

U.S. Firefighter Deaths Related to Training, 1996 - 2005

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Abstract

Training is a vital part of fire department operations, but it too often results in deaths and injuries. Between 1996 and 2005, 100 firefighters in the U.S. died while engaged in training-related activities (10 percent of all on-duty firefighter deaths). The deaths occurred during a broad range of activities, including apparatus and equipment drills; physical fitness; live fire training; underwater/dive training; and while attending classes or seminars.

Keywords: statistics, training, firefighter fatality

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U.S. Firefighter Deaths Related to Training, 1996 - 2005

Training is a vital part of fire department operations, but it too often results in unnecessary deaths and injuries. When we look back to 1977, the first year for which NFPA has complete records of on-duty firefighter fatalities, we find that 239 firefighters died during training activities over the 29-year period (7.3 percent of all on-duty firefighter deaths since 1977). The total number of training-related deaths in a year have ranged from a low of three to as many as 17 (in 1987). (See Figure 1.)

As the number of on-duty firefighter deaths overall has declined over the years, the lack of a sustained decline in deaths related to training has produced a pronounced increase in the *training* share of deaths. Figure 2 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.) As shown on the graph, over the past decade, the proportion of deaths annually has been rising since the mid-1990s, driven largely by increases in the number of deaths due to traumatic injuries.

This special study will focus on the most recent 10-year period -- 1996 through 2005. Over that period, 100 firefighters died while engaged in training-related activities (10.0 percent of all on-duty firefighter deaths). Of these 100 victims, 47 were volunteer firefighters, 39 were career firefighters, five were employees of state land management agencies, four were employees of federal land management agencies, two were civilian employees of the military, one was a contract pilot, one was a member of the military and one was employed by an industrial fire department.

Sudden Cardiac Deaths During Training Activities

Findings for firefighter fatalities overall indicate consistently that the number one cause of on-duty firefighter fatalities is sudden cardiac death, and that holds true, also, during training activities. Of the 100 training-related deaths in the 10-year period, 53 were due to sudden cardiac death. For all but nine of the 53 victims, a brief description of their past and present medical issues was reported. Of those 44, at least half had severe arteriosclerotic heart disease; 12 had had prior heart attacks; six were diabetic and six were hypertensive.

Sudden cardiac death among on-duty firefighters was discussed in detail in last year's firefighter fatality study. (See www.nfpa.org/assets/files/PDF/OSCardiacDeath.pdf)

The steps that should be taken to reduce the risk of heart attacks among firefighters were listed:

- conducting annual medical evaluations;
- screening for coronary artery disease (CAD) risk factors;
- conducting exercise stress tests (EST) for those with multiple CAD risk factors; and
- giving appropriate treatment for those risk factors and restrictions for firefighters with positive stress tests.

The risk factors for CAD include diabetes, smoking, high cholesterol, high blood pressure, family history and obesity or physical inactivity.

Type of Activity

Training-related deaths occurred during a broad range of activities as shown in Figure 3. The category where the most deaths were reported (36 deaths) involved apparatus and equipment drills. This category includes training on specific apparatus and equipment, ladder climbing, pump and drafting operations, SCBA and smoke drills, driver/pilot training and extrication. The second largest category was physical fitness training with 30 deaths. This category includes exercising at the station, as well as agility tests and fitness screenings, job task evaluations and pack tests. Live fire training claimed 14 lives, although not all of these deaths occurred within burn structures. There were eight deaths during underwater training. Five firefighters died while attending classes, seminars or meetings. One firefighter was killed during SWAT medic training.

In addition to these deaths, six firefighters died while traveling to or from training activities.

