FIREFIGHTER FATALITIES IN THE UNITED STATES – 2006

AND

WHAT'S CHANGED OVER THE PAST 30 YEARS?

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
www.nfpa.org

FIREFIGHTER FATALITIES IN THE UNITED STATES – 2006

AND

WHAT'S CHANGED OVER THE PAST 30 YEARS?

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
www.nfpa.org

FIREFIGTHER FATALITIES IN THE UNITED STATES – 2006

Rita F. Fahy
Paul R. LeBlanc
Joseph L. Molis
Fire Analysis and Research Division
National Fire Protection Association

June 2007

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
www.nfpa.org

Abstract

In 2006, a total of 89 on-duty firefighter deaths occurred in the U.S. This is a slight increase over the 87 firefighter fatalities that occurred in 2005. It was the second consecutive year, and the fifth out of the last 10 years, that the total number of deaths has been below 100. The largest share of deaths (38 deaths) occurred on the fire ground. Stress, exertion, and other medical-related issues, which usually result in heart attacks or other sudden cardiac events, continued to be the leading cause of fatal injury. Of the 38 stress-related fatalities in 2006, 34 (38%) were classified as sudden cardiac deaths.

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

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities who participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

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

For more information about the National Fire Protection Association, visit www.nfpa.org or call 617-770-3000. To learn more about the One-Stop Data Shop go to www.nfpa.org/osds or call 617-984-7450.

Copies of this analysis are available from:

National Fire Protection Association
One-Stop Data Shop
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org
e-mail: osds@nfpa.org
phone: 617-984-7450

2006 Experience

In 2006, a total of 89 on-duty firefighter deaths occurred in the U.S. This is a slight increase over the 87 firefighter fatalities that occurred in 2005. It was the second consecutive year, and the fifth out of 10 years, that the total number of deaths has been below 100.[1] Figure 1 shows firefighter deaths for the years 1977 through 2006, excluding the 340 firefighter deaths at the World Trade Center in 2001.

Of the 89 firefighters who died while on duty in 2006, 46 were volunteer firefighters, 23 were career firefighters, nine were employees of federal land management agencies, four were employees of state land management agencies, three were contractors to federal land management agencies, two were contractors to state land management agencies, one was a member of a prison inmate fire crew and one was a member of an industrial fire brigade.

In 2006, there were six multiple-fatality incidents -- the two most severe incidents killing a total of nine wildland firefighters. Five of these nine were overrun at a wildland fire and fatally injured (see incident summary). Three federal wildland agency firefighters on firewatch duty and a contract pilot were killed when their helicopter crashed on the way back from the lookout tower to the helibase. There were two additional fatal aircraft crashes on wildland fires. In one, two federal contractors were killed when their helicopter crashed into a river while they were refilling its water tanks. In the other, a firefighter and a state contractor died when their spotter plane crashed into trees in mountainous terrain during a reconnaissance flight. Four firefighters were killed in structural collapses in two fires in commercial properties -- two when a wall collapsed during overhaul operations and the other two when the floor collapsed beneath them.

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.[2] Since this is the 30th year that NFPA has published this report, we include a special look back over the progress that has been made in reducing on-duty firefighter deaths, and some of the issues that must be addressed to reduce the numbers further. 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 firefighter on-duty 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. 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 89 deaths by type of duty. Fire ground operations accounted for 38 deaths. Although this category continues to account for fewer than half of the on-duty fatalities, it is the highest reported number of such deaths since 2002, when 46 firefighters were fatally injured at fires. Seventeen of the victims were local volunteer firefighters and nine were municipal career firefighters.[3] Eleven of the victims worked for state or federal land management agencies and one was a member of a prison inmate crew.

There were 18 fatalities while responding to or returning from alarms -- half of them in collisions and rollovers and half due to sudden cardiac events. Seventeen of the victims were volunteer firefighters and one was a contractor to a state land management agency.

Eight deaths occurred during training activities. These included four during physical fitness activities, one at the station during preparation for a drill, one during an extrication drill, one during surf rescue training and one after live fire training.

Six firefighters were killed at non-fire emergencies, including four at scenes of motor vehicle crashes, one at an EMS call and one at a false alarm.

The remaining 19 firefighters died while involved in a variety of non-emergency-related on-duty activities. These activities included normal administrative or station duties (six deaths), community events (four deaths), errands (four deaths), and maintenance (one death). And finally, three firefighters and a contract pilot were killed when their helicopter crashed on its way back to the helibase.

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 exertion, stress and other (often medical) issues made up the largest category of fatalities. Of the 38 deaths in this category, 34 were classified as sudden cardiac deaths (usually heart attacks), three were due to strokes and one was determined to be either a sudden unexplained ventricular arrhythmia or a seizure. There is more detail on sudden cardiac deaths in a separate section of this article.

The second leading cause of fatal injury was struck by an object or contact with an object. The 28 firefighters killed included 19 in motor vehicle crashes and three struck by motor vehicles. Those deaths are discussed in a separate section of this article. Two firefighters were struck by a collapsing wall while operating outside at a structure fire, and another was struck and killed at a structure fire when an awning fell from a building. One firefighter cut his hand on a piece of equipment while working at the scene of a vehicle crash and his hand became infected. A firefighter was struck by a tree that was knocked over in the creation of a fireline. One firefighter was struck in the head by a rope that snapped while he was trying to tow a stuck apparatus at a wildland fire.

The next leading cause of fatal injury was caught or trapped, resulting in 20 deaths. Ten of these 20 firefighters were trapped by fire progress; seven of those 10 were on wildland fires and three were at structure fires. Five were killed in floor collapses and another when a ceiling collapsed. Three firefighters became lost inside fire-involved structures and ran out of air. A firefighter standing on top of a rescue vehicle in the station became caught between the vehicle and a ceiling beam and crushed when the driver drove out of the station without realizing he was there.

One firefighter fell from a fire apparatus at a prescribed burn. One firefighter was electrocuted while recovering a tarp from a fire-damaged roof. One firefighter was killed in a tornado while responding to the fire station.

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, 34 deaths, were due to sudden cardiac death. The other major categories were internal trauma (26 deaths), asphyxiation (nine deaths), burns (nine deaths), stroke or

aneurysm (three deaths) and crushing injuries (three deaths). The remaining deaths included two drownings, one electrocution, one due to septicemia and one due to a sudden arrythmia or seizure.

Sudden Cardiac Deaths

The number of on-duty sudden cardiac deaths in 2006 was at the lowest level in the 30 years that NFPA has done this study. Sudden cardiac death, most often the result of heart attack, is typically the leading nature of injury and usually accounts for close to half of the total on-duty deaths. When NFPA began publishing this study in 1977, the number of sudden cardiac deaths was over 70. Deaths in this category had fallen 25 percent by 1990. Since then, however, the number of sudden cardiac deaths has generally been between 40 and 50 each year, down approximately one-third since the late 1970s.

Of the 34 victims of sudden cardiac events in 2006, 15 were reported to have had prior heart problems -- usually prior heart attacks, bypass surgery or angioplasty/stent placement -- and post mortem medical documentation showed that 11 had severe arteriosclerotic heart disease, two had diabetes and three were hypertensive. (Some of the victims had more than one condition.) Over the past 25 years, post mortem information or other details on the victims' medical histories have been available for 713 of the 1,177 sudden cardiac death victims. Of those 713 victims, 603 (or 84.6 percent) had suffered prior heart attacks, had severe arteriosclerotic heart disease, had undergone bypass surgery or angioplasty/stent placement, or were diabetic.

Ages of Firefighters

The firefighters who died in 2006 ranged in age from 17 to 78, with a median age of 43 years. Figure 5 shows the distribution of firefighter deaths by age and cause of death (sudden cardiac death versus other causes).

Sudden cardiac death accounts for a higher proportion of the deaths among older firefighters, as might be expected. Almost 60 percent of the firefighters over age 40 who died in 2006 died of heart attacks or other cardiac events. The youngest victim of sudden cardiac death was aged 19; cardiomyopathy was found on autopsy. The condition had not been diagnosed previously.

Figure 6 shows death rates by age, using career and volunteer firefighter fatality data for the five-year period from 2002 through 2006 and estimates of the number of career and volunteer firefighters in each age group from the NFPA's 2004 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 less than half the all-age average. Firefighters in their 30s had a death rate approximately two-thirds the all-age average. The rate for firefighters in their fifties was almost twice the average and for firefighters age 60 and over, it was close to four times the average. Firefighters age 50 and over accounted for two-fifths of all firefighter deaths over the five-year period, although they account for fewer than one-fifth of all firefighters.

Fire Ground Deaths

Of the 38 fire ground deaths, 10 were due to internal trauma, nine to asphyxiation, nine to burns, eight were due to sudden cardiac death and one each were due to crushing injuries and drowning.

Figure 7 shows the distribution of the 38 fire ground deaths by fixed property use. The largest share of fire ground deaths in 2006 occurred on wildland fires (16 deaths). This is the highest number of deaths on wildland fires since 1999 when 17 firefighters were killed.

Fifteen of the 22 structure fire deaths occurred in residential properties. Fires in single-family dwellings killed 14 firefighters and a fire in an apartment building killed one firefighter. There were five deaths in three fires in stores. There was also one death in a fire in a vacant dwelling, and one death at a fire in a building undergoing renovations. None of the structures involved in fatal fires in 2006 were reported to have had automatic suppression systems installed.

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 2001 through 2005 (the 2006 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 vacant buildings and some nonresidential structures, such as mercantile and public assembly properties, are more hazardous to firefighters, on average. There were 6.5 fire ground deaths per 100,000 nonresidential structure fires from 2001 through 2005, compared to 3.7 deaths per 100,000 residential structure fires. The highest death rates over the five-year period occurred in stores and offices. The low rate in health care/correctional and educational buildings 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 reflects the small number of fatalities that have occurred in such structures in recent years.

Vehicle-Related Incidents

In 2006, 19 firefighters died in vehicle crashes. In addition to those deaths, three others were fatally struck by vehicles and one firefighter fell from a tanker.

Eight of the 19 firefighters killed in crashes were responding to or returning from incidents when the crashes occurred. All were single-fatality crashes.

Four of these eight victims were driving or riding in pumpers or water tenders:

- One firefighter was driving a pumper back to the station after a structure fire when the brakes failed. He tried to avoid a steep grade and stop the vehicle by driving into an open gravel pit, but he lost control of the vehicle, it rolled over and he was ejected. The investigation revealed that the brake line had cracked and brake fluid had leaked out. The victim was not wearing a seatbelt.
- A firefighter driving a brush truck back to crew quarters while assigned to a wildland fire drifted onto the shoulder of the road, overcorrected, and overturned. He was not wearing a seatbelt and was ejected. Alcohol was reported to be a factor in this crash.
- A cadet firefighter, riding as passenger in a tanker enroute to a house fire, was killed when the vehicle's brakes overheated and failed on a steep grade leading down to a single-lane bridge. The vehicle did not slow on the curve approaching the bridge, struck the guardrail and flipped off the bridge, landing upside down in the creek bed. The vehicle, which was formerly a propane delivery truck, had two seats and was not

equipped with seatbelts. Four firefighters were traveling in the vehicle -- two sitting in the passenger seat and the victim sitting on the floor between the two seats. The victim was trapped in the crushed cab.

- A firefighter driving a tanker on mutual aid to a structure fire lost control of the vehicle when the water in the tank shifted on a curve. He overcorrected, and the vehicle rolled, ejecting him. The victim was driving 63 mph in a 55 mph zone and was not wearing a seatbelt.

