The lieutenant on the rescue company was searching along the line of hose when the floor collapsed under him and he fell into the basement. He immediately began calling for help over his radio using a channel that limited the range to the fire ground and nearby fire stations. The remaining members of the rescue company, not knowing the origin of the distress calls and reporting only that they heard a loud noise, exited the building without realizing that their lieutenant was in trouble. A Firefighter Assist and Search Team (FAST) was deployed at the rear entrance on the left side of the building where the “mayday” was thought to be emanating from. At the same time, a firefighter on the FAST Team was standing with his company in front of the building when he heard the calls for help and found out that the trapped lieutenant had entered through the front of the building. He initiated a rescue attempt and also fell into the basement close to the lieutenant.

A head count was taken and it was reported that only the lieutenant was missing. The firefighter was not reported missing by his officer who responded to dispatch that the company was “OK” at the time. Firefighters operating in the delicatessen could hear a PASS alarm sounding but could not reach the area due to weakened floors, extreme fire conditions and continuing collapse. Later concerns arose when the firefighter could not be accounted for and numerous attempts were made to determine his whereabouts. He was erroneously reported to be operating at a remote location. At 06:10 a.m., another head count was taken and the firefighter was reported missing.

Due to fire conditions and the concern over the structure's integrity, it took another three hours before the bodies of the 45-year-old lieutenant and 34-year-old firefighter were removed. Both were dressed in full turn out clothing including SCBA's (Self-contained Breathing Apparatus). The firefighter's radio was not turned on. The cause of death for both victims was listed as inhalation of products of combustion.

U.S. FIRE SERVICE FATALITIES IN STRUCTURE FIRES, 1977-2009

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June 2010

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U.S. Fire Service Fatalities in Structure Fires, 1977-2009

Since 1977, the number of U.S. firefighter deaths annually at structure fires has dropped almost two-thirds, a finding that often has been credited to improvements in protective clothing and equipment, fire ground procedures, and training, but little attention has been paid to the drop in the number of structure fires themselves.[1] Over the same period, the annual number of structure fires declined by 53 percent.[2] (Figure 1) To what degree then has the decrease in firefighter deaths been driven by the drop in the number of fires?

A comparison of the decline in the number of structure fires and the decrease in the number of firefighter deaths at structure fires shows that the trends track fairly closely, indicating that the drop in deaths may have been, to a great degree, a result of the reduction in the number of fires. This leads to an important second question: how has the *rate* of deaths at structure fires trended over the same period? In other words, are firefighters as likely to die today at structure fires as they were 25 or 30 years ago?

In order to smooth out the year-to-year fluctuations in the number of deaths, Figure 2 displays a comparison of the number of structure fires and the *rate* of firefighter deaths at structure fires using a rolling three-year average. The mid-point of each three-year range is shown at the bottom of the graph. (Because the 2009 fire experience data is not yet available, an estimate was calculated based on the number of structure fires in the previous three years.)

The rate of firefighter deaths at structure fires in the late 1990s was roughly the same as the rate in the late 1970s. In the late 1970s, the death rate was approximately 5.8 deaths per 100,000 structure fires. That rate dropped to approximately 4.8 deaths per 100,000 structure fires around 1987, but rose again to 5.8 in 1991. After falling to 4.8 deaths per 100,000 structure fires in 1994, it increased to 5.7 deaths per 100,000 in the late 1990s. The death rate at structure fires then dropped steadily, to under 4.0 deaths per 100,000 structure fires by the mid-2000s, while the number of structure fires plateaued at approximately 520,000. Since the mid-2000s, the number of structure fires has remained relatively unchanged, while the death rate has increased.