Apparatus and Equipment Drills The 36 fatalities that occurred during apparatus and equipment drills included 21 sudden cardiac deaths and one seizure. Five firefighters died in falls - one from a height of 65 feet off a fully-extended aerial ladder during a drill; one from a second-story window in an unauthorized demonstration of the "emergency ladder bail technique;" a smoke jumper whose parachute failed to open; a recruit who fell from the roof of a structure while attempting to descend a ground ladder; and one from the tailgate of a pickup truck as it was moving about the training site. Four firefighters died in crashes -- two in aircraft (both crashes were due to pilot error) and two in road crashes involving water tenders during driver training. (Neither victim in the road crashes was wearing a seatbelt and

one of the vehicles had several defects.) Three firefighters were struck by vehicles -- one by a backing engine being driven by an operator with a suspended license, one by another vehicle involved in the drill where excessive speed and horseplay were cited as factors, and one by a driver operating under the influence of prescription medications and alcohol. One firefighter was struck in the head and fatally injured by an air jack during a training exercise involving putting tire chains on an engine. And one firefighter was killed when his head got caught between the rungs of a new 100-foot aerial ladder platform apparatus as it was retracting.

Physical Fitness Training Physical fitness training accounted for 30 firefighter deaths -- 23 were the result of sudden cardiac death, three due to heat stroke, three due to stroke or aneurysm, and one from a disease associated with sickle cell trait after collapsing during recruit training. Six of the sudden cardiac death victims were taking pack tests to qualify for wildland firefighting duties. Three of the six were career employees of land management agencies, two were volunteer firefighters and one was a career firefighter. Four of the six had severe arteriosclerotic heart disease and one had an unspecified heart problem. Four of the 23 sudden cardiac death victims were undergoing agility testing -- in one case to determine fitness to return to duty. That victim had previously failed two job task evaluations, had been placed on light duty and scheduled for rehabilitation, was found to have CAD and underwent cardiac catheterization. He was released for return-to-work with no restriction by a private physician in spite of ischemia during an EST. He died two days after returning to work, during a job task evaluation. According to the NIOSH investigation report, based on the guidelines of *NFPA 1582*, he should not have been cleared to return to full active-duty fire suppression. The other 13 victims of sudden cardiac death were working out (e.g., running, lifting weights, etc.), usually at the fire station, when they died. All of the 13 were found to have significant health problems, but interestingly, in several of the cases involving younger victims (under age 40), the NIOSH investigation reports indicated that they would not have been candidates for the sort of screening that could have detected their problems. Eleven of the 23 victims belonged to departments that required annual physical examinations (but three of the 11 only required them for firefighters over a specified age). Eight did not require annual physicals. (In one case, firefighters hired after 1991 would be required to have an annual physical in order to obtain a wildland firefighting Red Card to work out of state.) Information on requirements for annual physicals was not reported for the

other four victims of sudden cardiac death. Two of the three heat stroke victims were jogging as part of their recruit training. In one of those cases, the investigation report described a long list of errors made in the training, including: no acclimatization or time for conditioning, given the high heat and humidity conditions; no rest or water for over an hour; dark clothing; only one instructor, and that instructor was untrained; and the instructor's failure to recognize the symptoms of distress. In another case, with high temperatures but very low humidity, an experienced runner, inexplicably without water and without seeking available shade, collapsed and died on a routine fitness run.

Live Fire Training Live fire training resulted in 14 of the 100 deaths. Two firefighters were killed in one incident when they were caught in a flashover during search and rescue training in an acquired structure. One of the two was a 20-year-old in his first week on the fire department. The fire department had no written policy concerning live burns in acquired structures and used *NFPA 1403* only as a guide. The fire involved wooden pallets, straw and a foam mattress placed on the fire after it was ignited. Others involved in the training thought the search and rescue team had left the fire room, and could not determine why they had stayed in the room. A walk-through had been done before the exercise began.

An 18-year-old firefighter recruit died of smoke inhalation during a training exercise where he was playing the victim in an upstairs apartment of an acquired structure. In that exercise, in addition to the burn barrel, a fire was ignited in the foam mattress of a sleep sofa in the livingroom downstairs, close to the bottom of the stairs and quickly burned out of control. The officer in charge of the drill was convicted of negligent homicide. There was no pre-drill walkthrough; no one knew about the sofa fire; no safety line was in place; and no emergency evacuation ladders were in place. Two other firefighters were injured. This exercise was the first time the victim, who had received no formal training, wore SCBA in fire conditions. Although he was wearing his facepiece when found, his face was burned, indicating that he had removed the facepiece during the fire development.

