



## **Fire Fighter Dies During Operations at a Fire in a Three-Story Structure—Pennsylvania**

### **SUMMARY**

On June 17, 1999, a 50-year-old male Fire Fighter responded to a fire in a three-story structure. After assisting with laddering the building, removing plywood from windows and doors, and connecting his Truck to a water supply, the victim suffered a collapse which was witnessed by a paramedic who saw the Fire Fighter in apparent distress. Despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) on scene and at the hospital, the victim died. The death certificate and the autopsy, completed by the County Coroner, listed “arteriosclerotic cardiovascular disease” as the immediate cause of death.

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty heart attacks and cardiac arrests among fire fighters. This strategy consists of (1) minimizing physical stress on fire fighters; (2) screening to identify and subsequently rehabilitate high risk individuals; and (3) encouraging increased individual physical capacity. The following issues are relevant to this fire department:

- ***Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- ***Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program for fire fighters.***

### **INTRODUCTION & METHODS**

On June 17, 1999, a 50-year-old male Fire Fighter lost consciousness after assisting with exterior ventilation and water tower activities at a fire in a three-story vacant structure. Despite CPR and ALS administered by fire department paramedics and emergency department personnel, the victim died. NIOSH was notified of this fatality on June 17, 1999, by the United States Fire Administration. On July 1, 1999, NIOSH contacted the affected Fire Department to initiate the investigation. On August 3, 1999, a Safety and Occupational Health Specialist and an Epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Pennsylvania to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met with and/or interviewed the

- Fire Chief
- Deputy Chief for Administration
- Fire Investigators
- The Local representative of the International Association of Fire Fighters (IAFF)
- Crew members involved in this 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. 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:

<http://www.cdc.gov/niosh/firehome.html>

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- Emergency Medical Service paramedics involved in this incident
- Victim's brother

During the site visit NIOSH personnel reviewed

- Existing FD investigative records, including the fire fighter fatality investigation report, incident reports, coworker statements, and dispatch records
- The victim's personnel record maintained at the FD
- Emergency medical services—ambulance report
- The hospital's records of the resuscitation effort
- Autopsy results and death certificate
- Past medical records of the deceased
- FD policies and operating procedures
- FD training records
- The FD annual report for 1998

## INVESTIGATIVE RESULTS

*Incident Response.* On June 17, 1999, at 0411 hours, Engine 35 was dispatched to check for a strong odor of smoke. Engine 35 (Captain and three Fire Fighters) responded at 0414 hours and arrived in the area at 0418 hours. After searching on several streets, Engine 35 located a working structure fire, notified Dispatch, and requested a first alarm zone assignment and transfers.

The building involved in this incident—a former hospital—was a vacant, boarded-up, three-story structure of ordinary construction with a brick exterior. It measured 100 feet by 100 feet. There was structural damage to all floors due to water leaks through the roof. There was no electrical or gas service to the building.

At 0424 hours, Engine 36 (Captain and three Fire Fighters), Engine 37 (Captain and three Fire Fighters), Truck 34 (Lieutenant and three Fire

Fighters, [including the victim]), Battalion Chief 1, Battalion Chief 5 (Safety Officer), Engine 30 (Captain and three Fire Fighters) (Rapid Intervention Team), the Safety Unit (Captain and three Fire Fighters), and Mobile Air Compressor 2 were dispatched. At 0428 hours Medic 4 (two paramedics), Rescue 2 (two Paramedics), and an EMS supervisor were dispatched.

At 0428 hours, Engine 36 and Battalion Chief 1 (BC-1) arrived on scene, and BC-1 assumed command. A defensive exterior attack was ordered. Crew members of Engine 35 and Engine 36 advanced 1¾-inch attack lines to the structure, and they began to remove plywood from windows and direct streams into the structure. Engine 37 arrived on scene at 0430 hours and advanced a 2½-inch attack line to the structure. At 0431 hours a second alarm was requested. On the second alarm, Engine 3 (Captain and three Fire Fighters), Engine 34 (Captain and three Fire Fighters), Truck 33 (Lieutenant and three Fire Fighters), and a Deputy Chief were dispatched.

Truck 34 arrived on scene at 0432 hours and was positioned in front of the building for elevated master stream operations. Truck 33 arrived at 0440 hours. Truck 33 and Truck 34 were directed to provide ground ladders around the building and to remove plywood from remaining boarded doors and windows. The victim and his crew members, wearing full bunker gear and SCBA without facepiece, removed two, 20-foot portable ladders and a 16-foot portable ladder from Truck 34, carried them approximately 60 feet, and positioned them at the building for use in entry. The victim and his crew members then assisted with removing plywood from the front door and two windows.

Engine 3 arrived at 0441 hours. The victim and his Lieutenant assisted the Engine 3 crew members with advancing a 2½-inch attack line down the hill and into a parking lot for use in exterior attack. The



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Lieutenant advised the victim to return to Truck 34 and assist the Driver/Operator with water tower operations. The victim assisted the Driver/Operator in connecting a 5-inch supply line from Engine 35 into Truck 34.