Three of the crashes while responding to alarms involved personal vehicles:

- A firefighter driving to the fire station to respond to a fire alarm struck a tractor-trailer that was turning across the road from an intersecting street. The victim was speeding. No information was reported about seatbelt use, but he was not ejected.
- Another firefighter, driving over the speed limit to the fire station to respond to a motor vehicle crash, crashed into a utility pole. Wet pavement and speed were reported as factors in the crash. No information on seatbelt use was reported, but the victim was not ejected.
- A firefighter, responding on his motorcycle to the fire station for a call for a motor vehicle crash, failed to stop at a stop sign and hit a car in the intersection. Excessive speed was cited as a factor in this crash.

The eighth crash responding to or returning from emergency calls involved a rescue vehicle:

- The firefighter driving the rescue to a medical call for a woman in labor lost control of the vehicle on a curve and the vehicle slid, striking a utility pole on the driver's side. Excessive speed was cited as a factor in the crash. The victim was not wearing a seatbelt and was not ejected.

Five firefighters were killed in three crashes while operating over or on wildland fires.

- Two contractors for a federal wildland management agency were killed when the tail rotor gearbox fell off their helicopter, causing it to crash into a river while they were refilling the helicopter's water tanks. The final NTSB report on this crash has not been released yet.
- A firefighter and a contractor for a state wildland management agency died when their spotter plane crashed into trees in mountainous terrain during a reconnaissance

flight. No cause for the crash has been reported yet, and the final NTSB report has not yet been released.

- A firefighter died four weeks after being injured when his brush truck with a 1,000-gallon water tank overturned and rolled down a ravine when he attempted to retreat from a brush fire during pump-and-roll operations alongside a roadway. He was driving in soft sand, between the paved shoulder and a drop-off into a ravine. When he tried to back up, the driver's side wheels lost traction and the overloaded truck overturned. The tank was not baffled. The driver was not wearing a seatbelt and was ejected.

The remaining fatal crashes occurred while firefighters were engaged in a variety of on-duty activities:

- In the helicopter crash mentioned earlier, a contractor and three employees of a federal wildland management agency were killed. No details on the cause of the crash are available. The final NTSB report on this crash has not been released yet.
- After three hours of practicing loading and unloading a personal water craft (PWC) during surf rescue training in deep rough water, a fatigued firefighter drowned after his PWC capsized. He was wearing a dry suit and using a personal flotation device.
- A firefighter driving his personal vehicle to pick up surplus federal equipment crossed the centerline on the highway and struck a tractor trailer truck head on. He was wearing his seatbelt and was not ejected. It was daytime, but the road was wet. The victim's inattention and improper lane change were cited as factors in the crash.

Of the 10 deaths in road vehicles mentioned above, six of the victims were not wearing seatbelts (four were ejected), one was wearing his seatbelt, and one crash involved a motorcycle. Seatbelt use was not reported in the other two crashes. Excessive speed was a factor in at least five of the 10 crashes, and brake failures were cited in two others. Alcohol may have been a factor in one crash.

Three firefighters were struck by vehicles and killed. In the first incident, the victim had responded to a pre-dawn multi-car crash that occurred when moisture on the highway froze suddenly. Vehicles traveling 65-70 mph on the highway could not see the pileup until they came around a curve in the road. The driver of the truck that struck the firefighter was trying to avoid

another vehicle in front of him, and slid sideways across all traffic lanes. The victim, who was wearing personal protective equipment, lost her helmet when she was struck and suffered fatal head injuries. At the time of the fatal crash, a police officer was trying to place flares along the roadway to warn oncoming traffic. In the second incident, the victim was spray painting markings on a highway to indicate the location of hydrants. He stopped his brush truck in the passing lane of the roadway, leaving the hazard lights operating, and worked in front of the truck. A vehicle approaching at close to the speed limit in the same lane rear-ended the truck, which crushed the firefighter. In the third incident, a firefighter was struck by a vehicle backing out of a space in the parking lot of a bank while he was headed to deposit the fire department's bingo money. Careless driving and deficiencies in the vehicle's braking system were cited as factors in the incident.

And, finally, a firefighter fell out of the driver's seat of a water tender at a prescribed burn and was run over. Alcohol was reportedly a factor in the incident.

Other Findings

From 1997 through 2006, 69 firefighters (6.9 percent of all on-duty deaths) died in connection with intentionally-set fires. The share of these deaths annually has been dropping since 1985, in part because of the decline in intentionally-set fires over the same period; however, the number of such deaths in 2006 is the highest since 2002. Five firefighters died at one intentionally-set wildland fire, and three others were killed in connection with intentionally-set structure fires -- two while responding to fires and one while at the scene.

In 2006, a total of 24 firefighters were killed either on wildland fires, while responding to or returning from duty on wildland fires, or during activities associated with wildland fires. This is the third highest total in the last 10 years.

One firefighter suffered a fatal stroke at the scene of a false alarm in 2006. Over the past 10 years, 32 firefighter deaths have resulted from false calls, whether malicious or alarm malfunctions.

Of the eight training deaths, five firefighters suffered sudden cardiac death and another firefighter suffered a stroke; one firefighter drowned; and one was crushed.

Of the six deaths at non-fire emergencies, three were the result of sudden cardiac events; and one each from stroke, being struck by a vehicle, and a cut finger that became infected.

The distribution of deaths of career and volunteer firefighters from local fire departments is shown in Figure 9. The highest number of career and volunteer firefighter deaths occurred in 1977 and 1978, respectively. The annual death toll has fallen since then, with a steadier decline for the career fire service. The most recent sustained drop for both groups started in 1999. The 23 deaths of career firefighters in 2006 is the lowest number since 1993; the 46 deaths of volunteer firefighters is the lowest since 1994. Over the past 10 years, there have been an average of 58 volunteer firefighter deaths and 29 career firefighter deaths annually. A comparison of the fatality experience of the 69 career and volunteer firefighters killed in 2006 is shown in Table 1.

Conclusions

Although the total on-duty death toll in 2006 is only slightly higher than for 2005, there are some important differences worth calling out:

- Deaths at fires were at their highest level over the past four years. This was due largely to the increase in the number of deaths on wildland fires; deaths at structure fires over the same period have plateaued at approximately 20 per year.
- The lowest number of on-duty heart attacks deaths reported over the years of this study occurred in 2006.
- Deaths during training activities, highlighted in the 2005 fatality article, were at their lowest level since 1999.
- The number of career and volunteer firefighter fatalities were both close to their all-time lowest levels in 2006; the number of other types of firefighters killed on-duty was third highest since 1977.

Other patterns continue to appear in much the same form, year after year. Again in 2006, sudden cardiac death, usually heart attacks, accounted for the largest share of on-duty firefighter fatalities. A very large proportion of the victims had serious health problems, which had not necessarily been diagnosed or treated.

The risk factors for heart disease are well-known and *NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments*, outlines procedures for fire departments to follow in screening candidate firefighters and handling health problems that

might arise during an individual's fire service career. *NFPA 1500, Standard on Fire Department Occupational Safety and Health Program*, requires the establishment of a firefighter health and fitness program based on *NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters*, and requires that firefighters meet the medical requirements of *NFPA 1582*. Other information on developing a wellness-fitness program is available from the IAFC/IAFF Fire Service Joint Labor Management Wellness-Fitness Initiative.

Some very worrisome data on the health status of firefighters has been collected by the National Volunteer Fire Council (NVFC) over the past few years, as part of their Heart-Healthy Firefighter Program. At trade shows around the country, the program has screened over 5,000 firefighters, both career and volunteer, for blood pressure, cholesterol, body fat and glucose. (Almost 11,000 show participants, in all, have been screened.) 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. Of the almost 2,000 firefighters tested for body fat distribution 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). The blood pressure screenings in 2005 and 2006 found that 6.8 percent of the tested firefighters had Stage 2 hypertension; 31.5 percent had Stage 1 hypertension; and 46.4 were prehypertensive. Only 15.2 percent had normal blood pressure readings. Almost all of the 2,572 firefighters tested for glucose (non-fasting) in 2006 were found to be in the desirable range, with only 2.8 percent found to be diabetic and 6.3 percent pre-diabetic. Cholesterol screening done over the three years of the project found high or borderline high levels in 38.4 percent of the 5,411 firefighters tested. Through this program, many firefighters have come to understand their personal level of risk, and have adopted a more heart-healthy lifestyle. More information can be found at: www.healthy-firefighter.org.

Deaths in crashes continue to account for a significant proportion of the annual fatalities. Crashes are, in fact, the second leading cause of on-duty fatalities. In the 10 road crash deaths in 2006, six victims were not wearing seatbelts, and excessive speed was a factor in at least five crashes. 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. 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.

But, the focus of vehicle safety programs should not be exclusively on fire department apparatus, since personal vehicles were the vehicles most frequently involved in road crashes, accounting for almost a third of the road crash deaths from 1997 through 2006. The last edition of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, added 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.

NFPA partnered with many other fire service organizations to co-sponsor the third annual International Fire and EMS Safety Stand Down. The theme of the 2007 Stand Down was "Ready to Respond." This annual event is an important step in raising awareness across the fire service as to the steps fire departments and individual firefighters can take to reduce the risk of death and injury.

As demonstrated in the accompanying article, real progress in reducing firefighter on-duty fatalities has been made in some areas over the past 30 years. The fact that fewer than 90 firefighters were killed in each of the last two years is further evidence of this. However, sudden cardiac deaths and crashes continue to be major problems. Efforts must continue to reduce the incidence of heart disease among firefighters, especially by addressing the known risk factors. Driver and passenger safety, particularly the use of seatbelts, can have a direct and immediate impact on reducing some of the particularly preventable firefighter fatalities.

References

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

2.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.

3.For this report, the term *volunteer* refers to any firefighter whose principle 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.

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 2004," NFPA Fire Analysis and Research Division, Quincy, Massachusetts, January 2006. The analysis shown here assumes that the number of firefighters adequately estimates exposure and that the age distribution of career and volunteer firefighters is similar.

Credits

A study made possible by the cooperation and assistance of the United States fire service, the Public Safety Officers' Benefits Program of the Department of Justice, the United States Fire Administration, the National Institute for Occupational Safety and Health, 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 Thomas Hales, MD, MPH, of NIOSH, and Carl E. Peterson of NFPA's Public Fire Protection Division 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-on-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 increases as a result. The enactment of the USA PATRIOT bill in 2001 increased the benefit to $250,000. The current benefit is $295,194, tax free.

A decedent's spouse and minor children usually are the eligible beneficiaries. As a result of the reauthorization of the 2002 Mychal Judge Act, when there is no spouse or children, the PSOB Act now provides the benefits to the individual(s) designated by the officer at the time of death on the most recently executed designation of beneficiary on file with the officer's organization, or on the officer's most recently executed life insurance policy on file with the officer's organization. See the website below for full details.

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 benefit. Students may apply for PSOEA funds for up to 45 months of full-time classes. As of October 1, 2006, the maximum benefit a student may receive is $860 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 Program, 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.