A firefighter igniting the final burn in an acquired structure died of smoke inhalation and burns after he became trapped in the attic. *NFPA 1403* was not followed in this exercise. The victim used atomized diesel fuel through a garden sprayer on combustibles and directly on a free-burning fire in the attic, resulting in a flash fire. The combustibles used in the exercise included hay and debris found in the attic.

A recruit in his sixth week died of heat stroke at a live fire training exercise while operating a handline in a shipboard simulator. Four other recruits were treated for heat stress and burns. The training exercise did not follow *NFPA 1403*, and the investigation reports list a wide range of safety issues concerning the conduct of the drill, including no assigned safety officer or formal safety plan, no written pre-burn plan, no formal EMS plan, no RIT provision, and no monitoring of the fire environment, which became excessively hot. There was no walk-through before the exercise, and trainees were not told of alternative escape routes or exits. There was little oversight of the training class. Two fires were burning in the structure simultaneously, and the fuel used had not been specifically identified before the drill. Discipline at the drill included threats of termination if the recruits left the structure prematurely or were injured.

Sudden cardiac death claimed the lives of five firefighters during live fire training. Two of them had had prior heart attacks and a third had severe arteriosclerotic heart disease. Three of the five had been acting as observers during the training. One was setting up command at a training fire at which he was to be evaluated on his incident command knowledge. The fifth had pulled a rescue mannequin in a simulated ARFF rescue in an aircraft training simulator. This victim was one of those with a history of prior heart attacks and bypass surgery and had complained earlier in the day of not feeling well, but he did not want to postpone his participation in the training.

Two firefighters died at live fire training exercises as a result of aneurysms. One was working as pump operator and the other was preparing to enter the structure to conduct a search.

Two firefighters were struck and killed by apparatus at the scene of training exercises. One was deploying a handline in front of a crash truck when the engine's RPM unexpectedly increased, causing the vehicle to speed forward and strike him. Investigation of the incident determined that the vehicle's transmission was in the wrong gear. After the incident, the department installed safety kits on all similar vehicles. In the other incident, a firefighter assigned to traffic control while others were setting up an exercise in an acquired structure was struck by a pickup truck in the road. The victim was using a flashlight but not wearing a reflective vest in the low light conditions (dawn).

Underwater Training Water rescue training resulted in the deaths of eight firefighters -- six drowned, one suffered a fatal heart attack and one died of barotrauma (a condition that

most frequently occurs when a diver cannot or does not exhale during ascent). There is generally little information available as to what exactly went wrong in these training dives. In one case, the victim became entangled in a buoy line and ran out of air. Another became trapped under ice. He and his partner had not intended to go under the ice, but they were not tethered to the dock or shore. One victim became trapped underwater by ropes after running out of air. In other cases, divers failed to surface at the end of their dives, and no reason could be determined.

Classes, Seminars and Meetings Five firefighters died during classroom training, at seminars or while attending a conference. Sudden cardiac death claimed three lives. One victim suffered a fatal asthma attack. The fifth died of an overdose of prescription medication.

SWAT medic Training In a simulation of a high-risk traffic stop, a firefighter was shot in the eye during SWAT training when a pistol malfunctioned.

Traveling to and from Training Six firefighters died while traveling to or from training sessions. Three were killed in vehicle crashes, two fell from the open tailgates of pickup trucks and one was struck by a passing vehicle when he stopped to retrieve something that had fallen off the fire apparatus while the unit was returning from a training exercise.

Cause of Fatal Injury

Figure 4 shows the distribution of training-related deaths by cause of fatal injury or illness. As was found for total firefighter deaths in most years, the largest proportion of fatalities (in this case, 62 percent) were due to stress or overexertion, and usually resulted in sudden cardiac death or strokes.

The next largest category is struck by or contact with object and exposure with 15 deaths. These included seven in collisions, six firefighters struck by vehicles, one struck by a tree limb and one gunshot.

Twelve firefighters were caught or trapped -- seven underwater, four by fire progress in live fire training exercises and one by the rungs of a retracting aerial.

Seven firefighters died when they fell or jumped including three from the open tailgates of pickup trucks, two from structures, one from an aerial ladder. One firefighter's parachute failed to open during smoke jumper training.

Three firefighters were overcome by heat -- two by hot weather and one in a fire simulator. One firefighter died of a drug overdose.

