



Fire Fighter Dies While on Duty - Texas

SUMMARY

On March 10, 2001, a 53-year-old male career Driver-Engineer, while working overtime at Station 16, heard his regular-shift Engine company (Engine 32) dispatched to a call. Soon after, he began breathing heavily and subsequently stopped breathing. Crew members assessed him and found him to be unresponsive, not breathing, and pulseless. Approximately 41 minutes later, despite cardiopulmonary resuscitation (CPR) and advanced cardiac life support (ACLS) administered on the scene and at the hospital, the victim died. The autopsy revealed hypertensive and arteriosclerotic cardiovascular disease. The death certificate listed “hypertensive and arteriosclerotic cardiovascular disease” as the immediate cause of death.

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- ***Provide mandatory annual medical evaluations to ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- ***Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).***

- ***Incorporate exercise stress tests into the Fire Department’s medical evaluation program.***
- ***Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

INTRODUCTION AND METHODS

On March 10, 2001, a 53-year-old male Driver-Engineer lost consciousness while on duty at a fire station. Despite CPR and ACLS administered by crew members, the ambulance crew, and in the emergency department, the victim died. NIOSH was notified of this fatality on March 15, 2001, by the United States Fire Administration. On June 14, 2001, NIOSH contacted the affected Fire Department to initiate the investigation. On June 19, 2001, a Safety and Occupational Health Specialist and a Visiting Scientist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Texas to conduct an on-site investigation of the incident.

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at www.cdc.gov/niosh/firehome.html or call toll free 1-800-35-NIOSH

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During the investigation NIOSH personnel interviewed the following

- Fire Chief
- Fire Department Chaplain
- Union Local President
- Crew members from the victim's overtime shift
- Crew members from the victim's regular shift
- Responding ambulance service personnel
- Personal physician
- Victim's wife

During the site visit NIOSH personnel reviewed

- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 2000
- Fire Department incident report
- Emergency medical service (ambulance) incident report
- Hospital emergency department report
- Fire Department physical examination protocols
- Death certificate
- Autopsy record
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On March 10, 2001, the victim reported to work (on overtime) at Engine 16's quarters at approximately 0700 hours. After checking out his apparatus, the victim cooked breakfast for his crew. After breakfast, the crew cleaned the fire station and the apparatus. Over the course of the day, the victim and his crew responded to three alarms: a natural gas odor, a medical emergency, and a motor vehicle accident (MVA). At approximately 1700 hours, prior to eating supper, he called his wife and related that he was tired and would be going to bed early. At approximately 1900 hours, a box alarm came in from the area of town that he normally worked in. As one crew member turned away to monitor the radio, the victim, sitting in a chair, began waving his arms and gasping for air, and then he began shaking. The crew member radioed the Alarm Office for a Rescue Unit

and Battalion Chief 9, while other crew members retrieved oxygen equipment to treat the victim. Shortly thereafter he stopped breathing. Assessment revealed the victim was unresponsive, not breathing, and pulseless. An oral airway was placed and CPR (chest compressions and pressure ventilations via bag-valve-mask) was begun.

Rescue 52 was dispatched at 1912 hours. An automated external defibrillator (AED) was connected to the victim, revealing ventricular tachycardia (a heart rhythm unable to sustain life), which was immediately shocked (electrocardioversion). Four additional shocks were delivered prior to Rescue 52's arrival. Each time a shock was delivered, the victim would regain a heart beat lasting approximately 10 seconds.

At 1920 hours, Rescue 52 arrived on the scene. Reassessment found the victim unresponsive, not breathing, and pulseless. ACLS measures, including intubation and intravenous therapy, were begun. Paramedics connected a cardiac monitor to the victim, which revealed electromechanical disassociation. Rescue 52 began transport to a nearby hospital at 1933 hours and arrived at the hospital emergency department (ED) at 1941 hours. Inside the ED, a cardiac monitor revealed asystole (no heart beat). CPR and ACLS measures continued until 1952 hours, when the victim was pronounced dead by the attending physician.

Medical Findings. The death certificate, completed by the Medical Examiner, listed "hypertensive and arteriosclerotic cardiovascular disease" as the immediate cause of death. The carboxyhemoglobin level was not checked. Pertinent findings from the autopsy, performed by the Medical Examiner, on March 11, 2001, included

- Severe occlusive coronary artery disease
 - 75% narrowing of the right coronary artery
 - 75% narrowing of the diagonal branch

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- 50% narrowing of the left anterior descending coronary artery
- 50% narrowing of the left circumflex
- Cardiomegaly (enlarged heart)
- Left ventricular hypertrophy
- Pulmonary congestion and edema

The Driver-Engineer had the following risk factors for coronary artery disease (CAD): advancing age (greater than 45 years old), male gender, and a family history of CAD. The victim was not currently prescribed any medications. In 2000 the victim had a biannual physical examination which is given to all Driver-Engineers. The exam revealed a height of 5' 10" and a weight of 203 pounds, and a blood pressure of 160/90. He was referred to his private physician for follow-up regarding his blood pressure. The visit to his private physician revealed a blood pressure of 142/86, and he was subsequently cleared for "return to work."