Table 1
Comparison of On-Duty Deaths Between Career and Volunteer Firefighters, 2006*

	Career Firefighters		Volunteer Firefighters	
	Number of Deaths	**Percent of Deaths**	**Number of Deaths**	**Percent of Deaths**
Type of duty				
Operating at fire ground	9	39 %	17	37%
Responding to or returning from alarm	0	0	17	37
Operating at non-fire emergencies	4	17	2	4
Training	4	17	2	4
Other on-duty	6	26	8	17
TOTALS	23	100 %	46	100 %
Cause of fatal injury				
Exertion/stress/other related	12	52 %	23	50%
Struck by or contact with object	4	17	14	30
Caught or trapped	7	30	6	13
Fell	0	0	1	2
Other	0	0	2	4
TOTALS	23	100 %	46	100 %
Nature of fatal injury				
Sudden cardiac death	9	39 %	23	50%
Internal trauma	2	9	15	33
Asphyxiation	4	17	4	9
Burns	2	9	1	2
Crushing	1	4	2	4
Stroke/aneurysm	2	9	0	0
Drowning	1	4	0	0
Septicemia	1	4	0	0
Electrocution	0	0	1	2
Undetermined	1	4	0	0
TOTALS	23	100 %	46	100 %
Rank				
Firefighter	15	65 %	35	76%
Company officer	7	30	5	11
Chief officer	1	4	6	13
TOTALS	23	100 %	46	100 %

Table 1
Comparison of On-Duty Deaths Between Career and Volunteer Firefighters, 2006* (Continued)

	Career Firefighters		Volunteer Firefighters	
	Number of Deaths	**Percent of Deaths**	**Number of Deaths**	**Percent of Deaths**
Ages of Firefighters **All deaths**				
20 and under	0	0 %	3	7%
21 to 25	1	4	4	9
26 to 30	0	0	0	0
31 to 35	4	17	5	11
36 to 40	3	13	4	9
41 to 45	4	17	6	13
46 to 50	3	13	2	4
51 to 55	6	26	2	4
56 to 60	0	0	10	22
Over 60	2	9	10	22
TOTALS	23	100 %	46	100 %
Ages of Firefighters **Sudden cardiac deaths only**				
20 and under	0	0%	1	4%
36 to 40	1	11	1	4
41 to 45	1	11	3	13
46 to 50	3	33	2	9
51 to 55	4	44	2	9
56 to 60	0	0	7	30
over 60	0	0	7	30
TOTALS	9	100 %	23	100 %
Fire ground deaths by fixed property use				
Dwellings and apartments	4	44%	10	59%
Wildland	0	0	5	29
Stores	3	33	2	12
Vacant house	1	11	0	0
Building under renovation	1	11	0	0
TOTALS	9	100 %	17	100 %

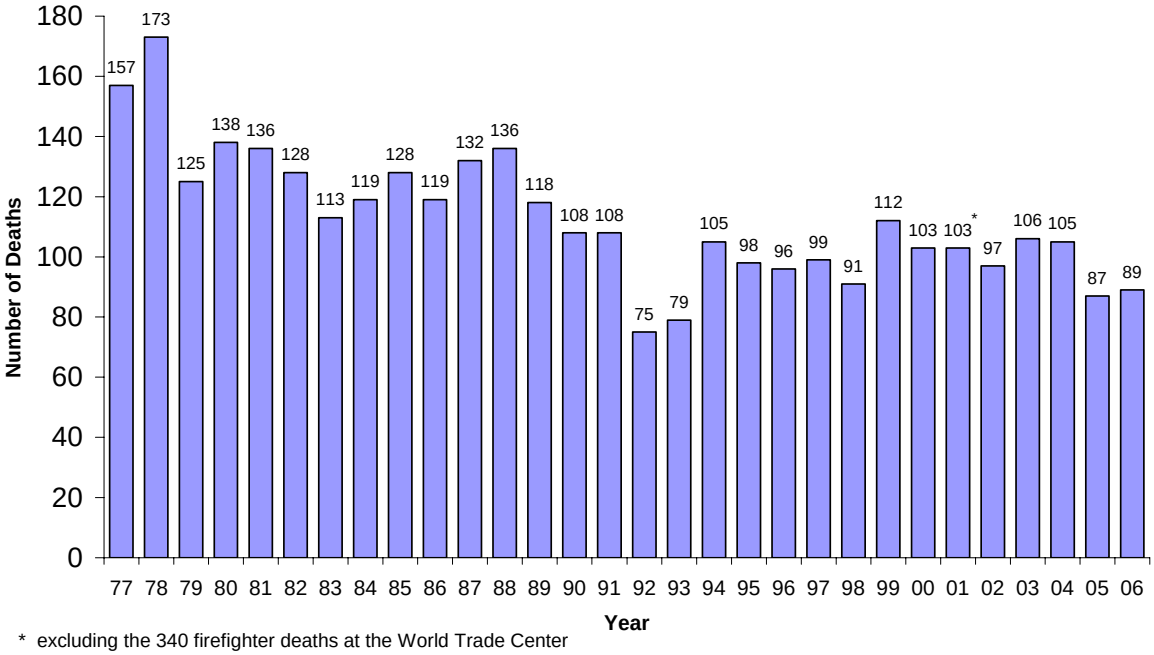
Table 1
Comparison of On-Duty Deaths Between Career and Volunteer Firefighters, 2006* (Continued)

	Career Firefighters		Volunteer Firefighters	
	Number of Deaths	**Percent of Deaths**	**Number of Deaths**	**Percent of Deaths**
Years of service				
5 or less	2	9 %	13	28%
6 to 10	4	17	7	15
11 to 15	1	4	4	9
16 to 20	8	35	3	7
21 to 25	3	13	3	7
26 to 30	5	22	1	2
over 30	0	0	12	26
Not reported	0	0	3	7
TOTALS	23	100 %	46	100 %
Attributes of fire ground deaths**				
Intentional fires	0		1	
Search and rescue operations	2		1	
Motor vehicle crashes	1		9	
False alarms	1		0	

* This table does not include the 20 victims who were employees of or contractors for state or federal land management agencies, or members of prison crews or industrial fire brigades.