Nature of Fatal Injury

The distribution of training-related deaths by nature of fatal injury is shown in Figure 5. Overall, more than half of the training fatalities (53 deaths) were due to sudden cardiac death. Almost all of these firefighters, for whom medical documentation was available, had had prior heart attacks, bypass surgery, severe arteriosclerotic heart disease, diabetes or hypertension.

Another 22 deaths were due to internal trauma and crushing injuries. This includes mainly the motor vehicle crashes and falls. The remaining deaths resulted from drowning (six deaths), stroke, aneurysm or embolism (six deaths), smoke inhalation and burns (four deaths), heat stroke (four deaths), and one each to a seizure, drug overdose, asthma, gunshot and complications due to sickle cell anemia.

Ages of Firefighters

The distribution of the training-related fatalities by age and cause of death is shown in Figure 6. The victims ranged in age from 17 to 74 years with a median age of 43 years. As can be seen in this graph, fatalities are more frequently the result of sudden cardiac death as age increases. Figure 7 shows the death rate (for career and volunteer firefighters only) in training-related incidents by age group. The rates for firefighters aged 20 to 39 are below the average for all firefighters. The rate for teenage firefighters is 50 percent higher than the all-age average. The rates climb from age 40 up, with a rate for firefighters age 60 and over that is more than double the average.

Conclusion

Firefighting is a dangerous profession but with proper attention to safety and health issues, on-duty fatalities can be reduced. Firefighter deaths during training are particularly needless. The purpose of training is to prevent deaths and injuries and should certainly not be the cause of casualties. Over the past 10 years, 100 firefighters died during training activities. Eight of the 100 were recruits.

NFPA publishes a range of standards that provide guidelines for safely conducting firefighter training. *NFPA 1403, Standard on Live Fire Training Evolutions* describes a process for conducting live fire training evolutions to ensure that they are conducted in safe facilities and that the exposure to health and safety hazards for the firefighters receiving the

training is minimized. The standard provides guidance on the prior qualifications necessary for firefighters to participate in such training, as well as preparation of the training site, its contents, and the manner of igniting the training fire, assignments of safety personnel, provisions for emergency egress, and preparation of records and reports on the training exercise. The standard specifically prohibits the ignition of any type of material whose burning properties are not known or that may be uncontrollable. Flammable or combustible liquids are never to be used in acquired structures, and only in limited amounts in certain circumstances in training center burn buildings.

As is true for all other types of duty, sudden cardiac death (usually heart attacks) accounts for the major share of training-related deaths, and many of the victims had had prior heart attacks, bypass surgery or heart disease. *NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments*, provides the medical requirements for candidate firefighters and identifies a category of existing medical conditions "that would preclude a person from performing as a member in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others." Among many others, these conditions include coronary artery disease, history of myocardial infarction, coronary artery bypass surgery, coronary angioplasty, cardiomyopathy, and myocarditis. *NFPA 1582* also establishes that the fire department physician evaluate an incumbent firefighter who has a medical condition and recommend possible restrictions from performing essential job tasks based on the firefighter's medical condition. There is an entire section devoted to cardiovascular disorders and which of the essential job tasks could be compromised if a member has specific cardiac disorders. It is up to the fire department to determine possible accommodations for members restricted from certain job tasks.

NFPA 1002, Standard on Fire Apparatus Driver/Operator Professional Qualifications, specifies the minimum job performance requirements for service as a fire department emergency vehicle driver, pump operator, aerial operator, tiller operator, wildland apparatus operator, aircraft rescue and fire-fighting apparatus operator, and mobile water supply apparatus operator. The standard requires that routine tests, inspections, and servicing functions on the systems and components of fire department vehicles be performed and that drivers and operators have the requisite knowledge and skills to "understand such effects on vehicle control as liquid surge, braking reaction time, and load factors; effects of high center of gravity on roll-over potential, general steering reactions, speed, and centrifugal

force; applicable laws and regulations; principles of skid avoidance, night driving, shifting, and gear patterns; negotiating intersections, railroad crossings, and bridges; weight and height limitations for both roads and bridges; identification and operation of automotive gauges; and operational limits." They must also have the "ability to operate passenger restraint devices; maintain safe following distances; maintain control of the vehicle while accelerating, decelerating, and turning, given road, weather, and traffic conditions; operate under adverse environmental or driving surface conditions; and use automotive gauges and controls."