The Deputy Chief arrived at 0444 hours and took command from BC-1. At 0451 hours, a third alarm was requested. Engine 5 (Captain and three Fire Fighters) and Engine 32 (Captain and three Fire Fighters) were dispatched.

At approximately 0515 hours, the Lieutenant from Truck 34 got refreshments for his crew and took them to Truck 34. He asked the crew if they were doing OK. The victim stated that he was fine. The Fire Chief arrived on scene at 0520 hours; however, command of the fire scene remained with the Deputy Chief. Exterior fire attack operations continued. At this approximate time, the victim complained to his Lieutenant that he was feeling light-headed. The Lieutenant advised him to sit down on the turntable. Crew members helped him remove his SCBA and turnout coat.

After approximately 20 minutes, the victim related to the Driver/Operator that he wanted down from the Truck to splash some water in his face to help him feel better. After the Driver/Operator helped the victim down from the Truck, the victim went behind the pumper parked in front of the Truck. Paramedics on scene were standing nearby and were watching the victim. After approximately 10 minutes, the victim did not reappear and the paramedics went to check on him. At 0550 hours, they approached the victim and asked him how he was doing. The victim had a seizure which lasted approximately 30 seconds. After coming out of the seizure, the victim related that he was fine and did not want medical treatment. As the paramedics began to insist that he get treated, the victim went into another seizure. The victim was placed onto the backboard atop the

stretcher and given oxygen via non-rebreather mask. After seizure activity ceased, the victim stopped breathing (0551 hours). The victim was given oxygen via bag-valve-mask (BVM). CPR (chest compressions and assisted ventilation with BVM with 100% oxygen) was initiated. He was loaded into Medic 4 and placed on a heart monitor which revealed ventricular fibrillation with no pulse. On scene, he was defibrillated five times and intubated. Intravenous (IV) access was established, and advanced life support (ALS) protocol was followed. Medic 4 departed the scene en route to the hospital at 0614 hours. En route, the victim was defibrillated a sixth time. Medic 4 arrived at the hospital at 0620 hours. CPR and ALS procedures were performed for a total of 23 minutes on scene and for 6 minutes during transport to the hospital.

Upon arrival in the emergency department (ED), the victim was found to be in asystole (no heart beat), unresponsive, and without vital signs. ALS activities were continued. No cardiac activity occurred in the ED. After approximately 9 minutes of aggressive ALS and an ultrasound screening showing cardiac standstill with no evidence of cardiac activity, the victim was pronounced dead at 0629 hours.

*Medical Findings.* The death certificate, based on autopsy, was completed by the Coroner, who listed “arteriosclerotic cardiovascular disease” as the immediate cause of death. The autopsy also indicated that this Fire Fighter died as a result of sustaining a fatal cardiac arrhythmia. Fire department medical records indicated that the victim had a medical history of hypertension, diagnosed in mid-1994, which was not treated with medication. He was diagnosed in mid-1995 as having “borderline” hypercholesterolemia (as listed in medical records). He was a current, approximately one-pack-per-day smoker. He was described by many fire fighters as physically fit but did not participate in weight-lifting and jogging activities.



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Pertinent findings from the autopsy, performed by the Coroner on June 18, 1999, are listed below:

1. Atherosclerotic coronary artery disease
  - Severe (75%) narrowing of the right coronary artery
  - Severe (80-90%) narrowing of the left anterior descending coronary artery
  - Severe (75-85%) narrowing of the left circumflex artery
  - Mild (30%) narrowing of the left main branch of the coronary artery
  - Myocardial fibrosis, focal
  - No evidence of a thrombus formation in any of the coronary arteries
2. Mild systemic atherosclerosis
  - Aorta
  - Right internal carotid artery at the base of the brain
3. No evidence of significant valvular or electrical heart problems
4. Moderate fatty change of the liver
5. Moderate pulmonary edema
6. Generalized congestion of viscera
7. Bilateral fibrous pleura plaques
8. Negative blood screen for alcohol or drugs

#### **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, the fire department was comprised of 896 uniformed personnel and served a population of 370,000 residents in a geographic area of 55 square miles. Fire fighters work the following tour of duty in 35

fire stations: Days 1-4, 0800-1800; Days 5-8, off duty; Days 9-12, 1800-0800; and off duty for 4 days. There are 4 platoons. Each shift of an engine company is staffed with a Captain and three Fire Fighters; each ladder company, a Lieutenant and three Fire Fighters. The emergency medical service is not a part of the fire department but is dispatched on all structure fires.

In 1998, the department responded to 30,901 total calls: 16,837 rescue (medical, lock-in, search) calls, 3,622 service calls, 3,589 false alarms, 2,423 fire or explosion calls, 2,374 good-intent calls, 2,013 hazardous condition calls, and 43 overpressure/rupture calls.

The day of the incident, the victim began his shift at 1800 hours, his first day back after the 4-day break. The shift was spent checking out the equipment and performing station maintenance. While performing this work, the victim did not report or show signs of discomfort, pain, or distress. The incident described was the victim's second call during his shift. The first was a nonemergency response.