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

Figure 1
On-Duty Firefighter Deaths - 1977-2006



* excluding the 340 firefighter deaths at the World Trade Center

Figure 2
Firefighter Deaths by Type of Duty - 2006

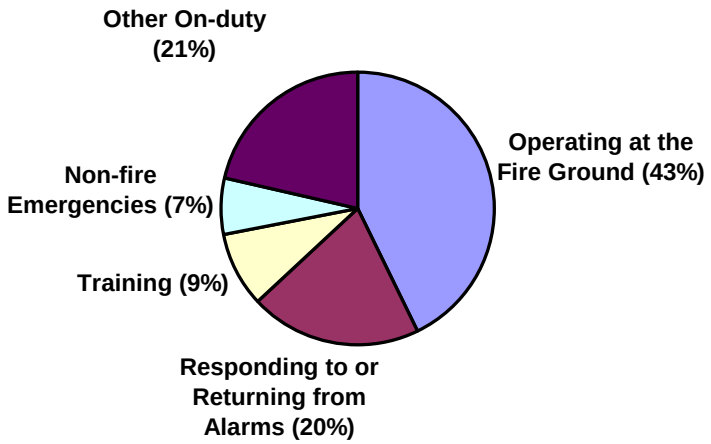


Figure 3
Firefighter Deaths by Cause of Injury -- 2006

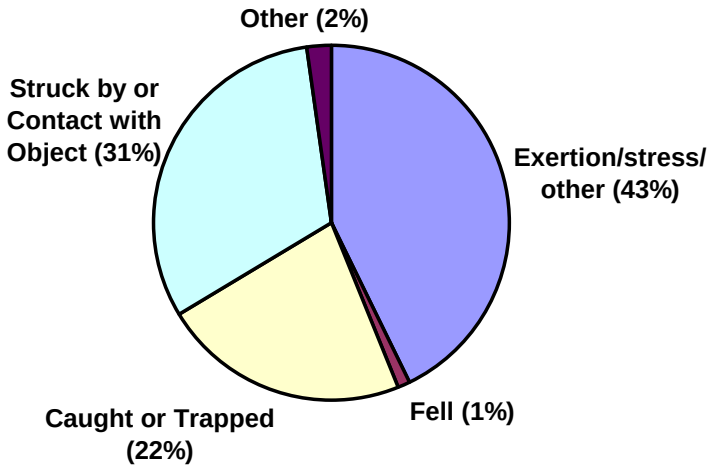


Figure 4
Firefighter Deaths by Nature of Injury -- 2006

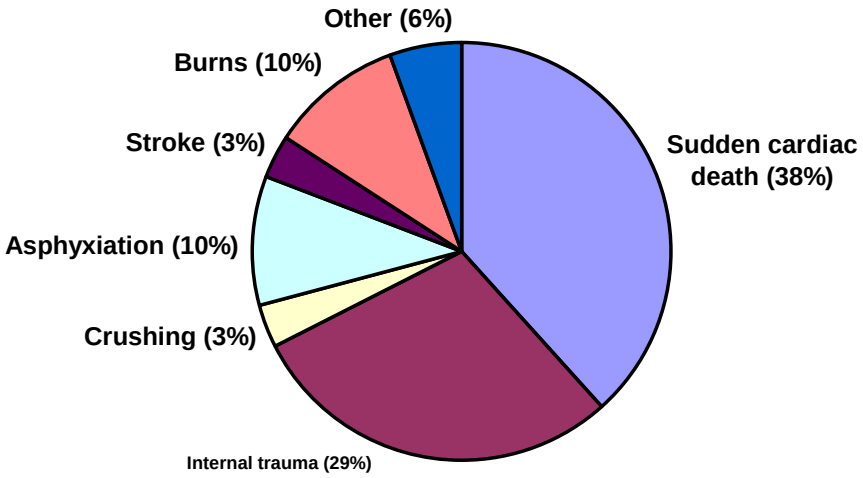


Figure 5
On-Duty Firefighter Deaths by Age and Cause of Death -- 2006

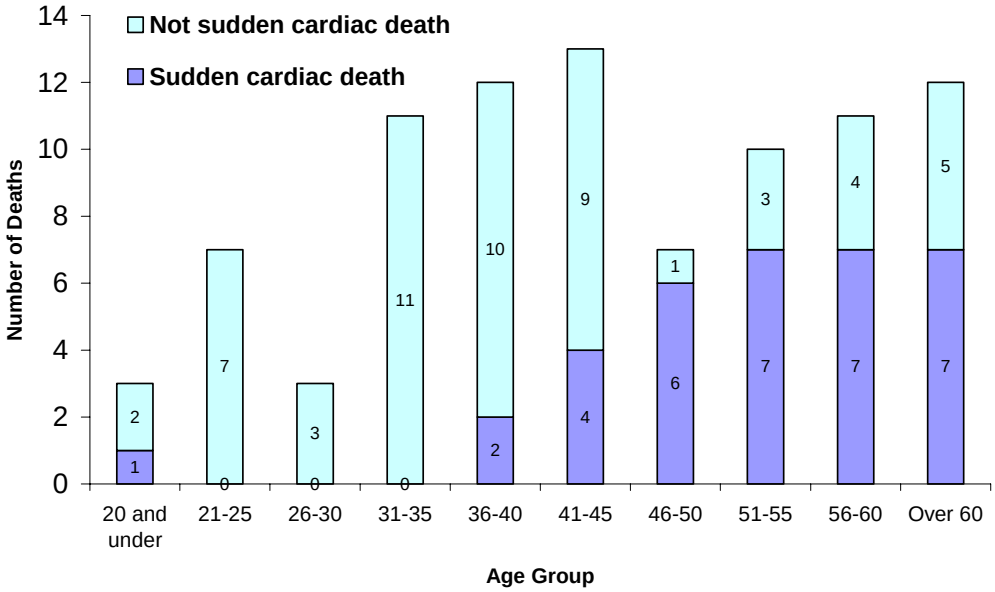
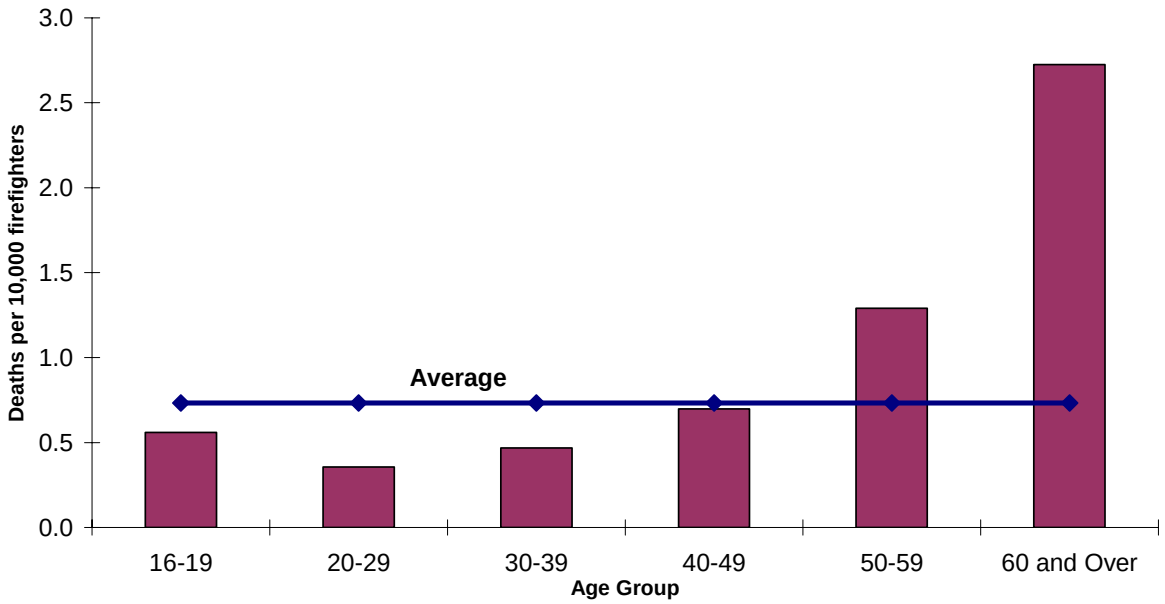
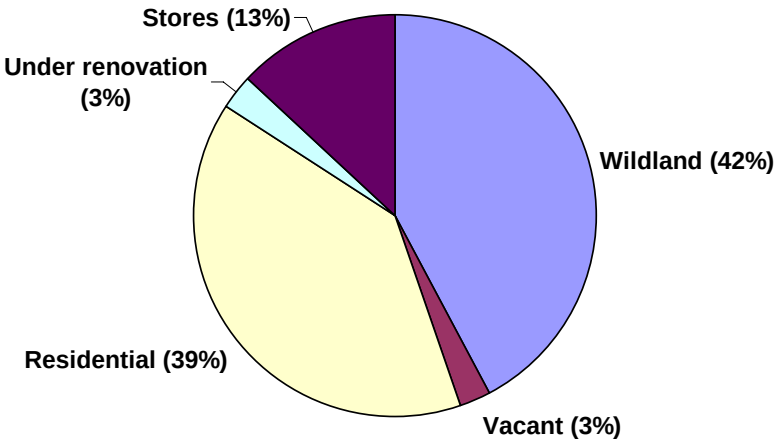


Figure 6
On-Duty Death Rates per 10,000 Career and Volunteer Firefighters
2002-2006*



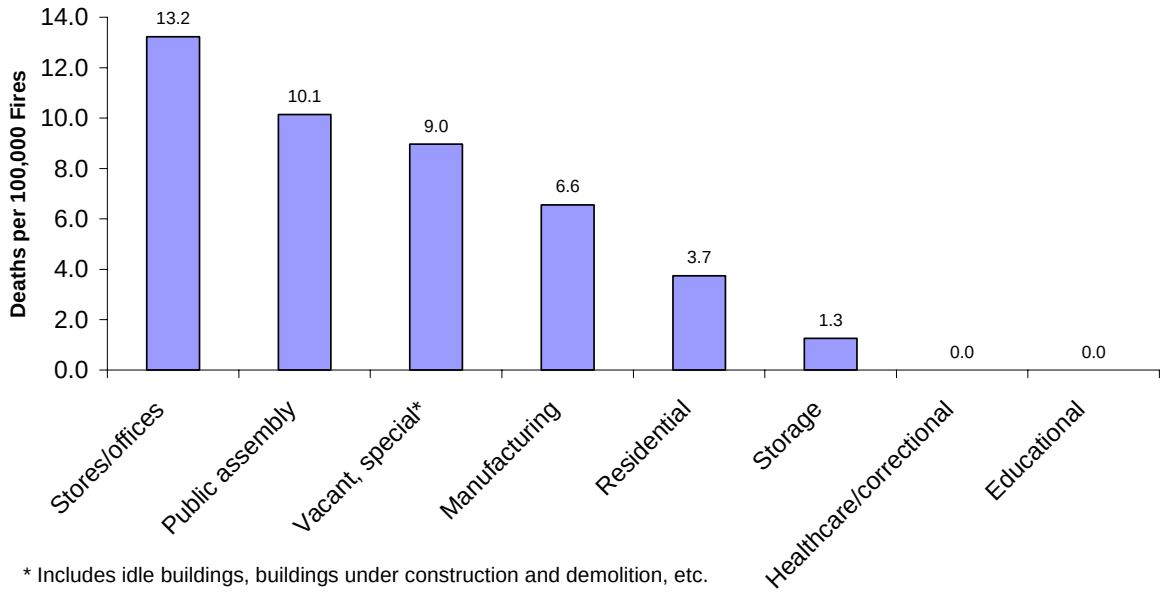
* excluding the 340 firefighter deaths at the World Trade Center in 2001

Figure 7
Fire Ground Deaths by Fixed Property Use -- 2006*



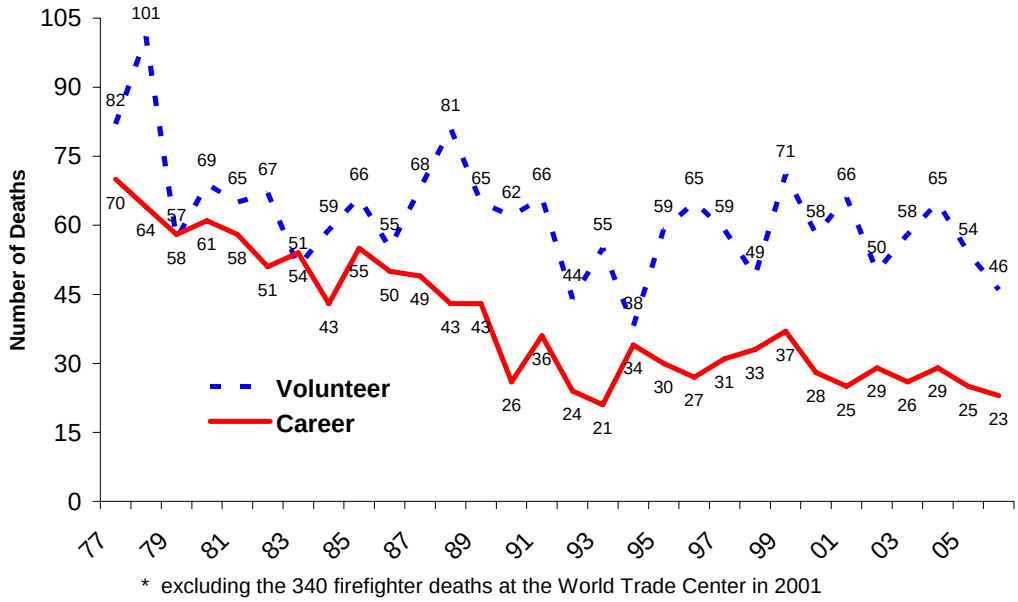
*** There were 38 deaths on the fire ground in 2006.**

Figure 8
On-Duty Fire Ground Deaths per 100,000 Structure Fires
2001-2005
(excluding the World Trade Center deaths in 2001)



* Includes idle buildings, buildings under construction and demolition, etc.

Figure 9
Firefighter Deaths - Local Career vs. Local Volunteer
1977 - 2006*



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

SELECTED FIREFIGHTER FATALITY INCIDENTS

Firefighter dies of septicemia

At 10 p.m. on January 28, firefighters were called to the scene of a fatal vehicle crash to perform extrication. After the extrication was completed, a 65-year-old firefighter wearing knee-high boots, protective trousers, and latex gloves cut his right index finger while placing the equipment back on the apparatus. He cleaned the cut as best he could at the scene.

The next day, he started to feel ill, and the day after, he went to a hospital complaining of pain in his back, shoulder, and arm. He was given pain medication and placed on three days of light duty. Seven days after the incident, he collapsed at home and was rushed to the hospital, where he went into cardiac arrest. He was resuscitated but died the following day from septicemia.

Fire captain drowns while training

At 12:30 p.m. on March 20, four members of a surf-rescue team began a training session for certification as basic-level personal watercraft operators. Two members acted as monitors, one on shore and the other on a personal watercraft. During the first part of the drill, the other two members, a firefighter and a captain, were to operate solo on their own watercraft, capsizing them, then righting and getting back on them. After successfully drilling for two hours, the team went to the shore for a 15-minute break. They drank some liquids and then went back out to continue to drill.

The second part of the drill consisted of the two firefighters riding together on one watercraft to practice picking up a victim out of the water. After a number of revolutions, they went back to shore and exchanged places.

As they maneuvered back out to deep water, however, rough seas overturned the watercraft, and the two became separated from it. The firefighter who was driving was able to get back to the craft, but the captain, who was dressed in a dry suit, starting drifting away.

When he saw what was happening, the monitor on the personal watercraft went to help the drifting captain. When the monitor reached him, the captain said he was too tired to climb aboard. The monitor then looked at the driver holding on to the overturned craft who gave him an ‘I’m okay’ sign. The monitor turned his attention back to the captain, instructing him to hold onto his craft and let the machine pull him to shore.

When a large wave separated them during the attempt, the monitor circled back to the captain and gave him a personal flotation device to put on. The captain tried to put it on but was unable to, so the monitor circled around again and told the captain to hold onto his craft so he could pull him to shore. The captain let the personal flotation device go as he grasped the craft.

As they approached the shore, the captain again let go of the monitor’s watercraft and rolled over onto his face. The monitor circled back, jumped off his craft into chest-high water, turned the unresponsive captain on his back, and brought him to shore with the help of the on-shore

monitor. They immediately administered first aid, and the unconscious man was transported to a hospital.

Two days later, the fire captain, who had nine years of service, died from hypoxic ischemic encephalopathy, damage to cells in the central nervous system due to lack of oxygen.

Firefighter hit by falling tree

At 12:30 p.m. on April 13, a 49-year-old wildland firefighter/technician with 28 years of service was killed as he directed a bulldozer operator constructing a control line in preparation for a prescribed burn. At the time, he was wearing a fire-resistive shirt and trousers, leather boots, and gloves, but he did not have his helmet on.

The technician had instructed the bulldozer operator to knock down a certain tree he thought might cause the fire to escape their control. As he talked with the communication center by radio, he was distracted and walked into the path of the falling tree.