These and all other NFPA codes and standards can be viewed on NFPA's website as a public service to enhance the safety of the public and the fire service community.

Motor vehicle crashes during training sessions or while traveling to or from training sessions represent an area where ordinary precautions and attention to driving rules and road conditions should have an impact. Seatbelts should be worn at all times in all vehicles.

NIOSH has investigated several deaths that occurred during dive training exercises and has made several recommendations to improve safety:

- consider developing a pre-dive checklist for all diving situations, including training;
- consider that appropriate medical fitness evaluations for SCUBA work are obtained and updated on all divers;
- ensure that equipment checks are performed before each dive and any defective equipment is repaired or replaced before the dive takes place;
- ensure that all participants in diver training have practiced the specific evolution in a controlled environment such as a swimming pool before attempting the evolution in open water;
- ensure that positive communication is established among all divers and those personnel who remain on the surface;
- ensure that all divers record each dive in a dive log;
- ensure that divers are trained to perform rescue operations for other divers who may be in distress;
- ensure that search-and-rescue operations establish and use reference points to conduct searches;
- consider supplying divers with an alternative air source;

- consider upgrading manual underwater communication devices with hands-free underwater communication devices;
- consider upgrading their diving standard operating procedures (SOPs) and include the 29 Code of Federal Regulations (CFR) 1910 for commercial diving operations.

NIOSH investigation reports are available on their website: www.cdc.gov/niosh/fire/.

Since training exercises should be conducted in controlled settings, they must be designed so as not to endanger the participants. This requires that recommended safety procedures be followed. That, in combination with competent instruction, should result in the level of safety necessary to protect lives.

Acknowledgements

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Figure 1
Deaths of U.S. Firefighters During Training
1977 - 2005

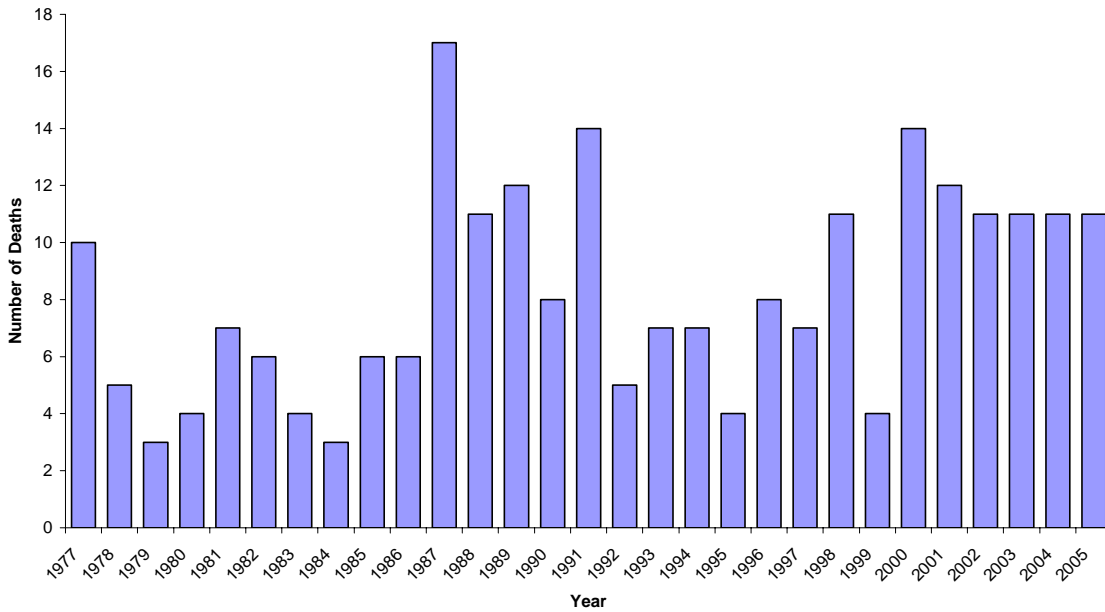


Figure 2
Proportion of training-related deaths annually
(3-year rolling average)