Given the improvements in personal protective clothing and equipment, training and operating procedures over the past two decades, what is the cause of these deaths, and are there any specific areas where deaths are increasing? A review of the data shows that the rate of sudden cardiac deaths at structure fires (inside and outside) has been dropping since the early 1980s, as has the rate of non-sudden-cardiac-death fatalities outside at structure fires. Sudden cardiac deaths at structure fires occurred at the rate of 2.6 deaths per 100,000 fires in the late 1970s and dropped to 1.1 deaths per 100,000 structure fires in the most recent three-year period. The rate of non-sudden-cardiac-death fatalities *outside* of structures dropped over the same time interval to a low of 0.4 deaths per 100,000 structure fires, after reaching a peak of 1.7 in the mid-1980s. (Figure 3)

The one area that had shown marked increases over the period is the rate of deaths due to traumatic injuries while operating inside structures. (Figure 4) In the late 1970s, traumatic deaths inside structures occurred at a rate of 1.8 deaths per 100,000 structure fires and by the late 1990s had risen to approximately 3 deaths per 100,000 structure fires. The rate then dropped over the next several years to 1.7 deaths per 100,000 structure fires, but rose in recent years to more than 3 deaths per 100,000 structure fires. Part of the sharp increase in death rates over the past three years can be explained by a single, nine-fatality fire in 2007, but the dashed line in Figure 4 shows that the trend would still be increasing even without that fire.

Almost all of these non-sudden-cardiac-death fatalities inside at structure fires were the result of smoke inhalation or asphyxiation (63.5 percent), burns (19.5 percent) and crushing or internal trauma (15.3 percent). The rate at which these deaths have occurred per 100,000 structure fires is shown in Figure 5. All three categories were trending upward through the late 1990s, then fell. In this decade, however, asphyxiation and smoke inhalation deaths have climbed back to previous levels (or exceeded previous levels, with the 2007 nine-fatality included). Burn fatalities returned to the rate seen in the late 1990s. Only crushing and other internal traumatic injuries have decreased again, back to the lowest rates over the past 30 years.

The major causes of these traumatic injuries inside structures were firefighters becoming lost inside, structural collapse and fire progression (including backdraft, flashover and explosion). Although individually there were no consistent trends when looking at cause of injury, together there was a clear upward trend over the full 33-year period. (Figure 6)

In order to reduce the number of deaths of firefighters operating inside at structure fires, it is crucially important to understand how they are happening and why they are not decreasing. A detailed look at each incident is beyond the scope of this analysis, but the National Institute for Occupational Safety and Health (NIOSH) has a program of on-site data collection and investigation of on-duty firefighter fatalities that is providing a valuable database. Reports on many of the most recent fatalities can be found on their website: www.cdc.gov/niosh/firehome.html. However, we can give some general findings from the past decade (2000 through 2009).

In that 10-year period, 138 firefighters died while operating inside at structure fires. The deaths were the result of asphyxiation (78 deaths), burns (25 deaths), sudden cardiac death (20 deaths), and crushing injuries or internal trauma (15 deaths). Just over half the deaths occurred at one- and two-family dwellings (71 deaths). There were 24 deaths at retail establishments, 19 in apartment buildings, five in restaurants, four in storage facilities, two in a church, two in a woodmill and one in a nightclub. The remaining 10 deaths were in vacant dwellings (seven deaths), an office building under demolition (two deaths), and a dwelling under renovation (one death).

For the 78 firefighters since 2000 who died of asphyxiation (including smoke inhalation) while operating inside at structure fires, the major causes of injury were caught in structural collapses (27 deaths, of which 18 were in roof collapses, six in floor collapses, two in ceiling collapses and one in a wall collapse), caught by the progress of the fire, backdraft or flashover (24 deaths); and becoming lost inside the structure and running out of air (18 deaths). Five others fell through holes burned in floors, two were exposed to smoke while operating in the structure, one was struck by a falling awning, and one became trapped in product in a grain silo. All but three of the 78 victims were wearing self-contained breathing apparatus. Two of those three were operating at fires in their own homes, and were wearing no personal protective equipment. The third was a fire chief who entered a grain silo to assist fallen firefighters and was asphyxiated himself. Of those who were using SCBA, 14 did not have their facepieces in place. This could be because they removed the facepiece or it was knocked off when the victim fell or was struck. Eight of the 78 asphyxiation deaths were the result of compression or mechanical asphyxia, which can occur when a victim is trapped under debris or in a hole and is unable to breathe.