On-scene personnel who rushed to the technician to give him first aid found him unresponsive with no vital signs. They called for an ambulance and rescue squad, which took him to a hospital where he was pronounced dead. The nature of death was listed as blunt force injuries to the head.

Firefighter struck by towline

At 3 p.m. on April 8, firefighters responding to an alarm of fire at a farm saw that a fire in a pile of brush the farmer was burning had spread out of control and was moving toward a neighbor's property.

During firefighting operations, a pumper became stuck in the soft ground, and a tractor was brought to pull it free. A rope was connected to a tow hook on the driver's side of the pumper's front bumper, and the other end was attached to a clevis on the tractor. When tension was applied, the clevis broke, and the rope snapped back, crashing through the windshield and hitting the firefighter in the head.

On-scene personnel provided first aid immediately, and the victim was taken by ambulance to a local hospital. From there, he was air lifted to another hospital, where he died three days later from blunt trauma to the head.

Firefighter electrocuted

On June 16 at 7:30 p.m., firefighters returned to a single-story building that had burned several days earlier to retrieve a tarpaulin they had used to cover a hole in the roof. As a 12-year veteran climbed a ground ladder to the roof to retrieve the tarp, he touched an energized electric sign mounted on the front of the building and suffered a severe shock that immediately rendered him unconscious.

The 43-year-old firefighter was treated at the scene by other firefighters and bystanders and then rushed to a hospital where he was pronounced dead. The nature of his death was listed as electrocution.

It was not reported what protective clothing, if any, the firefighter was wearing. The sign was improperly grounded.

Pilot and co-pilot die in helicopter crash

On July 29, a helicopter was flown to a riverside base heliport and from there was dispatched to help fight one of several wildfires that were burning simultaneously. On August 4, the helicopter went through a number of maintenance and flight tests after its number one engine was replaced, and maintenance and management personnel put it back in service at 4:45 p.m. It was then dispatched to drop water on the wildfire.

Two hours later, the helicopter returned to refuel and was again examined by maintenance personnel before resuming its firefighting support. Its water tanks were filled, the water dropped on the fire, and the water tanks were being refilled when the crash occurred.

A witness said that the helicopter was over the filling site when he heard a loud bang and saw a large object, later identified as the tail rotor gearbox with three of the four tail rotor blades attached, fall off the helicopter. The helicopter then pitched nose down in a 45-degree spiral onto the rocky shoreline.

The pilot and co-pilot both died as a result of the crash. The pilot died of traumatic injuries, and the co-pilot drowned. A fracture in a spindle that is part of the tail rotor gearbox is reported to have caused the crash.

Firefighter dies of aneurysm

Firefighters responding to an alarm at an apartment house at 10:59 p.m. on August 10 quickly determined that the cause of the alarm was smoke from cooking. After resetting the alarm system, they returned to the fire station, where a 45-year-old firefighter with 8 years' service began complaining of a headache. Minutes later, her symptoms were so severe that she was taken to the hospital.

She became unresponsive en route and never regained consciousness. She died the following day of a cerebral aneurysm.

Fire lieutenant dies when trapped after collapse

On August 13, firefighters responded to a 911 call reporting a fire in an unoccupied, single-family dwelling at 12:24 p.m. The ground floor of the two-story, wood-frame structure covered 3,500 square feet (325 square meters).

After size-up, one three-person crew from the first-arriving engine company entered the building with a 1 ¾-inch hose line, followed by a two-person crew from the ambulance to perform a search and rescue operation. As they entered the building, the attack crew went to the right in search of the fire, while the two-person crew moved to the left. All five firefighters were dressed in full protective ensembles and were using self-contained breathing apparatus.

When the remaining first alarm units arrived, command was transferred to a chief and one of the engine companies was assigned as the rapid intervention crew. Shortly after the first two companies entered the building, a truss failed, causing portions of the first floor to collapse into the fully involved basement, taking the search-and-rescue crew with them. The firefighter and her lieutenant fell 10 feet (3 meters), landing on either side of a wall that divided the basement. The two used their radios to alert other personnel on scene, who were reassigned to rescue them. A second alarm was also sounded.

The firefighter, who fell into a room with windows, was rescued. She sustained a fractured hip, a fractured rib, and burns. The lieutenant fell into a windowless room where his only exit was blocked by debris. The fire was so intense that rescuers were unable to reach him, even though they could hear his PASS device sounding and his calls for help over his radio. He died of smoke inhalation.

Fire/police officer collapses at fire station

A 78-year-old fire/police officer with 59 years' service arrived at the fire station on August 28 at 9:46 a.m. to respond to a roof collapse at general retail store caused by heavy rain. Shortly after he arrived, however, he began complaining of tightness in his chest and shortness of breath. He collapsed shortly thereafter and was pronounced dead at a local hospital.
The cause of death is listed as atherosclerotic heart disease. The officer had suffered a previous heart attack and had had bypass surgery.

Assistant fire chief dies in single-vehicle crash

On September 4 at 1:30 p.m., a 43-year-old assistant fire chief with 21 years of service was responding to a request for mutual aid in the department's 1,500-gallon (5,678-liter) tanker (tender) apparatus when the tanker went off the right side of the paved, two-lane road as he started out of a 20-degree, left-hand curve. The tanker traveled 141 feet (43 meters) along the grassy shoulder before he over-corrected and brought the vehicle back onto the road, where it skidded 90 feet (27 meters) in a counter-clockwise direction. When the chief over-corrected a

second time, the water apparently shifted, causing the tanker to rotate clockwise for another 27 feet (8 meters) before it went off the other side of the road.

The tanker traveled 46 feet (14 meters) off the road, and then rolled four times along a 153-foot (47-meter) path before coming to a stop. The driver, who was not wearing his seat belt, was ejected between the second and the third revolutions.

Firefighters sent to the crash site began emergency medical care, including cardiopulmonary resuscitation, then transported him to a hospital, where he was pronounced dead as a result of blunt force trauma to the head and chest. Speed and the chief's inability to regain control of the tanker were cited as causes of the crash. The weather and road conditions were not factors.

The fire he was responding to was intentionally set in a vacant building.

Fire lieutenant hit by vehicle

A 36-year-old fire lieutenant with 18 years' service died at 10 a.m. on September 22 while spray painting markings on a state highway to indicate where the fire hydrants were located. He had parked the department's brush truck in the inside travel lane with its hazard lights blinking and was working in front of the truck when another vehicle crashed into it at an estimated speed of 50 miles (80 kilometers) per hour. The impact pushed the brush truck forward over the lieutenant, who was pronounced dead at the scene. Cause of death was listed as crush injuries to the head and neck.

Wildland firefighters overrun by fire

On October 26, firefighters were notified at 1:11 a.m. that a wildland fire intentionally set at the bottom of a slope was quickly spreading uphill toward a rural residential community. Twelve minutes later, the first-arriving company reported that the fast-moving blaze already involved 10 acres (4 hectares) and had spread into another organization's jurisdiction.

At 3:07 a.m., incident command was transferred to a division chief, who reported that the fire had spread to more than 500 acres (202 hectares) and had reached the top of the peak. At 4:02 a.m., the command post instructed two engine companies to respond to a threatened area to help evacuate residents and protect structures.

The first engine company stopped at a house and evacuated an elderly woman. The second company checked a house, found no one home, and moved on to a second house, where they met a sector command officer. It was now 6:20 a.m. They discussed their action plan, the state of the weather, topographical features, the locations of other resources, and the safety zone. After the officer left, the engine crew deployed their firefighting equipment and set up a portable pump at the house's swimming pool.

At 6:40 a.m., the engine crew was advised that the fire was spreading extremely quickly up the slope and was told to evacuate the area. At 7:10 a.m., the fire, driven by winds exceeding 50 miles (80 kilometers) per hour overran the five-person crew, which didn't have time to deploy fire shelters. All five crew members died of burns. Three died at the scene, one died on the way to a hospital, and the fifth died five days later.

By the time the fire was brought under control, it had burned 40,200 acres (16,268 hectares) and destroyed 34 homes and 20 outbuildings. Twelve other firefighters received minor injuries.

Firefighter dies after being trapped

On November 1, firefighters responding to a 4:00 a.m. alarm of fire at a four-story, single-family house found flames spreading into the rear of the structure from a burning gazebo on the rear deck. The structure, which was of heavy timber construction, covered 11,000 square feet (1,021 square meters) and had no fire detection or suppression system.

When the fire awakened occupants, they were unable to use the telephones in their house. The owner went to a neighbor's to call for help, resulting in a 10-minute delay.

Two attack teams dressed in full protective ensembles with self-contained breathing apparatus each advanced a 1 ¾-inch hose line into the house, one into the rear of the first level and the other up the stairs to a landing. This second team was ascending the next set of stairs when they encountered thick, black smoke and extreme heat. The incident commander ordered them out of the building, and they were evacuating when they were overrun by rapid flame spread.
In the confusion, one firefighter turned the wrong way, missed the stairwell, and became lost. When the rest of his crew left the building and a head count determined that he was still inside, the commander ordered a rapid intervention team into the building. They found the missing firefighter from the sound of his PASS device, in a loft on the second level opposite the stairway. He was in the prone position, unresponsive, and his face piece had melted. The 32-year-old firefighter died on the scene of smoke inhalation.

Firefighter dies of sudden cardiac arrest

On December 1, an on-duty firefighter with 17 years of service was jogging in a parking lot next to the fire station as part of his unsupervised physical fitness training when he collapsed. A passerby spotted the firefighter lying in a grassy area and notified the firefighters in the station at 6:00 p.m. They immediately began cardiopulmonary resuscitation, but resuscitation efforts on scene, en route, and at the hospital were unsuccessful.

Although the 44-year-old firefighter was active in competitive sports and appeared to be in excellent physical condition, he had an unknown pre-existing heart condition.

WHAT'S CHANGED OVER THE PAST 30 YEARS?

Rita F. Fahy
Paul R. LeBlanc
Joseph L. Molis
Fire Analysis and Research Division
National Fire Protection Association

June 2007

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
www.nfpa.org

For more information about the National Fire Protection Association, visit www.nfpa.org or call 617-770-3000. To learn more about the One-Stop Data Shop go to www.nfpa.org/osds or call 617-984-7450.

Copies of this analysis are available from:

National Fire Protection Association
One-Stop Data Shop
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org
e-mail: osds@nfpa.org
phone: 617-984-7450

Introduction

NFPA has published many articles on firefighter deaths over the years, but in 1977 a concentrated effort was made to identify all on-duty fatalities that had occurred in the previous year. Since then, NFPA has conducted an annual comprehensive study of on-duty deaths in the U.S. This marks the 30th year of this study, and provides a good opportunity to see how things have -- and, maybe, have not -- changed over the 30 years.

The average number of on-duty firefighter deaths to occur annually has dropped by one third over the past 30 years. In the late 1970's, an average of 151 firefighters were killed on duty annually. By the 1990's, that average had dropped to 97 deaths per year. So far in this first decade of the 21st century, the annual average has held steady at 99 deaths per year. There have been four years with firefighter death tolls below 90. In 2006, 89 firefighters died as a result of on-duty injuries.

There are two major forces driving this decrease in deaths. First is the drop in the number of on-duty fatalities annually attributed to sudden cardiac death. In the first five years of this study, an average of 65 such deaths occurred. In the most recent five years, the annual average dropped to 41. The other significant drop is in the number of deaths at fires. In the first five years, an average of 79 deaths occurred annually on the fire ground; 59 of those 79 deaths at fires involving structures. In the most recent five years, that number has dropped to an average of 34 deaths annually on the fire ground, with 22 of those deaths at structure fires. There is some overlap here, since a large share of the fatalities at structure fires each year were due to sudden cardiac death.

