



## Fire Fighter Dies During Night at Fire Station – Mississippi

### SUMMARY

On May 29, 2002, a 45-year-old male career Engineer (the deceased) was on-duty at his fire station, having returned to his station at 0245 hours from an EMS call and went back to bed in the bunkroom at approximately 0300 hours. Around 0530 hours the deceased would typically awaken first, make coffee, then rouse the remainder of the crew. This morning, however, he failed to awaken, and, at approximately 0615 hours, crew members found him unresponsive in his bunk. He had no pulse, no respirations, and was cool to the touch. Since he was obviously expired for some time, cardiopulmonary resuscitation (CPR) was not begun. He was pronounced dead at the station by the coroner. The death certificate completed by the Chief Medical Examiner, and the autopsy completed by the Pathologist, both listed “sudden cardiac death” secondary to hypertensive heart disease and coronary artery disease as the 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 they represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- *Modify current mandatory preplacement medical evaluations to be consistent with NFPA 1582.*
- *Ensure that fire fighters are cleared for duty, following an injury/illness, by a physician*

*knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.*

- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*

Although unrelated to this fatality, the Fire Department should consider these additional recommendations based on safety and economic considerations:

- *Provide adequate fire fighter staffing to ensure safe operating conditions.*
- *Discontinue x-ray's of the Lumbar spine.*

### INTRODUCTION AND METHODS

On May 29, 2002, a 45-year-old male fire fighter lost consciousness during the night while on duty at his fire station. The victim was pronounced dead at the station. On June 11, 2002, NIOSH contacted the affected Fire Department to initiate the investigation. On January 13, 2003, a Safety and

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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Occupational Health Specialist and an Occupational Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to Mississippi to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the

- Fire Chief
- Training Officer
- Crew members
- City Personnel Director
- Victim's spouse

During the site visit NIOSH personnel reviewed

- Fire Department policies and operating guidelines
- Fire Department training records
- Hospital emergency department report
- Death certificate
- Autopsy report
- Past medical records of the deceased

**INVESTIGATIVE RESULTS**

***Incident.*** On May 28, 2002, the victim arrived at his fire station (Station 4) for duty at 0700 hours. He was assigned to Engine 24 as the Engineer. Engine 24 crew spent the day (0830 hours until 1600 hours) performing company inspections (An engine company inspecting the buildings in their first response district). After these inspections the crew returned to their station.

At 0230 hours, while asleep, Engine 24 was dispatched to a nearby nursing home for a medical emergency. Arriving on-scene at 0233 hours, the nurse advised the crew that they were not needed, and Engine 24 returned to their station. The deceased ate a snack and returned to his bunk at approximately 0300 hours.

The deceased would typically rise around 0530 hours, make coffee, and rouse the remainder of the crew.

However, this morning, he did not wake up the crew. One crew member, who had awakened, noticed the deceased in bed (approximately 0600 hours) and thought he was sleeping in. The crew member walked by his bed and shook the bed, but the deceased did not wake up. The crew member touched the victim, and he was cold to the touch. The crew member alerted the remaining crew member on duty and called 911 and Station One. An ambulance responded and Emergency Medical Technicians (EMT) found the deceased unresponsive, pulseless, not breathing, and obviously deceased. No resuscitation measures were initiated. The coroner was notified, and pronounced the victim dead at the fire station.

***Medical Findings.*** The death certificate was completed by the Chief Medical Examiner, who listed sudden cardiac death as the immediate cause of death. No carboxyhemoglobin level was drawn. His alcohol blood screen was negative. Pertinent findings from the autopsy, performed by the pathologist, on May 29, 2002, included:

- Coronary Artery Disease (CAD) as evidenced by:
  - 40% luminal narrowing of right coronary artery
  - 70% luminal narrowing of the left main coronary artery
  - 40% luminal narrowing of the left anterior descending coronary artery.
- An enlarged heart (460 grams).
- Histologic and visual inspection of the heart failed to reveal evidence of acute or remote infarction.
- Microscopic analysis reveals ischemic change manifested by nuclear hyperchromatism, nuclear outline irregularity, and nuclear enlargement of the nuclei of the individual rhabdomyocytes

The Engineer had the following risk factors for CAD: male gender, age over 45, and hyperlipidemia.

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Besides these risk factors, he also was borderline overweight (Overweight/Obesity being another risk factor). Although he had risk factors for CAD, he had never been diagnosed with CAD. The victim was not currently taking medication. Off-duty, the Engineer worked as an auto mechanic at his home garage. On-duty, he exercised periodically, performing weight lifting and walking around a nearby track. According to his wife and coworkers, the Engineer did not express symptoms of chest pain, shortness of breath, or any other symptom indicative of a heart condition at any time preceding the incident.