According to his wife and crew members, the victim had no complaints of chest pains or any other heart-related illness. During the 2 weeks prior to and the day of the incident, the victim did not report any symptoms suggestive of angina or heart attack to anyone. His only complaint was that he was tired.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 1,600 uniformed personnel and served a population of 1,100,000 residents in a geographic area of 378 square miles. There are 55 fire stations.

In the first half of fiscal year 2001, the Department responded to 80,913 calls: 42,724 rescue calls, 12,698 false calls, 8,138 service calls, 5,117 hazardous condition calls, 3,713 good intent calls, 2,137 non-transmitted calls, 2,086 other fire calls, 1,716 vehicle fires, 1,584 structure fires, 829

overpressure calls, and 171 other calls. The day before the incident, the victim worked his regular 24-hour shift and responded to five calls: a box alarm at 1557 hours (canceled), a car fire at 1958 hours (vehicle fully involved; victim assisted with opening the car hood), a rescue call for an unconscious person at 2035 hours, a rescue call for an injured person at 2049 hours, and a motor vehicle accident at 2305 hours.

Training. The Fire Department requires all new fire fighter applicants to have 45 college credit hours or a "C" average or better and to pass a written civil service test, a math and reading test, a physical ability test, a polygraph test, a background check, a drug test, and a physical examination before being hired. Newly hired fire fighters are then sent to the 15-month fire fighter-paramedic training course at the City Fire Academy to become certified as a Fire Fighter-Paramedic.

Recurrent training occurs daily on each shift. The State minimum requirement for fire fighter certification is the 469-hour Fire Fighter course and the 40-hour Emergency Care-Ambulance course. The State requires a minimum of 20 hours of training for recertification. Annual recertification is required for hazardous materials while paramedic recertification is biannual. The victim was certified as a Fire Fighter and a Driver-Engineer. He had 31 years of fire fighting experience.

Preemployment/Preplacement Evaluations. The Department requires a preemployment/preplacement medical evaluation for all new hires, regardless of age. Components of this evaluation include the following:

- A complete medical history
- Physical examination
- Blood tests: complete blood chemistry
- Pulmonary function test (PFT)
- Audiogram
- Vision screen

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- Chest X-ray
- Urinalysis

These evaluations are performed by the City physician. Once this evaluation is complete, the City physician makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the City's personnel director.

Periodic Evaluations. Periodic medical evaluations are required by this Department for all hazardous materials (HazMat) fire fighters and Driver-Engineers every other year. Components of the evaluation for HazMat fire fighters include the following:

- A complete medical history
- Physical examination
- Blood tests: complete blood chemistry
- Pulmonary function test
- Chest X-ray
- Urinalysis
- Audiogram
- Vision screen

Components of the periodic medical evaluation for Driver-Engineers include the following:

- Blood pressure
- Urinalysis
- Audiogram
- Vision screen

The City physician performs the periodic medical evaluations for Driver-Engineers. A contractor performs the evaluations for the HazMat fire fighters. Medical clearance for self-contained breathing apparatus (SCBA) use and for fire suppression is not required for **all** fire fighters. Body composition analysis (body mass index) is conducted annually and resting 12-lead ECG and blood pressure measurement are conducted semiannually on all fire fighters. Fire fighters may voluntarily participate in an annual health fair, at which blood tests and general health assessments are given. (Approximately 50% of the fire fighters participate). If an employee is

injured at work, or is ill and off work for more than three shifts, the employee is evaluated by his or her personal physician, who forwards a recommendation regarding "return to work" to the City physician, who makes the final determination. Exercise (strength and aerobic) equipment is located in the fire stations. Voluntary wellness/fitness/programs are in place for the Department. Health maintenance programs are available from the City.

The victim was last cleared for duty by the City physician in 2000. He exercised regularly by walking on a treadmill, jogging, and performing strength training.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.^{2,3} The victim had three of these risk factors (age over 45, male gender, and family history).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.⁴ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁵ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁶ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Although the victim did not have a blood clot in any of his coronary arteries on autopsy (less than 50% of heart attack victims have them), he did have moderate to severe coronary atherosclerotic disease.

