



## **Fire Fighter Dies After Performing Ventilation at a Fire in a Two-Story Dwelling - Pennsylvania**

### **SUMMARY**

On October 7, 2003, a 43-year-old male Fire Fighter (FF) responded to a fire in a two-story dwelling. After performing “up and over” ventilation (climbing two ladders to the roof and removing windows below the roof line with a closet hook), the FF had a witnessed collapse on the roof. After approximately 47 minutes of cardiopulmonary resuscitation (CPR) and advanced life support (ALS) on-scene and at the hospital, the FF died. The death certificate and the autopsy, both completed by the City Medical Examiner, listed “ischemic heart disease” as the immediate cause of death and “smoke inhalation” as a significant condition. Pertinent autopsy results included mild coronary artery disease, fibrosis of the left ventricle [consistent with remote (old) heart attack], and cardiomegaly.

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 individuals at higher risk; and 3) encouraging increased individual physical capacity. The following issues are relevant to this fire department:

- ***Provide mandatory annual medical evaluations to ALL fire fighters consistent with NFPA 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others***
- ***Consider requiring exercise stress tests for ALL fire fighters with two or more risk factors for coronary artery disease (CAD)***

- ***Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity***
- ***Ensure fire fighters wear self-contained breathing apparatus (SCBA) when working in a potentially hazardous atmosphere***
- ***Ensure fire fighters wear self-contained breathing apparatus (SCBA) when working in a potentially hazardous atmosphere***
- ***Carboxyhemoglobin levels should be tested as soon as possible on symptomatic or unresponsive fire fighters exposed to smoke***

### **INTRODUCTION AND METHODS**

On October 7, 2003, a 43-year-old male Fire Fighter lost consciousness after performing ventilation at a fire in a two-story dwelling. Despite CPR and ALS administered by crew members, fire department (FD) paramedics, and emergency room personnel, the victim died. NIOSH was notified of this fatality on October 8, 2003, by the United States Fire

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](http://www.cdc.gov/niosh/firehome.html) or call toll free 1-800-35-NIOSH



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Administration. On October 8, 2003, NIOSH contacted the affected Fire Department to initiate the investigation. On December 8, 2003, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Pennsylvania to conduct an onsite investigation of the incident.

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

- Fire Marshal
- International Association of Fire Fighters (IAFF) Local President
- FD Personnel Director
- City Medical Examiner
- Crew members involved in this incident
- Victim's spouse
- Civilian witness

During the site-visit NIOSH personnel reviewed:

- Existing FD investigative records, including the Department's fire fighter fatality investigation report, incident reports, co-worker 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 2002

NIOSH personnel also:

- Visited the area where the structure fire occurred

**INVESTIGATIVE RESULTS**

Incident Response. On October 7, 2003, the FF arrived for work at his fire station at approximately 0730 hours. He was assigned to Ladder 16 as the tillerman for his 10-hour shift.

At 0745 hours, Engine 6, Engine 28, Ladder 16, Ladder 3, and Battalion 10 were dispatched on a tactical box alarm to a fire in a two-story dwelling. The structure involved was an occupied, two-story, masonry, semi-detached, single family dwelling with basement, measuring 14' x 50', and was of ordinary construction. (See photograph). At the time of dispatch, the temperature was 45°F and relative humidity was 87%. Wind direction was from the North at 5 miles per hour.

Battalion 10 (Battalion Chief and an Aide), Engine 6 (Lieutenant [LT] and three Fire Fighters), Engine 28 (Lieutenant and five Fire Fighters), Ladder 16 (Acting Lieutenant and four Fire Fighters [including the deceased]), and Ladder 3 (Lieutenant and five Fire Fighters) responded at 0746 hours. Engine 6 arrived on the scene at 0747 hours. The LT radioed Dispatch that there was a medium smoke condition and that the first Engine and Ladder would go into service. A fire fighter and the LT stretched a 1¾-inch hoseline to the front of the structure and up the stairs to the fire room.