Of the 25 firefighters who died of burns inside at structure fires since 1990, 13 were caught or trapped by fire progress, backdraft or flashover, seven were caught in structural collapses, two fell through holes burned in floors, two became lost inside the structures and one was trapped by falling debris inside the structure.

Of the 15 firefighters who died as a result of crushing injuries or internal trauma, nine were killed in structural collapses, three jumped or fell from windows, one fell on a camera and ruptured his spleen, one was crushed in a manlift and one was struck by a door and power saw in an explosion.

Full details on construction are not available for many of the collapse incidents and incidents where firefighters fell through floor, but between 2000 and 2009, seven incidents were identified where lightweight wood trusses and/or pre-engineered I-beams were involved in the collapse. These seven incidents claimed nine lives. Eleven firefighters were killed in two fires where steel roof trusses collapsed.

The apparent increase in the rate of firefighter deaths while operating inside at structure fires raises some important questions: Are firefighters putting themselves at greater risk while operating at fires inside structures? Do firefighters think modern protective equipment provides a higher level of protection but do not realize the limitations of that equipment or are ignoring those limitations? Have some aspects of modern building construction or changes in the burning properties of today's contents and furnishings changed the way fires develop? Were adequate resources available on-scene to deal with the various demands presented? This area of the firefighter fatality problem requires closer analysis and NIOSH's investigation program will provide some important answers. In the meantime, there is a lot that can be done to reduce these deaths.

Incident command systems and personnel accountability programs must be in place to ensure that incident managers know where their firefighters are. Firefighters must stay with their crews while operating inside structures. If firefighters encounter difficulties, Rapid Intervention Crews can be crucial in saving lives, but will only work when the locations of firefighters are well tracked and reported correctly.

During fire suppression operations, firefighters must remain highly aware of their surroundings -- conditions can change rapidly and firefighters who have moved too far into a building may find their escape route cut off or too long to traverse. Firefighters must recognize the danger signs -- fires burning in basements and attics indicating the potential for structural collapse, hot smoke and rolling flames at the ceiling indicating a potential flashover, and heavy, dirty smoke pushing through cracks in walls and at eaves indicating a potential backdraft, etc. -- and respect them.

PASS devices must be turned on whenever firefighters enter a structure. Firefighters must be aware of their air supply and usage and exit the building before their low air alarm sounds. Low air alarms must be heeded when they sound, and firefighters operating in large or complex structures must be aware that the time they need to evacuate the building might exceed the time available when they are warned that only 25% of their air supply remains. Firefighters must also know when self contained breathing apparatus can be safely removed.

All these safety recommendations are covered in NFPA's series of standards for the fire service. But one additional point may not have been stressed sufficiently. The various safety recommendations work together as a system, and to a large degree, they rely on each other for their success. Compliance with half of the recommendations, for example, may not produce half of the safety benefit, because so much of the benefit depends on the interaction of the safety provisions. More than ever, it is clear that fire department management and safety officers need to guide their departments to *full* compliance with all safety requirements.

Anecdotally, there is a growing concern in the fire service related to whether firefighters and fire officers receive the degree of training and experience necessary to properly assess the risks on the fire ground. If the number of structure fires is decreasing, how in fact do firefighters and fire officers gain the experience to understand fire progression, fire behavior, and what happens to the structural integrity of a building under fire conditions?

Training is an integral component to allow firefighters and fire officers alike the opportunity to learn the intricate and un-exact science of firefighting. Computer and other types of simulations, where trainees are "put in the hot seat" of making decisions using incident command and fighting fires in different types of building construction, can help. The components of the command system, and its risk management decision-making process, can all be learned in the classroom simulation environment. A careful critique of fire ground procedures following each fire, including an analysis of what went right and what went wrong, is a great opportunity not only for the people involved but for those firefighters and officers who were not at the incident to learn and improve their understanding of fire behavior.