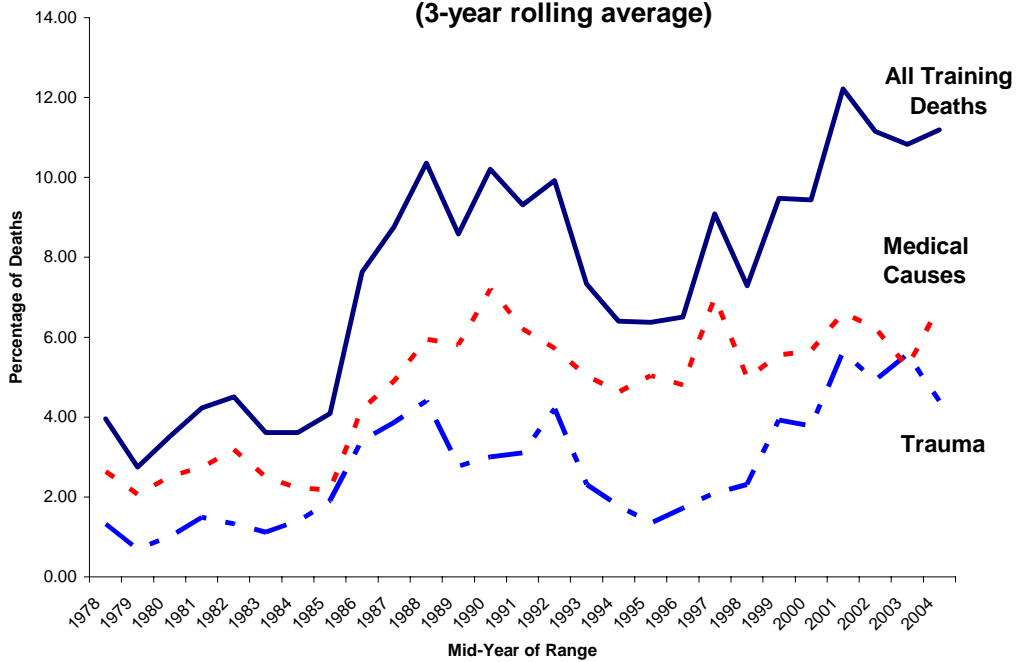


Figure 3
Training Deaths by Category

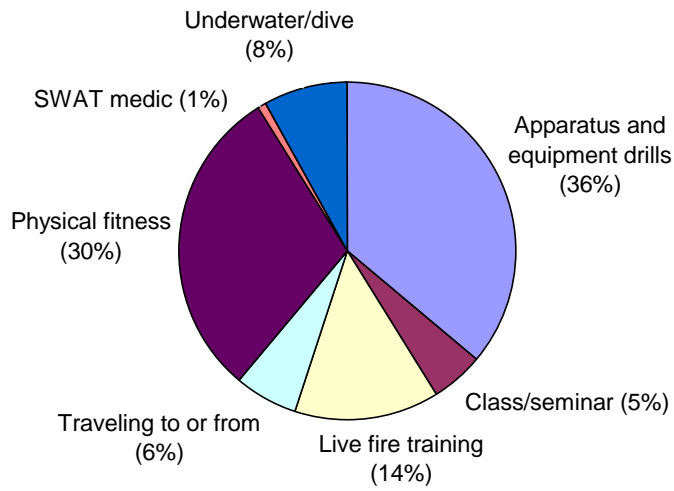


Figure 4
Cause of Fatal Injury

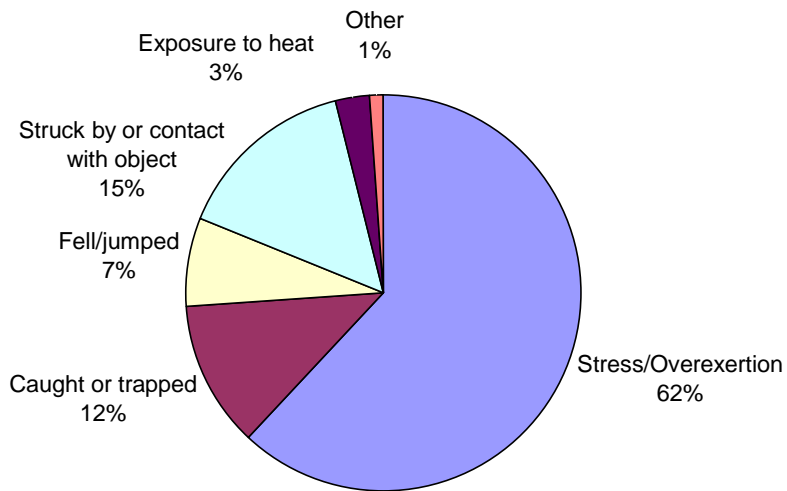


Figure 5 Nature of Fatal Injury