Deaths due to falls from apparatus, which claimed at least three deaths in most of the first 11 years, virtually disappeared in the 1990s. One such death has occurred in three of the past four years, however.

These and other trends will be discussed in more detail in this brief review of the past 30 years.

Sudden cardiac death

In the first five years of this study, an average of 65 on-duty fatalities each year were due to sudden cardiac death. In the most recent five years, the annual average dropped to 41. Sudden Cardiac Death is defined by the American Heart Association on their website (www.americanheart.org) as "the sudden, abrupt loss of heart function in a person who may or may not have diagnosed heart disease." The number of sudden cardiac deaths annually has fallen by approximately one third from the late 1970s; however, since the early 1990s, the number of deaths each year has tended to fluctuate between 40 and 50, with no clear trend up or down. There were 34 sudden cardiac deaths in 2006 -- the lowest number recorded over the 30 years of this study. (Figure 1)

The largest proportion of the victims experienced cardiac symptoms during fire ground operations (42.9 percent). The next largest proportion involved firefighters responding to or returning from alarms (25.3 percent). In its investigations of on-duty cardiac-related fatalities, NIOSH reports " Firefighting activities are strenuous and often require firefighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and to persist through the course of fire suppression activities."[1] A recent article in the New England Journal of Medicine looked at the risk of dying during specific fire department duties, and concluded that the risk of dying of coronary heart disease was 10 to 100 times higher during firefighting activities than during non-emergency fire-department duties.[2]

Deaths at structure fires

Since 1977, the number of U.S. firefighter deaths annually at structure fires has dropped 69 percent. In the late 1970s, an average of approximately 60 deaths occurred each year at structure fires. That number dropped to an average of 20 per year in the past three years. This finding has

[1] See, for example, "Report Number FACE-F2004-46, Fire fighter collapses and dies while assisting with fire suppression efforts at a residential fire," http://www.cdc.gov/niosh/face200446.html The NIOSH studies cite Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. J Occup Med *17*:247-250

[2] Stefanos N. Kales, M.D., M.P.H., Elpidoforos S. Soteriades, M.D., Sc.D., Costas A. Christophi, Ph.D., and David C. Christiani, M.D., M.P.H., "Emergency Duties and Deaths from Heart Disease among Firefighters in the United States," *New England Journal of Medicine*, Vol. 356, No. 12, 2007, pp. 1207-1215.

often been credited to improvements in protective clothing and equipment, fire ground command and control procedures, and training, and although those changes certainly played a role, little attention has been paid to the drop in the number of structure fires themselves. Figure 2 compares the number of structure fires and the number of deaths at structure fires over the 30-year period. While deaths at structure fires has dropped 69 percent, the annual number of structure fires declined by 53 percent.[3] To what degree then has the decrease in firefighter deaths been driven by the drop in the number of structure fires?

This 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 just as likely to die at structure fires today as they were 25 or 30 years ago?

In order to smooth out the year-to-year fluctuations in the number of deaths, Figure 3 displays a comparison of the number of structure fires and the *rate* of firefighter deaths at structure fires using a rolling three-year average. Increases in death rates can result in either of two ways: if the number of deaths increases while the number of fires stays the same or decreases, rates will rise. If the number of deaths stays the same, while the number of fires decreases, rates will also rise (e.g., more deaths will occur, per fire). In the same way, rates can decrease either when the number of deaths drops while the number of fires stays the same or increases, or if the number of fires increases while the number of deaths stays the same. When both number of fires and number of deaths move in the same direction, the rate of deaths per fire can remain relatively flat.

The mid-point of each three-year range is shown at the bottom of the graph. The rate of firefighter deaths at structure fires in the late 1990s was roughly the same as the rate in the late 1970s. Since 1999, however, the death rate at structure fires has dropped steadily, to

[3] Karter, M.J., "U.S. Fire Loss for 2005," *NFPA Journal*, Vol. 100, No. 5, pp. 46-51 (2006). The number of structure fires in 2006 is estimated from the totals between 2003 and 2005.

approximately 4.0 deaths per 100,000 structure fires over the last three years (2004 through 2006), while the number of structure fires has plateaued.

Given the improvements in personal protective clothing and equipment, training and fire ground command and control over the past three decades, what is the cause of these deaths, and are there any areas where deaths are increasing? A review of the data shows that the rate of sudden cardiac deaths at structure fires has been dropping since the early 1980s. 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 1.3 deaths per 100,000 structure fires in the most recent three-year period. The rate of non-cardiac fatalities *outside* at structure fires dropped as well, since the mid-1980s, but rose again over the past few years. The rate of these fatalities fell to a low of 0.4 deaths per 100,000 structure fires, after reaching a peak of 1.7 in the mid-1980s, but has risen recently to 0.7 deaths per 100,000 structure fires. (Figure 4) The five most frequent causes of these fatal injuries over the years were struck by structural collapse (38.6 percent), caught in explosions (17.3 percent), falls (11.8 percent), struck by vehicles (8.2 percent) and electrocution (6.4 percent).

The one area that had shown marked increases during the period is the rate of deaths due to traumatic injuries while operating *inside* structures. 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 3.0 deaths per 100,000 structure fires. Since that time, the rate has fallen, and now stands at 1.9 deaths per 100,000 structure fires, a rate only slightly lower than that observed in the early 1980s. Almost all of these non-cardiac fatalities inside structure fires were the result of smoke inhalation (62.1 percent), burns (19.1 percent) and crushing or internal trauma (16.5 percent).

In order to reduce the number of deaths of firefighters operating inside structure fires, it is crucially important to understand how they are happening. 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 provides a valuable database. Reports on many of the most recent fatalities can be found on their website: www.cdc.gov/niosh/firehome.html. A further review of the NFPA data since 1977 will be completed during the summer.

Deaths related to wildland fires

The largest share of fire ground deaths in 2006 occurred on wildland fires (16 deaths). This is only the second time in the 30-year period that wildland fires accounted for the largest share of fire ground deaths. (The previous time was in 1999.) Just as the severity of the wildland fire season varies from year to year, the number of firefighters deaths can vary widely, as shown in Figure 5. Over the 30-year period, the number of firefighter killed on wildland fires has ranged from a low of six in 1982 to a high of 33 in 1994, the year 14 firefighters were killed on the South Canyon fire. In contrast to 1994, the deaths in 1999 occurred in 24 separate incidents, the most severe of which were two fires that each killed two firefighters. A total of 338 firefighters were killed on wildland fires over the 30-year period.

Besides the deaths on the fire ground, an additional 138 firefighters died while responding to and returning from wildland fires. In 2003, 15 firefighters died while traveling to or from fires, including one incident where eight firefighters were killed when their van crashed while they were on their way home. In two other years, 1984 and 1994, 10 firefighters died while responding to or returning from wildland fires.

Wildland fires frequently claim a large number of lives in a single incident. Besides the South Canyon fire, there have been eight fires that killed four or more firefighters, most recently the Esperanza fire in California in 2006 that killed five firefighters.

There is no clear trend in wildland fire deaths over the past year, except when looking at deaths in aircraft crashes (see Figure 6). These deaths, which have occurred both during firefighting operations and while responding to or returning from the fire ground, have been increasing. The increase in crashes is due, to some degree, to the increased use of aircraft in wildland firefighting over the years.

Almost half of the victims of wildland fires were volunteer firefighters (45.2 percent), followed by contractors for state and federal land management agencies (17.0 percent), employees of federal land management agencies (16.8 percent), and employees of state land management agencies (9.8 percent). The remaining victims were career firefighters (6.2 percent), members or

supervisors of prison inmate crews (3.3 percent) or military or industrial firefighters (1.7 percent).

Deaths in road vehicle crashes

Deaths in road vehicle crashes over the past 30 years are shown in Figure 7. Crashes consistently account for the second largest share of firefighter deaths, overall. These crashes occurred during all types of on-duty assignments, not just while responding to or returning from alarms. Three quarters of the victims in these crashes were volunteer firefighters. Fourteen percent were career firefighters and the remaining victims were contractors for, or employees of, state and federal land management agencies. More than one third of the deaths involved firefighters' personal vehicles (37.7 percent). Another 22.7 percent occurred in crashes involving water tenders (tankers) and 21.7 percent involved engines or pumpers. Of the 406 victims, 76 percent were known to not be wearing seatbelts or using restraint systems. Only 13.3 percent were wearing seatbelts or using other restraints. Excessive speed for road conditions is a frequently cited cause of these fatal crashes, as are operator error, including failure to stop at traffic signals and train tracks. Poor maintenance has been a factor in some of the crashes.

Obeying traffic laws, using seat belts, driving sober and controlling driving speeds would prevent most of the firefighter fatalities in road crashes each year. Two NFPA standards are available to help fire departments establish safe driving programs: NFPA 1002, *Standard on Fire Apparatus Driver/Operator Professional Qualifications*, and NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*. NFPA 1002 identifies the minimum job performance requirements for firefighters who drive and operate fire apparatus, in both emergency and nonemergency situations. NFPA 1451 provides for the development of a written vehicle operations training program, including the organizational procedures for training, vehicle maintenance, and identifying equipment deficiencies. In addition, *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.

Falls from apparatus while responding to or returning from alarms

From 1977 through 1987 (11 years), a total of 41 career or volunteer firefighters died, at least 3 each year except for 1979, when they fell from apparatus while responding to or returning from alarms. (See Figure 8.)

In 1987, the first edition of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, was issued with requirements that all firefighters riding on fire apparatus be seated and belted any time the apparatus is in motion. That same year, a Tentative Interim Amendment to NFPA 1901, *Standard for Automotive Fire Apparatus*, required the provision of seats and seatbelts for the maximum number of persons who are going to ride on the apparatus. NFPA 1901 was extensively revised in 1991, including a new requirement for total enclosure of driver and crew areas on apparatus.

Although it cannot be specifically credited to these changes in the standards, no such deaths occurred from 1992 through 1998. Over the past eight years (1999 through 2006), a total of four such deaths occurred. Three of the four deaths involved apparatus built before 1991 (two of which were reserve pieces). The fourth vehicle was a reserve piece built in 1998. None of the four victims was using available seatbelts.

One of the vehicles, an open-cab ladder truck built in 1965, had been modified in 1991, adding an additional forward-facing jumpseat on each side of the apparatus in the crew riding area behind the driver and officer, to eliminate the practice of riding on the back step, and replacing the personnel bar in the jumpseat area with a locking gate across the entrance to the seating area. Seatbelts were installed in all riding positions, but they were not large enough to accommodate firefighters wearing full protective clothing. The victim was standing in the jumpseat area and fell when the truck rounded a turn after leaving the station. In the second incident, a firefighter riding in the jump seat of a 1989 canopy-cab apparatus may have released her seatbelt to retrieve her hearing protection, and fell out of the vehicle as it made a turn. The vehicle had no safety gates or bars. In the third incident, a firefighter fell from the jump seat area of a 1976 canopy-cab apparatus that had been modified in 2001 when half-style doors with slam-type latches were installed at the entrances to the jump seat areas. The victim may have been standing, donning his

gear, when he fell from the apparatus. Investigators believe the lock on the door was not engaged.

An enclosed crew-riding area does not guarantee protection. In the fourth incident, a firefighter riding in a 1998 quint was not wearing his seatbelt, and investigators believe he was donning his air pack as the quint entered a turn. As the vehicle turned, the passenger door opened, and the victim fell out when he reached out to close the door. The seatbelt monitoring system in the fire apparatus was not functioning and at least one of the seat sensors had been disabled.