Meanwhile, Ladder 16 had arrived on the scene. A crew member retrieved a 16-foot ladder, carried it to the front of the dwelling, and placed it to the porch roof. The deceased FF was assigned to perform "up and over" ventilation. Wearing full bunker gear (weighing 20 pounds) without self-contained breathing apparatus (SCBA), he retrieved a 16-foot ladder (weighing 43 pounds) and an 8-foot ceiling hook (weighing 6 pounds) and carried them to the front of the dwelling. While carrying the ceiling hook, he climbed the first ladder and, with assistance from the crew member, pulled the second ladder up and placed it onto the porch roof. The crew member removed the front second floor windows and the deceased FF climbed the second ladder to the roof. Once on the roof he removed the window to the fire room, then walked to the rear edge of the roof and removed the window at the rear of the dwelling.



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When Battalion 10 (BC 10) arrived on the scene at 0750 hours, Engine 6 advised BC 10 that the fire was knocked down. A search was conducted and that all occupants were accounted for. The window in the fire room was removed with the hosestream and the air conditioner removed from the lower portion of the window. The fire was placed under control at 0752 hours. Ladder 3 was released and Engine 28 and Battalion 10 were made available at 0753 hours.

With ventilation complete, the deceased FF walked toward the front of the roof. According to a civilian witness who lived across the street from the fire building, the FF appeared to be checking for something. After about two minutes, the witness saw the FF collapse face down, shaking his left leg as though it was hurt (approximately 0755 hours).

At 0757 hours, a call was received at 911 from the civilian witness reporting a fire fighter had collapsed on the roof. The witness also mentioned this to a street bystander who relayed this information to the Driver/Operator of Engine 6. The Driver/Operator notified crew members inside the dwelling while Dispatch tried to notify Engine 6. Unable to contact Engine 6, Dispatch then advised BC 10 to check members on the roof. BC 10's Aid notified Ladder 16, whose members began checking the roof at 0759 hours. Seconds later, a Dispatch supervisor advised BC 10 of the details of the 911 call — a member in distress on the roof.

At 0801 hours, a crew member of Ladder 16 ascended the portable ladders to the roof and saw the FF face down and unresponsive. The crew member yelled to fire fighters below that there was a problem, finished climbing onto the roof, and activated the emergency button on the deceased's portable radio. BC 10's Aid requested a squad (ambulance) to report to the scene. At 0802 hours, Dispatch notified Medic 8, who responded to the location.

All fire fighters hired after October 1974 are certified emergency medical technicians (EMTs) and all fire fighters are trained in CPR and automated external defibrillator (AED) use. When the crew member on the roof rolled the FF over and noted the FF was not breathing, mouth-to-mouth ventilations were attempted. The FF had vomited, and the crew member was clearing the FF's airway as other crew members accessed the roof. Being unresponsive without a pulse, CPR (chest compressions) was begun. While the aerial ladder on Ladder 16 was being raised to the roof, the semi-automated external defibrillator (SAED) and the medical bag with oxygen equipment were brought up to the roof via the portable ladders already in place. The FF's bunker coat and shirt were opened, the SAED was connected to the FF's chest, and no shock was advised. CPR continued as an oral airway was inserted.

Medic 8 arrived on the scene at 0803 hours. Both paramedics re-evaluated the FF who was unresponsive, pulseless, and not breathing. The SAED again advised "No shock" and CPR was continued. Paramedics connected the FF to a cardiac monitor, which revealed fine ventricular fibrillation (V.fib.) and two "stacked" (in sequence) shocks were administered. The FF's heart rhythm reverted to asystole (no heart beat) and CPR continued. He was intubated with tube placement confirmed by auscultation and CO<sub>2</sub> detector. The collapsed FF was placed into a Stokes basket, carried down the aerial ladder to the ground.

Once on the ground and inside Medic 8, ALS procedures were followed which included the placement of an intravenous (IV) line through which ALS medications were administered. Medic 8 departed for the hospital at 0815 hours, arriving at the emergency department (ED) at 0818 hours. Inside the ED, full ALS protocols were followed with no change in patient status. At 0848 hours (53

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minutes after his collapse) the FF was pronounced dead and resuscitation efforts were discontinued.