Pre-incident planning is a key element in training, as well. A pre-incident plan can help responders identify critical features of a structure and its contents and help to anticipate potential scenarios and develop tactical options. The 2010 edition of NFPA 1620, *Pre-Incident Planning*, was a complete revision of the previous edition, and changes the document from a recommended practice to a standard, with minimum requirements for developing pre-incident plans for emergency responders. It is important to note, however, that over half of the firefighter deaths while operating inside at structure fires in the past 10 years occurred at house fires, which would not be subject to pre-incident plans.

NFPA has standards for training, professional qualifications, and incident management. It is incumbent upon today's fire service leaders to provide the certification and recurrent training as well as the proper promotional assessment processes to ensure company and chief officers understand the environment their firefighters are exposed to and the proper operational procedures to deal with that environment so the safety of everyone on the fireground is improved. The fireground is a very unforgiving learning environment.

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1. Fahy, R.F., LeBlanc, P.R. and Molis, J.L., " Firefighter Fatalities in the United States -- 2009," National Fire Protection Association, Quincy MA, July 2010.

2. Karter, M.J., " Fire Loss in the United States," National Fire Protection Association, Quincy MA, August 2009 (revised September 2009).

Figure 1
The drop in firefighter deaths at structure fires follows, and recently surpasses, the drop in structure fires

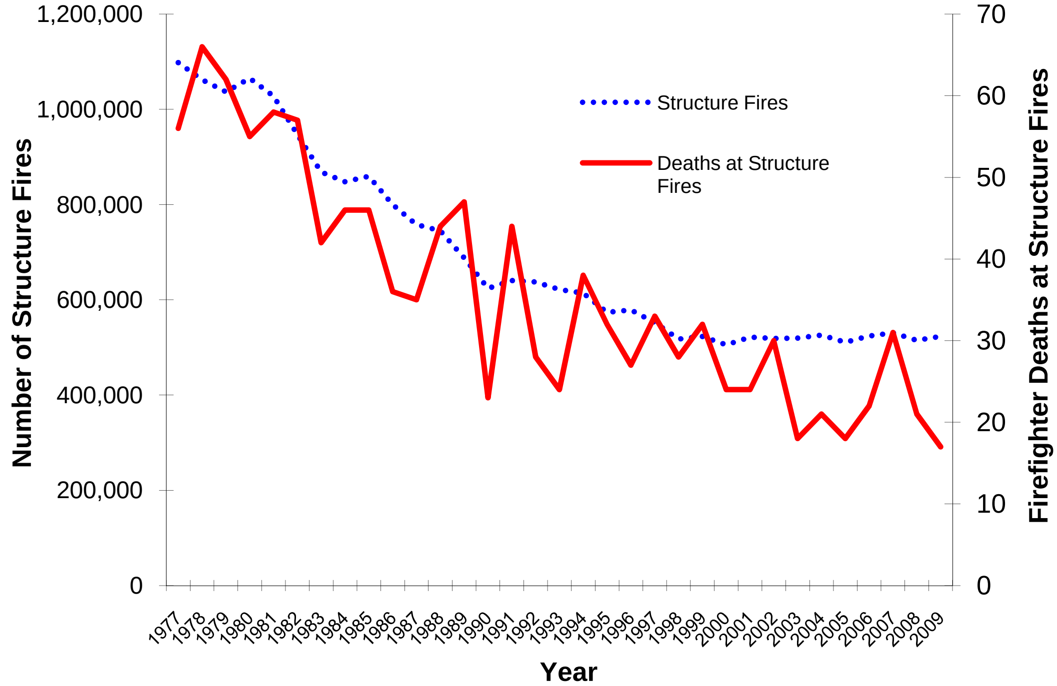

Figure 2
While the number of structure fires and deaths at structure fires has dropped, the rate of firefighter deaths at structure fires has not followed the same pattern