All four of these incidents were investigated by NIOSH. The conclusions and recommendations in the four reports are similar:

- Fire departments should ensure, when feasible, that each crew riding position is within a fully enclosed personnel area.
- Fire departments should ensure that the emergency fire apparatus are equipped and functional to provide adequate safety for the riders and drivers/operators, and all seating areas, including seat belts and doors, are inspected during routine maintenance checks and that safety concerns are documented and addressed.
- Fire departments should ensure that all interior crew and driving compartment door handles are designed and installed to protect against inadvertent opening.
- Fire departments should consistently enforce and repeatedly train members on standard operating procedures/guidelines (SOPs/SOGs) that require all persons responding in emergency vehicles to be secured by seat belts or safety restraints at all times the vehicle is in motion.
- Fire departments should ensure that the donning or doffing of equipment and personal protective clothing that requires removal of any personal restraining device is prohibited while the vehicle is in motion.

Deaths during training activities

Deaths during training activities accounted for 7.4 percent of all on-duty firefighter fatalities over the past 30 years. The disturbing fact is that firefighter deaths during training are particularly needless, as the purpose of training is to *prevent* deaths and injuries and should certainly not be

the cause of casualties. The total number of training-related deaths in a year have ranged from a low of three to as many as 17. (See Figure 9.) In the past 10 years, almost twice as many training deaths occurred as in the first 10-year period (102 deaths between 1997 and 2006 vs. 54 deaths between 1977 and 1986). Figure 10 shows the trends for training-related deaths overall and compares trauma deaths and medical-related deaths over the period. (A running three-year average is shown in order to smooth out the year-to-year fluctuations.)

A detailed review of training deaths was published last year, so only a few points will be re-stated here. The largest shares of training-related deaths occurred while the victims were participating in apparatus and equipment drill and while firefighters were taking part in physical fitness training. Just over half of the firefighters who died while training died due to cardiac events. Traumatic injuries, smoke inhalation and drowning were the next three major causes of death.

Summary

A review of the almost 3,400 on-duty firefighter fatalities that have occurred in the U.S. between 1977 and 2006 shows some areas where significant improvements have occurred, and highlighted areas where much work remains to be done. The average number of deaths annually has dropped by more than one-third, falls from apparatus during responses have almost been eliminated, heart attack deaths are down by a third, and improvements in everything to protective equipment to emergency medicine have reduced deaths at structure fires. However, preventable problems such as the health issues that result in increased risk of heart attack and stroke contribute to making sudden cardiac death the number one cause of on-duty firefighter deaths. Preventable deaths such as road crashes where seatbelts were not used, and training deaths where adequate precautions were not taken, continue to occur.

Snapshots of the changes over the years

- The average number of firefighter deaths to occur annually has dropped by one third over the past 30 years.

- Deaths due to falls from apparatus, which claimed at least three deaths in almost all of the first 11 years, virtually disappeared in the 1990s, but have reoccurred in recent years.
- On-duty sudden cardiac deaths have dropped by more than one third, but remain the number one cause of on-duty firefighter deaths.
- Crashes continue to be the second leading cause of on-duty fatalities, and there has been no sustained trend up or down for such deaths. The victims are mainly volunteer firefighters, and personal vehicles and tankers are the types of vehicle most frequently involved.
- More training deaths occurred in the last decade than in the first 10 years, which may be due to more training activities underway today. Over half were due to sudden cardiac death.

Figure 1
U.S. On-Duty Firefighter Fatalities
Due to Sudden Cardiac Death
1977 - 2006

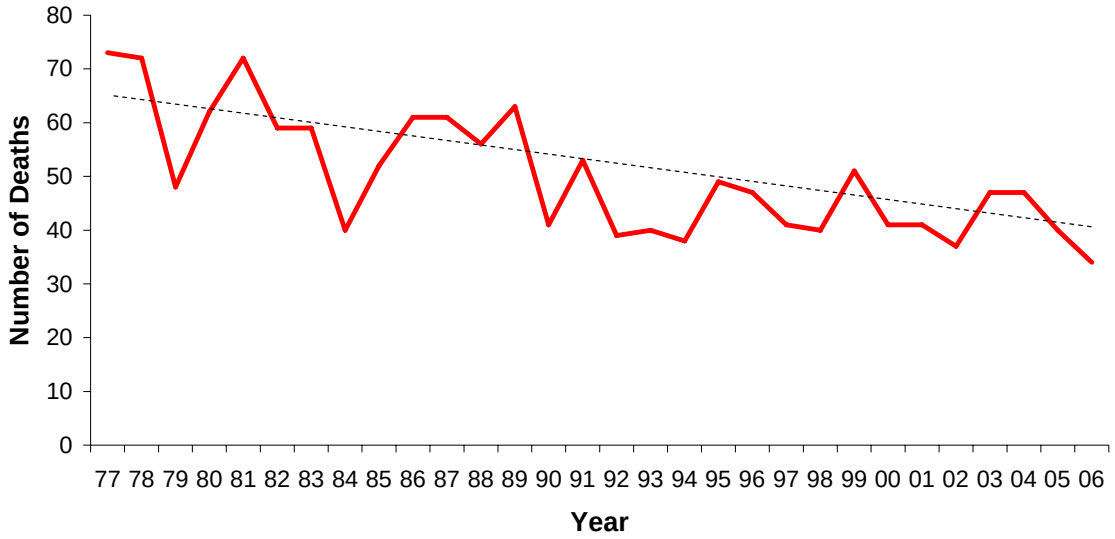


Figure 2
The drop in firefighter deaths at structure fires
follows, and recently surpasses, the drop in structure fires.

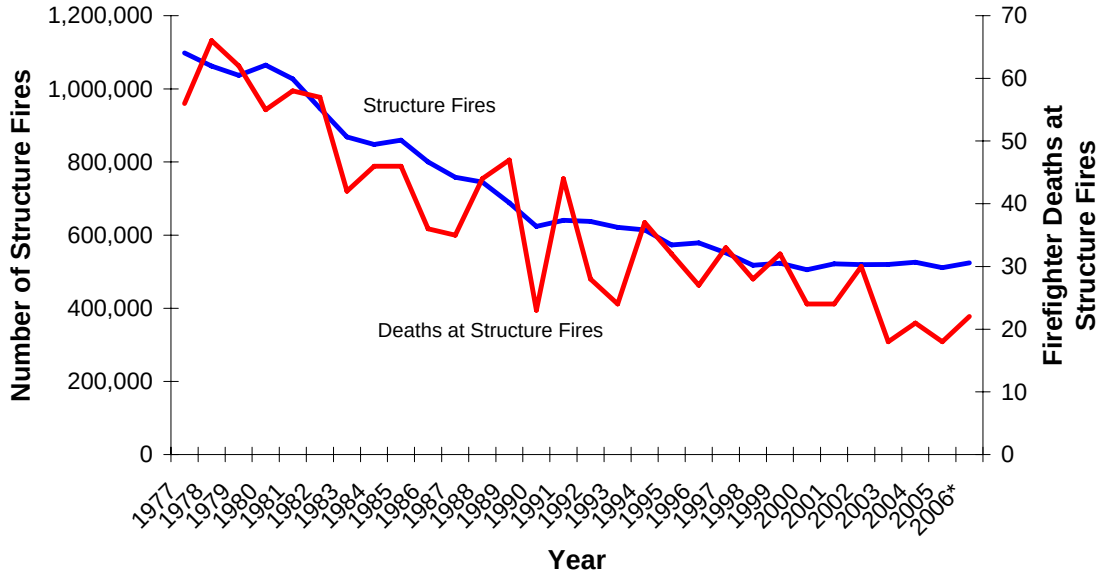


Figure 3
While the number of structure fires and deaths at structure fires has dropped, the rate of firefighter deaths at structure fires has not dropped as much.

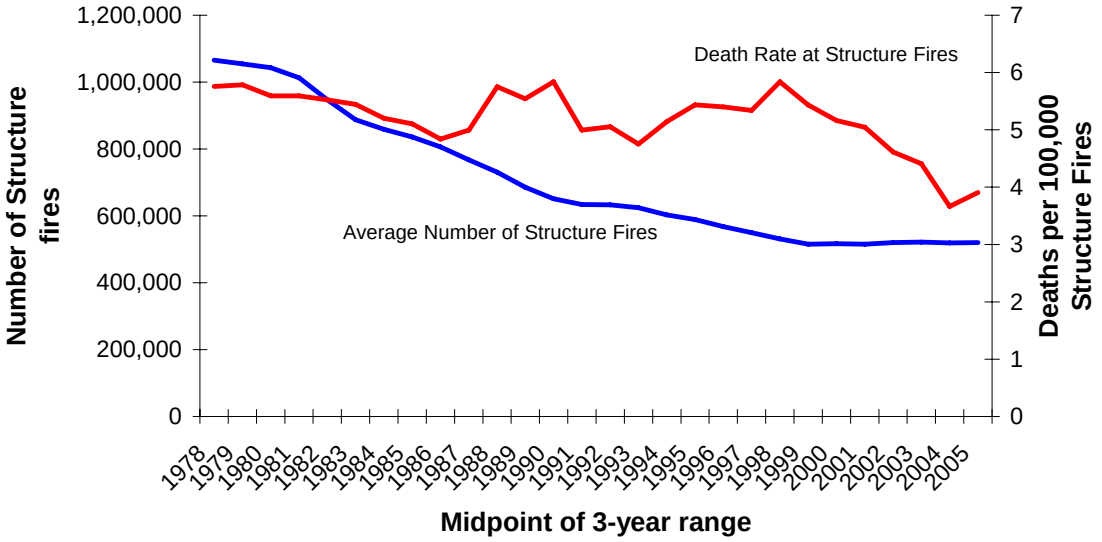


Figure 4
Death Rates for Firefighters at Structure Fires by Location and Nature of Fatal Injury