***Medical Findings.*** The death certificate, completed by the City Medical Examiner, listed “ischemic heart disease” as the immediate cause of death and “smoke inhalation” as a significant condition. Pertinent findings from the autopsy, performed by the Medical Examiner on October 7, 2003, are listed below:

- Cardiomegaly (heart weighing 552 grams with normal less than 400 grams)<sup>1</sup>
- Mild atherosclerotic coronary artery disease involving the left main coronary artery
- Remote (old) myocardial infarction involving the apex and left posterior ventricular wall
- Fibrosis within the apex and left posterior ventricular wall (as determined by microscopic examination)
- Evidence of smoke inhalation (moderate amount of soot in the trachea and large airways of both lungs)
- Carboxyhemoglobin (measure of carbon monoxide in the blood) level negative

On autopsy, the deceased weighed 230 pounds and was 70 inches tall, giving him a body mass index (BMI) of 33 kilograms per square meter (kg/m<sup>2</sup>). (A BMI over 30.0 kg/m<sup>2</sup> is considered obese).<sup>2</sup>

The heart was further examined for use as a possible donation and the following was identified:

- Heart weighed 436 grams (normal less than 400 grams)<sup>1</sup>
- Left ventricle was 2.4 centimeters (24 millimeters) thick (normal between 7.6-8.8 mm)<sup>3</sup>
- No thrombus

The heart was weighed at the donation center without the aortic and pulmonary heart valves, thus making up the difference in weights.

At his annual medical evaluations, performed by his primary care physician from 1991 to 2003, he was noted to have:

- Hypertension diagnosed since at least 1991 and treated with prescription medication since at least 1994.
- Hypercholesterolemia diagnosed in 2003 and treated with some success by diet and prescription medications.
- Mild asthma and mild chronic obstructive pulmonary disease (COPD) diagnosed in 1997 and treated with inhaled steroids and bronchodilators. He smoked approximately one pack of cigarettes per week. His most recent spirometry testing in 1997 revealed abnormal results in forced expiratory volume at one second (FEV<sub>1</sub>) of 54% (normal e” 80%) and a FEV<sub>1</sub>/FVC ratio of 64 (normal e” 70), but normal forced vital capacity (FVC) of 83% (normal e” 80%).<sup>4</sup>

According to the FF’s wife and Fire Department personnel, the FF did not participate in regular exercise and had no complaints of angina (chest pain) or any symptoms suggestive of acute heart-related problems.

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

At the time of the NIOSH investigation, the FD was comprised of 2,432 uniformed personnel and served a population of 1,480,000 residents, in a geographic area of 130 square miles. There are 60 fire stations where fire fighters work the following tour of duty: Day 1, 0800-1800; Day 2, 0800-1800; Day 3, 1800-0800; Day 4, 1800-0800; off-duty for 4 days. There are 4 platoons. Each shift of an engine company is staffed with an officer and three fire fighters; each ladder company, an officer and four fire fighters. The emergency medical service is a component of the FD.



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In 2002, the Department responded to 247,631 total calls: 191,861 total medical incidents and 55,770 total fire and emergency service incidents (33,655 other responses [police assist, medical assist, citizen assist, malfunctioning equipment], 8,367 non-structure fires, 11,238 false alarms, and 2,510 structure fires). Total calls includes 20 multiple alarm fires.

The day of the incident, the deceased arrived for his shift at 0730 hours. He was printing the run summary for the previous shift when the call came in to respond to the incident described herein.

Training. The FD provides all new fire fighters with the basic 15-week recruit training, conducted at the city's Fire Academy, to become certified Fire Fighters. All fire fighters are semi-automated external defibrillator (SAED)- and Emergency Medical Technician (EMT)- certified. The victim was a certified Fire Fighter/EMT, Hazmat First Responder, and had 7 years of fire fighting experience.

Pre-placement Evaluations. The Department requires: (1) a pre-placement medical evaluation for all new hires, (2) a physical examination when a fire fighter is promoted, and (3) a physical examination when a fire fighter is off-duty for illness/injury for more than 14 days. Components of the pre-placement evaluation for all applicants include:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Vision test
- Hearing test
- Complete blood count (CBC)
- Cholesterol and triglycerides
- Urinalysis
- Urine drug test
- Pulmonary function tests (lung tests)
- Resting Electrocardiogram

- Exercise stress test (EST)
- Chest x-ray

These evaluations are performed by the Office of the City Medical Director, who makes a decision regarding medical clearance for fire fighting duties. New hires are also required to complete a physical capacity test at the city Fire Academy. This is a non-timed performance evaluation of typical fire fighting duties.