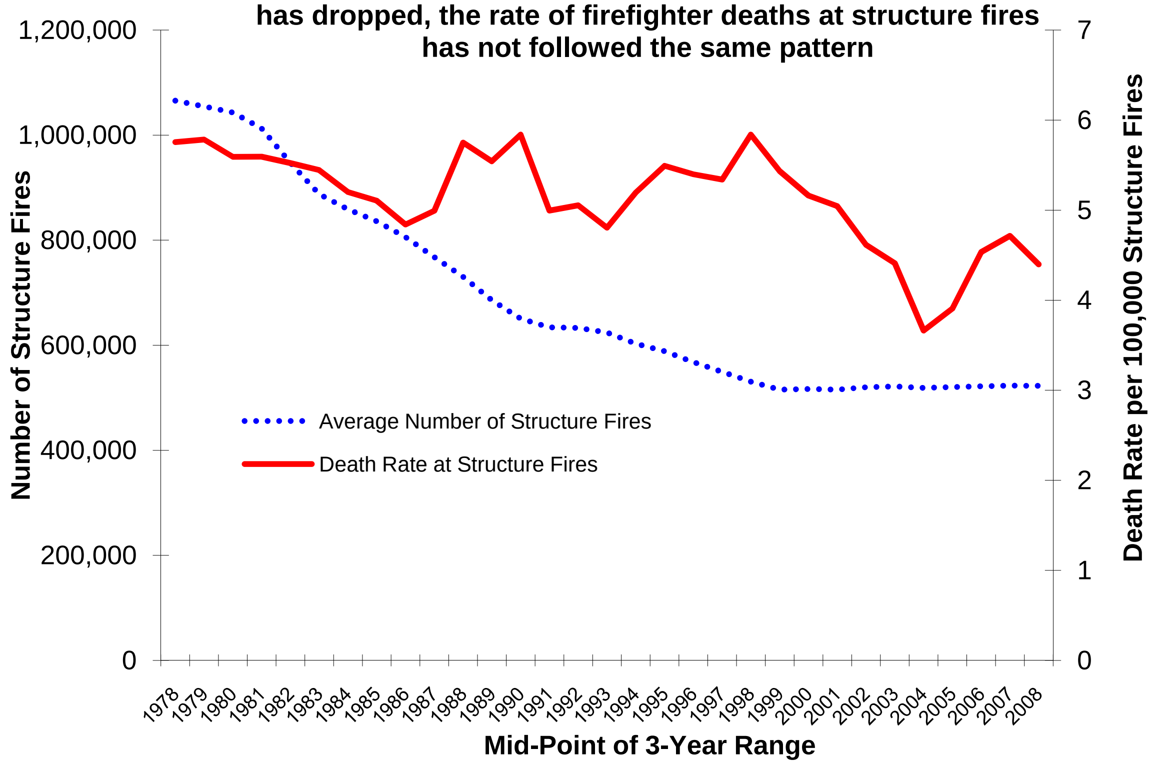

Figure 3
The rate of sudden cardiac deaths at structure fires and non-SCD deaths outside structure fires have been dropping, although the decrease for deaths outside has not been steady.