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Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.⁶ Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.^{7,8}

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.⁹ Fire fighting activities are strenuous and often require fire fighters 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 persist through the course of fire suppression activities.¹⁰⁻¹² Even when energy costs are moderate (as measured by oxygen consumption) and work is performed in a thermoneutral environment, heart rates may be high (over 170 beats per minute) owing to the insulative properties of the personal protective clothing.¹³ Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.¹⁴⁻¹⁷ The victim wore full bunker gear during the eight emergency responses he made over a 36-hour period. His activities ranged from walking on level ground to assisting with patient care to gaining access to a car's engine compartment. This is considered a light-to-moderate level of physical exertion.¹⁸

The physical stress of responding to these alarms and his underlying atherosclerotic CAD contributed to this fire fighter's "probable" heart attack, subsequent cardiac arrest, and sudden death. The term "probable" is used because autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or ECG findings are required to "confirm" a heart attack (myocardial infarction). The victim did not have a coronary artery thrombus on

autopsy; he died prior to the cardiac isoenzymes becoming positive, and he had no heart beat to show the characteristic findings of a heart attack on his ECG.

To reduce the risk of heart attacks and sudden cardiac arrest among fire fighters, the NFPA has developed guidelines entitled "Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians," otherwise known as NFPA 1582.¹⁹ NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.¹⁹ NFPA 1582 also recommends a thorough examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year). The Department requires a preemployment/preplacement medical examination for all new hires but does not require periodic medical evaluations for all fire fighters. Periodic medical evaluations are offered only to HazMat fire fighters and Driver-Engineers.

NFPA 1582 recommends, in addition to screening for risk factors for CAD, an exercise stress EKG, otherwise known as an EST. The EST is used to screen individuals for CAD. Unfortunately, it has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina), young men, and women.^{20,21} This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.^{22,23}

When these asymptomatic individuals **have** risk factors for CAD, however, recommendations vary by organization. The American College of Cardiology/American Heart Association (ACC/AHA) identifies four groups for EST although they



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note that the “usefulness/efficacy is less well established by evidence/opinion.”²²

Group 1: Persons with multiple risk factors. They define five risk factors for CAD: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic greater than 140 mm Hg or diastolic greater than 90 mm Hg), smoking, diabetes, and family history of premature CAD (cardiac event in first-degree relative less than 60 years old).

Group 2: Men over the age of 40 and women over the age of 50 (especially if sedentary) who plan to start vigorous exercise.

Group 3: Men over the age of 40 and women over the age of 50 who are at high risk for CAD due to other diseases (e.g., chronic renal failure).

Group 4: Men over the age of 40 and women over the age of 50 who are involved in occupations in which impairment might impact public safety.

The U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).²³

The USPSTF indicates that evidence is insufficient to recommend screening middle age and older men or women in the general population; however, “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”²³

Since the victim had several CAD risk factors, the performance of an EST is recommended by NFPA 1582. Had an EST been performed, it is possible his CAD would have been identified, thereby leading to further evaluation and treatment, and

possibly the prevention of his sudden cardiac death.

RECOMMENDATIONS

The following recommendations address health and safety generally. It is unclear if any of these recommendations could have prevented the sudden cardiac arrest and subsequent death of this Driver-Engineer. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but represent published research or consensus votes of technical committees of the NFPA or fire service labor/ management groups.

Recommendation #1: Provide mandatory annual medical evaluations to ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,¹⁹ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²⁴ The Department is not legally required to follow any of these standards. Nonetheless, we recommend the City and Union **work together** to establish the content and frequency to be consistent with the above guidelines.

Specifically, according to NFPA 1582, “the use of chest X-rays in surveillance activities in the absence of significant exposures, symptoms, or medical findings has not been shown to reduce respiratory or other health impairment. Therefore, only pre-

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placement chest X-rays are recommended.” The extra chest X-rays being conducted by the Fire Department expose incumbents to unnecessary radiation and represent an unnecessary expense for the Fire Department.

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 should be applied in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, addresses these issues in Chapter 8-7.1 and 8-7.2.²⁵

The success of medical programs hinges on protecting the affected fire fighter. The Department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) if the fire fighter is not medically qualified to return to active fire fighting duties, provide permanent alternate duty positions or other supportive and/or compensated alternatives.

Recommendation #2: Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).

OSHA’s Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.²⁶ These clearance evaluations are required for private industry employees and public

employees in States operating OSHA-approved State plans. Texas is not a State-plan State; therefore, public sector employers are not required to comply with OSHA standards. However, we recommend following this standard, and a copy of the OSHA medical checklist has been provided to the Fire Department.

Recommendation #3: Incorporate exercise stress tests into the Fire Department’s medical evaluation program.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend at least biannual EST for fire fighters.^{19,24} They recommend that these tests begin at age 35 for those with CAD risk factors, and at age 40 for those without CAD risk factors. The EST could be conducted by the fire fighter’s personal physician, the City physician, or the Department’s contract physician. If the fire fighter’s personal physician or the contracted physician conducts the test, the results must be communicated to the City physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Recommendation #4: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.²⁷ NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.²⁵ In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve

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fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.²⁴ The Fire Department and the Union should review these materials to identify applicable elements for their Department. Other large-city negotiated programs can also be reviewed as potential models.

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