Periodic Evaluations. There are no routine annual/periodic medical evaluations required by this Department for **all** fire fighters. If an employee is injured at work, he/she must be cleared for "return to work" by a physician in a Workman's Compensation Clinic. If an employee is away from work for a non-service connected illness/injury for more than six days, he/she must have a physical examination and be cleared for "return to work" by the City Medical Director. Those fire fighters assigned to the hazardous materials unit have medical evaluations every two years. The contents of these evaluations are the same as the pre-placement evaluation. There are no annual/periodic physical capacity tests required by this Department. Some fire stations have exercise (strength and aerobic) equipment, typically purchased by the fire fighters themselves. There are voluntary smoking cessation and weight control programs; however, there is no required fitness/wellness program. There is no specific required medical clearance for SCBA use. The deceased FF had his last FD physical evaluation in 1996.

## **DISCUSSION**

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>5</sup> Risk factors for its development include increasing age, male gender, family history of coronary artery

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disease, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes.<sup>6</sup> The victim had five of the risk factors for coronary artery disease: family history of CAD, smoking, high blood pressure, high blood cholesterol, and obesity/lack of exercise.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>7</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>8</sup> 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.<sup>9</sup> This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. The deceased did not have a blood clot on autopsy but he did have evidence of atherosclerotic disease in his coronary arteries with 25-50% narrowing of the left main coronary artery and fibrosis in the apex and left posterior ventricular wall, indicating an old myocardial infarction (MI) according to the ME. There was no evidence at autopsy of a recent MI.

Atherosclerosis in a coronary artery may cause ischemic heart disease which occurs when the blood flow within a coronary artery, probably the left main coronary artery in this case, is limited to the point where the oxygen needs of the heart muscle cannot be met. Chronic ischemic heart disease causes hypertrophy of the heart muscle and cardiomegaly. All of these factors, independently and in combination (ischemia, cardiomegaly, or myocardial infarction), increase the risk of cardiac arrhythmia, remote MI, and sudden cardiac death.

It is also possible/probable that the FF suffered a heart attack, which caused an arrhythmia and sudden cardiac death (SCD). The term “possible/probable” is used because autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or ECG

findings are required to “confirm” a heart attack [myocardial infarction (MI)]. 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.

Angina is the most common presenting symptom of myocardial ischemia and underlying CAD, but in many persons the first evidence of CAD may be myocardial infarction or sudden death.<sup>10</sup> Some individuals may not experience angina with ischemia, as evidenced by up to 20% of heart attacks being “silent,” i.e., painless.<sup>7</sup> He did not report any episodes of chest pain during physical activity on or off-the-job.

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.<sup>11</sup> Firefighting 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>12-14</sup> 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.<sup>15</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>16-19</sup> While at the fire scene, the Fire Fighter, while wearing full bunker gear (weighing 20 pounds), retrieved a 16-foot ladder (weighing 43 pounds) and an 8-foot ceiling hook (weighing 6 pounds) and carried them to the front of the dwelling. While carrying the ceiling hook, he climbed the first ladder and, with assistance from a crew member, pulled a second ground ladder up and placed it onto the porch roof. He climbed the second ladder to the roof, walked across to the edge,



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removed the window to the fire room, then walked to the rear edge and removed the window at the rear of the dwelling. This is considered a moderate level of physical exertion.<sup>11,20</sup> The physical stress of responding to the alarm and performing a moderate level of physical exertion, coupled with his underlying atherosclerotic CAD probably contributed to this fire fighter's "heart attack," subsequent cardiac arrest, and death.