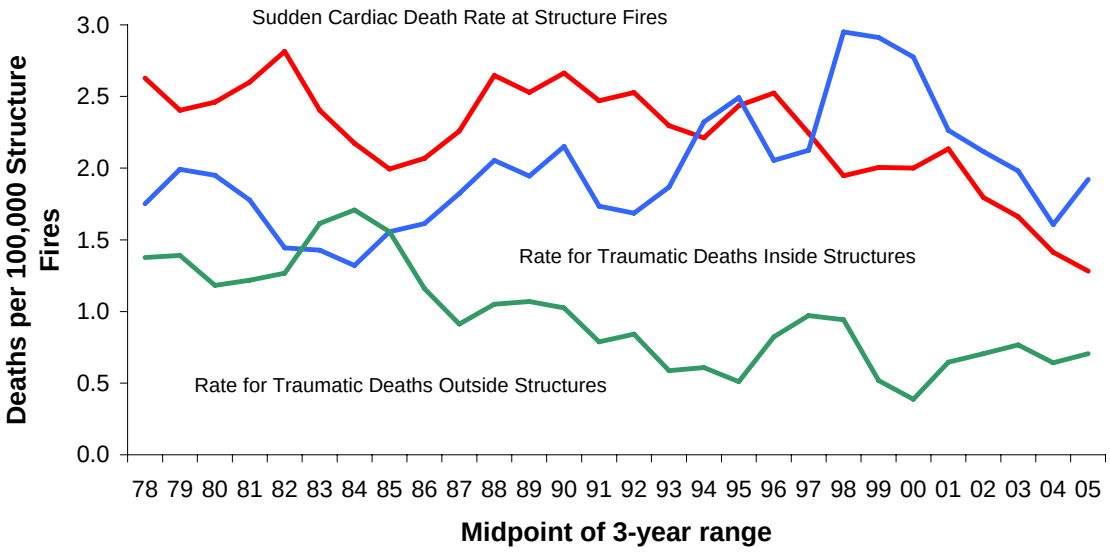


Figure 5
Fatal Wildland Fires and Associated Firefighter Deaths
1977 - 2006

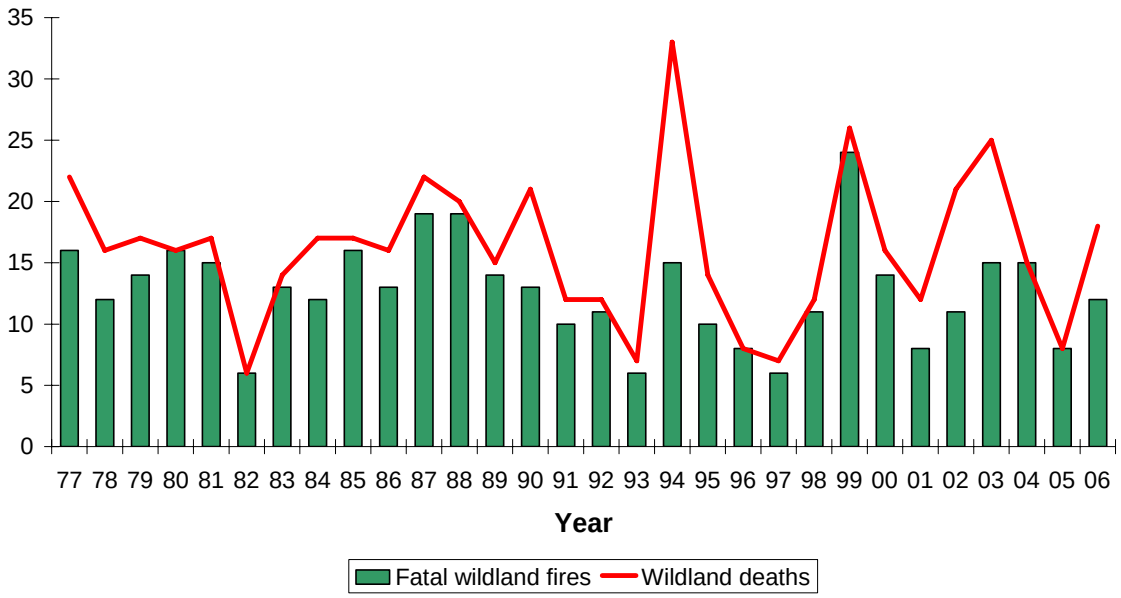


Figure 6
Firefighter Deaths in Aircraft Crashes
Related to Wildland Fires

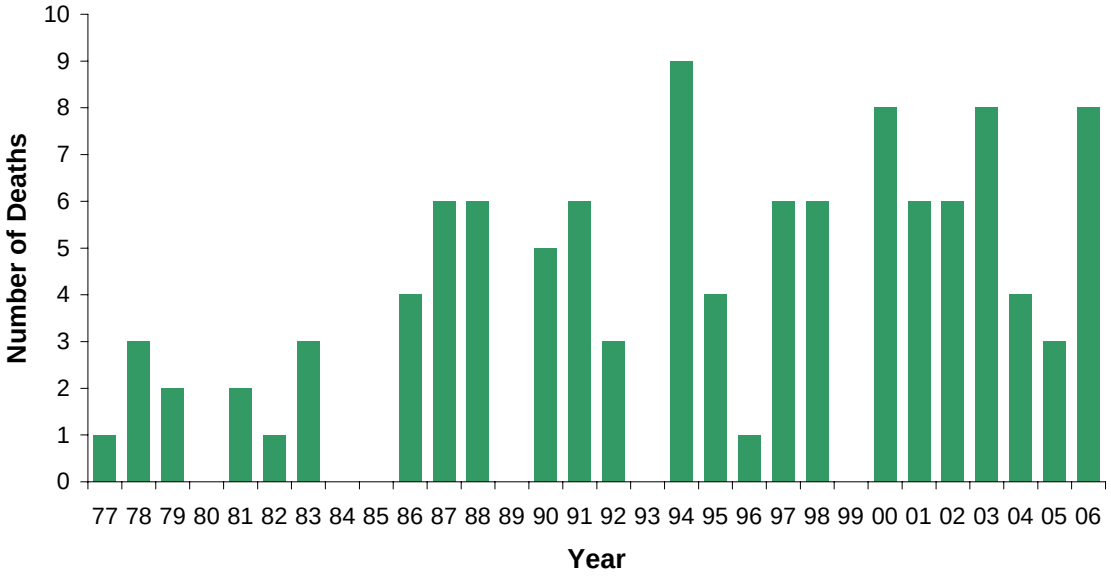


Figure 7
On-Duty Firefighter Deaths in Road Vehicle Crashes
1977 - 2006

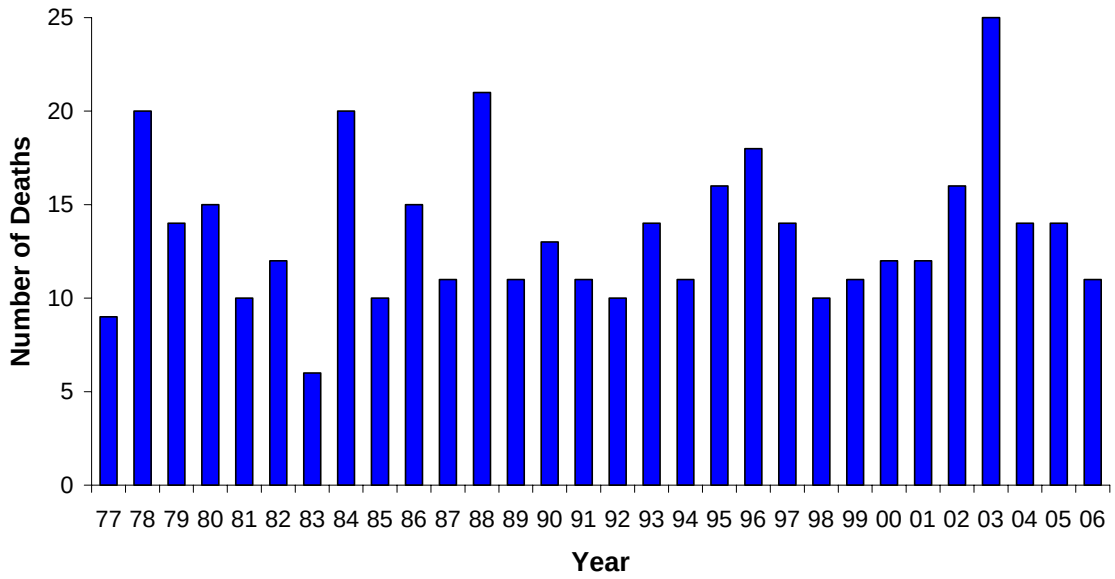


Figure 8
Deaths of Career and Volunteer Firefighters
Resulting from Falls from Apparatus
While Responding to or Returning from Alarms

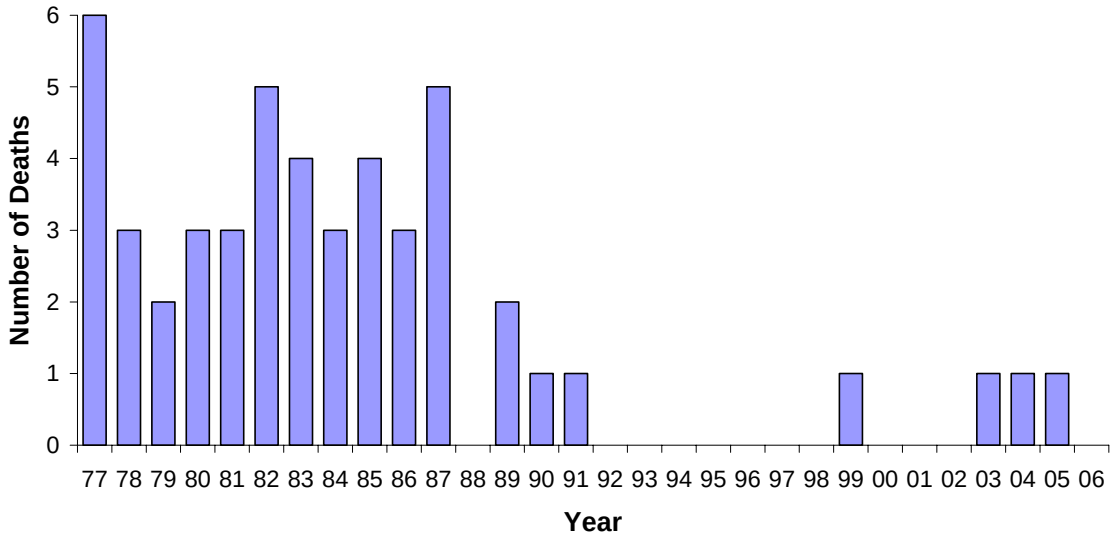


Figure 9
Deaths of U.S. Firefighters during Training
1977 - 2006

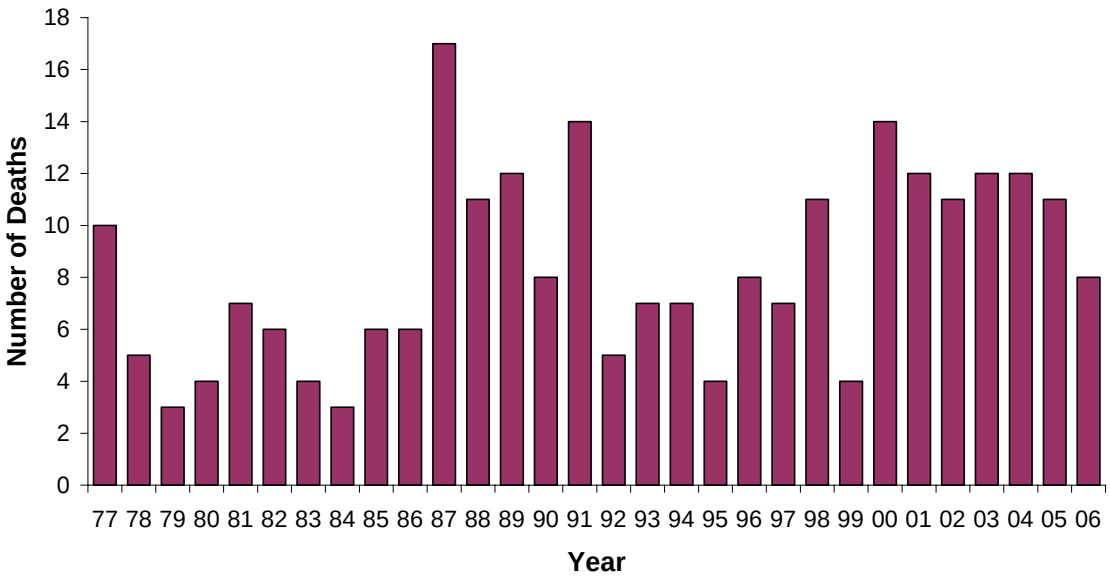


Figure 10
Proportion of Training-Related Deaths Annually
(3-year rolling average)