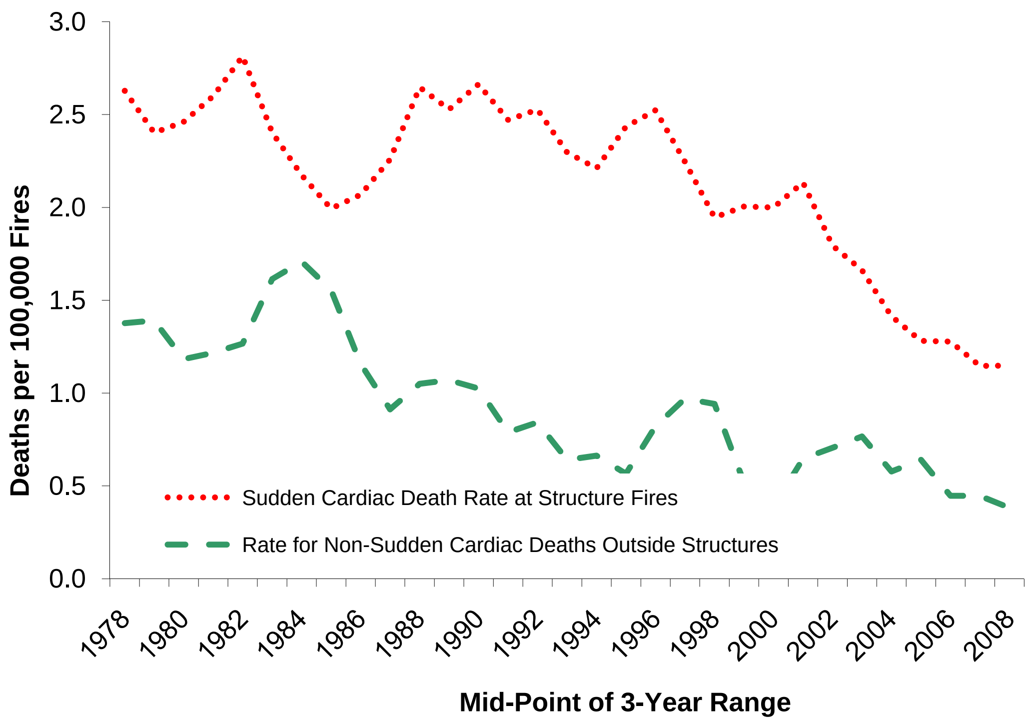

Figure 4
While the rate of non-cardiac deaths outside structure fires has been dropping, the rate for non-cardiac deaths inside remains high