Firefighters' exposure to carbon monoxide represents a relatively constant occupational hazard.<sup>21,22</sup> Carbon monoxide (CO) levels up to 1,900 parts per million (ppm) have been found during the knockdown phase and up to 82 ppm during overhaul.<sup>22</sup> Even wearing respiratory protection may not eliminate a fire fighter's exposure to CO. In fact, CO levels from 1-105 ppm have been found inside fire fighters' SCBA masks.<sup>22</sup> Exertional levels and, therefore, ventilatory rates may be so great during firefighting that even in moderate or low levels of atmospheric carbon monoxide the COHb can rise to dangerous levels within minutes.<sup>21</sup> The deceased performed ventilation activities on the roof without breathing air from a SCBA. There was a negligible amount of COHb (< 5%) at autopsy. However, an exposure to CO did occur.

To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the NFPA has developed guidelines entitled "Standard on Comprehensive Occupational Medical Program for Fire Departments," otherwise known as NFPA 1582.<sup>23</sup> To screen for CAD, NFPA 1582 recommends an exercise stress test (EST) for asymptomatic fire fighters with two or more risk factors for CAD [family history of premature (less than age 60) cardiac event, hypertension (diastolic blood pressure greater than 90 mmHg), diabetes mellitus, cigarette smoking, and hypercholesterolemia (total cholesterol greater than 240 mg/dL)].<sup>23</sup> This recommendation is consistent with recommendations from the American Heart Association/ American

College of Cardiology (AHA/ACC) and the Department of Transportation (DOT) regarding EST in asymptomatic individuals.<sup>24,25</sup>

Since the deceased was male and had four risk factors for CAD, the performance of an EST is recommended by NFPA 1582 and is probably recommended by ACC/AHA as a guide to risk-reduction therapy.<sup>24</sup> If an EST had been performed, his CAD might have been detected, resulting in further evaluation and treatment prior to his "heart attack," and possibly preventing his sudden cardiac death.

### **RECOMMENDATIONS**

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 death 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.

***Recommendation #1: Provide mandatory annual medical evaluations to ALL fire fighters consistent with NFPA 1582 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 Comprehensive Occupational Medical Program for Fire Departments,<sup>23</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>26</sup> The Department is not legally required to follow any of these standards.



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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 B 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>27</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 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: Consider requiring exercise stress tests for fire fighters with two or more risk factors for coronary artery disease (CAD).***

NFPA 1582, IAFF/IAFC wellness/fitness initiative, and the American Heart Association recommend EST for fire fighters with two or more CAD risk factors.<sup>23,24,26</sup> The EST could be conducted by the fire fighter's personal physician or the City contract physician. If the fire fighter's personal 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 #3: 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.<sup>28</sup> 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.<sup>27</sup> NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, provides the minimum requirements for a health-related fitness program.<sup>29</sup> 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 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.<sup>26</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. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.<sup>30-32</sup> A similar cost savings has been reported by the wellness program at the Phoenix Fire Department, where a 12-year commitment has resulted in a significant reduction in their disability pension costs.<sup>33</sup>

***Recommendation #4: Ensure fire fighters wear self-contained breathing apparatus (SCBA)***



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*when working in a potentially hazardous atmosphere*

(Accessed September 2003.) Available from <http://www.nhlbisupport.com/bmi/bmicalc.htm>

NFPA 1500 states, "When engaged in any operation where they could encounter atmospheres that are immediately dangerous to life or health (IDLH) or where the atmosphere is unknown, the fire department shall provide and require all members to use SCBA that has been certified as being compliant with NFPA 1981.<sup>27</sup> Such operations would include roof ventilation and other areas subject to smoke and gases.

***Recommendation #5: Carboxyhemoglobin levels should be tested as soon as possible on symptomatic or unresponsive fire fighters exposed to smoke.***

Unfortunately, a carboxyhemoglobin level was not done at the hospital; this would have provided a good assessment of the victim's exposure to carbon monoxide. It is unlikely however, that his carboxyhemoglobin level would have been elevated given the victim's estimated time of smoke exposure. Furthermore, knowledge of his carboxyhemoglobin level would not have affected his treatment or outcome since he was already receiving oxygen and was pronounced dead shortly after arrival at the hospital. Nonetheless, to assist the investigation of fire-related deaths, we recommend performing carboxyhemoglobin levels to rule out carbon monoxide poisoning.

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**INVESTIGATOR INFORMATION**

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**Photo.** Two story, single-family dwelling involved in this incident.