Training. The fire department provides all new fire fighters with the basic 14-week recruit training conducted at the city's Training Academy to become certified to the Fire Fighter II level. All are certified as Medical Responder Technicians (MRT) and in Hazardous Materials Operations, automated external defibrillator (AED), and cardiopulmonary resuscitation (CPR). The victim had 18 years of fire fighting experience and was certified as a Fire Fighter, Hazardous Materials Operations, MRT, CPR, and AED. He had been assigned to Truck 34 for 1 year prior to his death.

Preemployment/Preplacement Evaluations. The department requires (1) a preemployment/preplacement medical evaluation for all new hires, (2) an annual physical examination for HAZMAT fire



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fighters, and (3) a physical examination when a fire fighter is off duty for illness/injury for more than 14 days. Components of this evaluation for all applicants include

- A complete medical history
- Height, weight, and vital sign.
- Physical examination
- Eye examination for Telebinocular vision
- Audiogram
- Complete blood count (CBC) and Differential
- Blood lipid profile (total cholesterol, HDL cholesterol, triglycerides).
- Blood Chemical Profile
- Urinalysis Routine/Microscopic
- Combined Cardiovascular Pulmonary Stress Test
- Non-Department of Transportation (DOT) Urine Drug Screen

These evaluations are performed by a City Civil Service Physician. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the Civil Service Physician. New hires are also required to complete a physical capacity test. This is a timed-performance evaluation of typical fire fighting duties. Medical clearance for SCBA use is ascertained during the physical examination.

*Periodic Evaluations.* This department does not require annual/periodic medical evaluations for all fire fighters; only those who are assigned to a Hazardous Materials unit are required to undergo annual/periodic medical evaluations. If employees are injured at work, they must be cleared for “return to work,” and this clearance must go through the city physician. This department does not require annual/periodic physical capacity tests. Although some stations have exercise (strength and aerobic) equipment, typically purchased by the fire fighters themselves, no voluntary or required fitness/wellness program is in place, nor is there a specific required periodic medical clearance for SCBA use.

## **DISCUSSION**

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>1</sup> Risk factors for its development include family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes.<sup>2</sup> The victim had three of these risk factors (smoking, high cholesterol, and high blood pressure), and on autopsy, he had atherosclerotic disease in his coronary arteries.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>3</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>4</sup>

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.<sup>5-7</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>8-11</sup> The mental and physical stress of responding to the emergency, carrying 16- and 20-foot portable ladders for 60 feet, assisting in moving attack and supply hose, removing plywood from the structure, and his previously undiagnosed underlying atherosclerotic coronary artery disease all probably contributed to this victim’s fatal cardiac arrhythmia and sudden cardiac death.

This victim did not report prior episodes of angina (heart pain) during physical activity performed on or off the job. However, sudden cardiac arrest is often the first overt manifestation of ischemic heart disease.<sup>12</sup>



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Discrepancies occurred in the frequency and content of the Department's medical evaluation and those recommended by the NFPA.<sup>13</sup> For example, the Department conducted extensive preemployment/preplacement medical evaluations, including treadmill stress tests on all applicants, regardless of age. The NFPA recommends stress tests for those 35 years old and above with known CAD risk factors, and 40 years old and above for those without CAD risk factors.

The NFPA also recommends annual medical evaluations, with periodic medical examinations. Stress tests are included as part of these medical examinations. It is assumed that if a treadmill test was performed on this Fire Fighter, his underlying CAD would have been identified and he would have been directed toward further evaluation and treatment.<sup>14</sup>

#### **RECOMMENDATIONS AND DISCUSSION**

The following recommendations address health and safety generally. 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 research presented in the literature or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order and are not listed in a priority manner.

***Recommendation #1: Fire Fighters should have annual medical evaluations 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 scheduling of periodic medical evaluations for fire fighters can be found in *NFPA 1582, Standard on Medical Requirements for Fire Fighters*,<sup>13</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.<sup>15</sup> The department is not legally required to follow any of these standards. Nonetheless, we recommend the City and Union **negotiate** the content and frequency to be consistent with the above guidelines.

Specifically, the preemployment/preplacement stress (EKG) tests are not necessary for applicants under the age of 35 and represent an unnecessary expense for the department. On the other hand, annual/periodic medical evaluations should be conducted and should include stress tests, beginning at age 35, for fire fighters with risk factors for CAD. 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. Applying NFPA 1582 involves legal issues, so it should be carried out 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.<sup>16</sup>

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



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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: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program for fire fighters.***

NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>16</sup> In 1997, the International Association of Fire Fighters and the International Association of Fire Chiefs joined in a comprehensive *Fire Service Joint Labor Management Wellness/Fitness Initiative* to improve 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 with a video detailing elements of such a program.<sup>15</sup> 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. By all reports, this particular fire fighter was very aerobically and physically fit. However, the department did not have a fitness program in place.

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