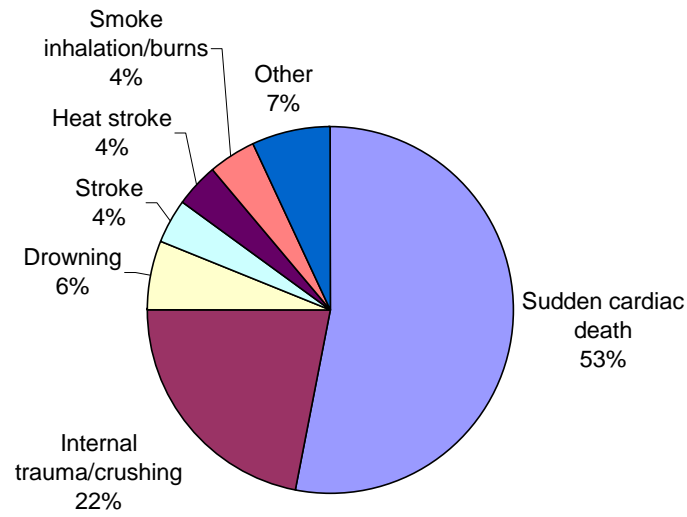


Figure 6 Training Deaths by Age and Cause of Death

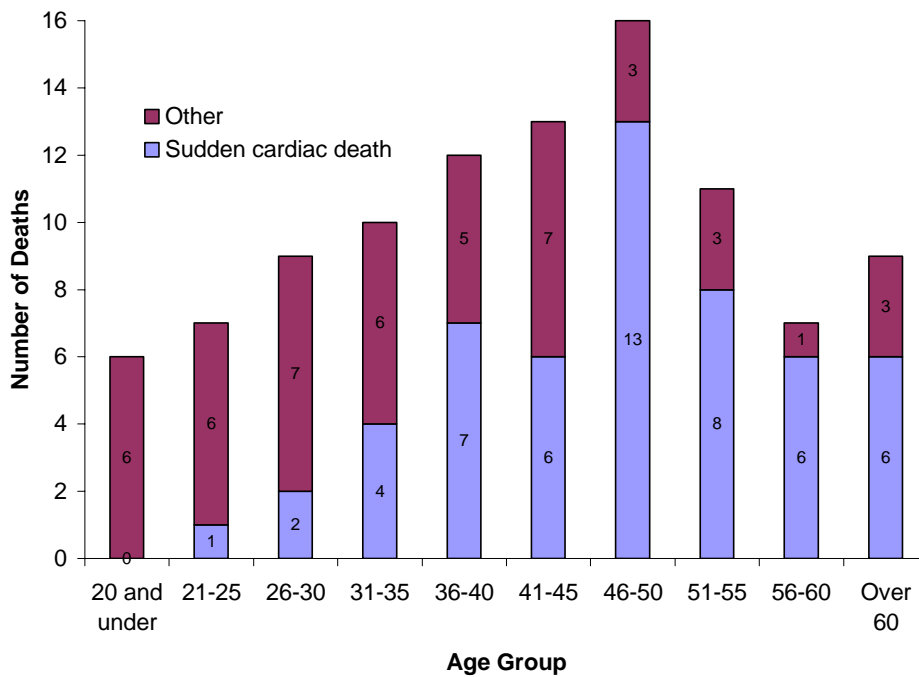


Figure 7
Death Rates for Training-Related Fatalities
per 100,000 Career and Volunteer Firefighters