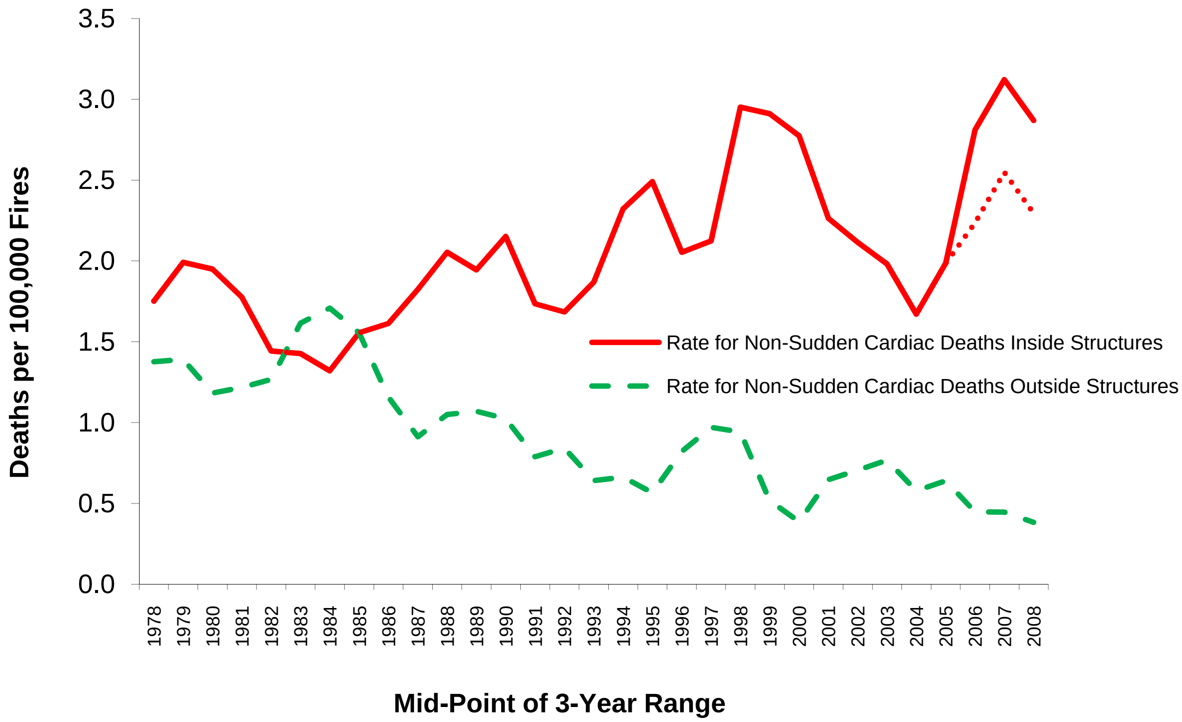

Figure 5
Almost all of the non-cardiac deaths inside structure fires were due to smoke inhalation, burns or crushing injuries, and the death rates due to these causes have not been falling.

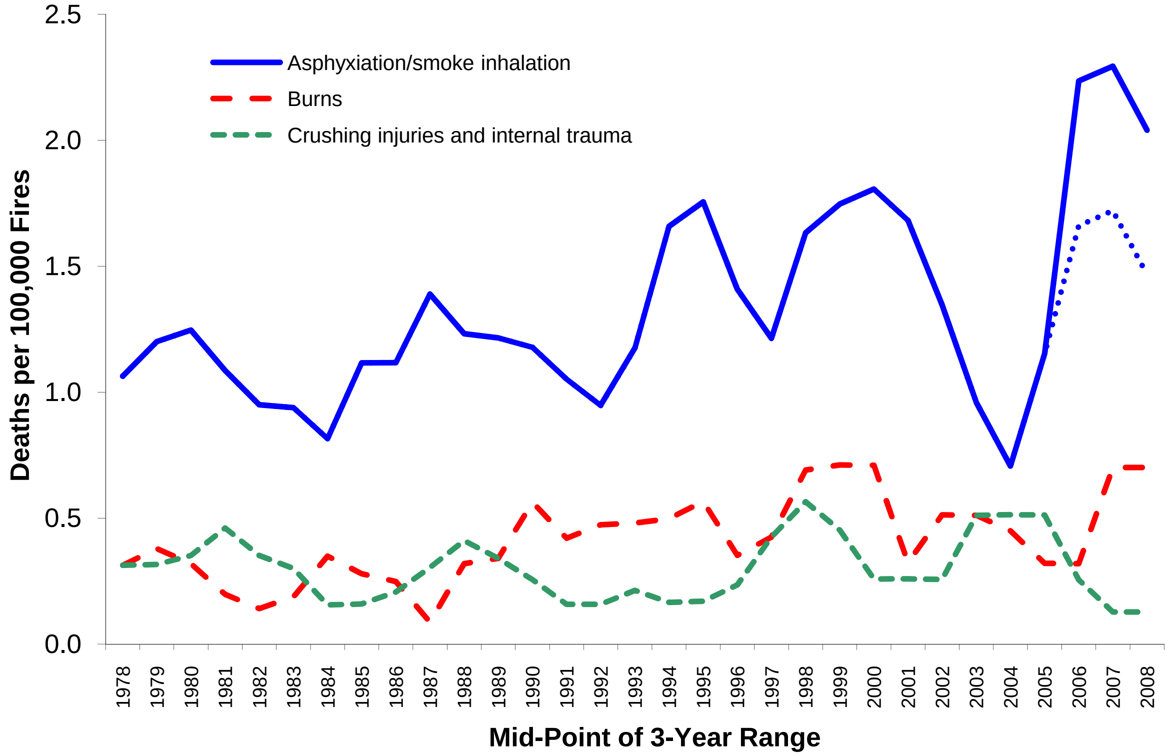

Figure 6
Death Rates for the Three Major Causes of Fatal Injuries 1977 - 2009