On July 7, 2001, the victim had an annual fire fighter physical examination performed by the city's contracted clinic. The exam revealed that the victim had hyperlipidemia (Total cholesterol-228 milligrams/deciliter, normal 100-199 mg/dL) and (Triglycerides-241 mg/dL, normal 0-199 mg/dL.) The blood pressure was 122/82 millimeters of Mercury (mm Hg). The patient underwent a graded exercise stress test - bicycle ergometer in which the victim reached 89% of his maximum heart rate in seven minutes with no signs of ischemic changes on the 12-lead EKG. The victim was cleared by the contractor for full duty. On autopsy, the Engineer was shown to have had a Body Mass Index (BMI) of 25.8 kilograms per meters squared ( $\text{kg}/\text{m}^2$ ). A BMI above 25  $\text{kg}/\text{m}^2$  indicates overweight, and a BMI above 30  $\text{kg}/\text{m}^2$  indicates obesity.<sup>1</sup>

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

At the time of the NIOSH investigation, the combination Fire Department consisted of 69 career fire fighters serving a resident population of 26,000 in a geographic area of 22 square miles. There are five fire stations. Fire fighters, including the deceased, worked the following schedule: 24 hours on duty, 48 hours off duty, from 0700 hours to 0700 hours.

In 2002, the Fire Department responded to 2,076 calls: 1,359 rescue and EMS calls, 325 false alarms and false calls, 211 fires, 62 hazardous condition calls, 43 good intent calls, 35 service calls, 26 special type calls, 9 explosions, and 6 severe weather and natural disaster calls.

*Training.* New career fire fighter applicants must pass a candidate physical ability test (CPAT), a written exam, and a background check prior to being placed on the civil service eligibility list. When a vacancy occurs, the fire fighter candidate is selected from the civil service list and must pass an oral interview prior to being conditionally employed. The candidate must then pass a pre-placement physical examination prior to being fully hired. Once hired, the fire fighter receives six weeks' training at the State Fire Academy to become certified as a Fire Fighter I and II, Hazardous Materials Basic and Operations level, and an Emergency Medical Rescuer (EMR). Until required training is completed, fire fighters are not allowed to perform hazardous duty, which includes fire fighting with SCBA use. Fire fighters may receive additional training to become EMTs.

The State minimum standard for fire fighter certification is the Fire Fighter I and II program. There is no State requirement for fire fighter recertification. Annual recertification is required for hazardous materials certification. Bi-annual recertification is required for EMT certification. The victim was certified as a Fire Fighter I and II, Driver Operator, Hazardous Materials operations level, EMT, and Safety Officer and he had 18 years of fire-fighting experience.

*Preplacement Evaluations.* The Fire Department requires a preplacement medical evaluation for all new hires. The components of this evaluation are listed below:

- A complete medical history
- Height, weight, and vital signs
- Physical examination



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- Urine drug screen
- Routine urine
- Lumbar spine x-ray
- Chest x-ray
- Vision test

These evaluations are performed by a medical clinic under contract with the city. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the City Human Resources Department.

***Periodic Evaluations.*** Annual medical evaluations are required by this FD and consist of:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests:
  - Comprehensive metabolic panel
  - complete blood count with differential (CBC)
  - liver profile
- Graded exercise stress test - bicycle ergometer
- Spirometry
- Resting electrocardiogram (ECG)
- Audiogram
- Vision test

These evaluations are performed by a medical clinic under contract with the City. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties will be made by the examining physician and forwarded to the City Human Resources Department. Medical clearance for SCBA use is conducted yearly by the same clinic that performs the periodic evaluations. If an employee has either an occupational/non-occupational injury or illness involving time away from work, he/she must be cleared for “return to work” by their private physician.

The FD has implemented a wellness program which includes nutrition and wellness information along with

individual fitness plans based on the results of a field testing assessment which examines flexibility (sit and reach exercise), muscular strength/endurance (timed push-ups and sit-ups), and cardiovascular capacity (timed 1.5 mile run/walk). Time is given during the work shift to participate in a fitness program, but participation is voluntary. All fire stations currently have both strength and aerobic equipment. The victim did exercise frequently, either at home or work and would achieve an estimated Metabolic Equivalent (METs) level of five (moderate exertion, with deep breathing).

## **DISCUSSION**

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>2</sup> Risk factors for its development including increasing age, male gender, heredity, tobacco smoke, high blood cholesterol, high blood pressure, physical inactivity, obesity/overweight, and diabetes.<sup>3</sup> The victim had four of these risk factors: male gender, age over 45, borderline overweight, and hyperlipidemia. By all accounts, the victim never reported symptoms of angina (e.g., chest pain on exertion). Unfortunately, sudden cardiac death is often the first overt manifestations of ischemic heart disease.<sup>4</sup>

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>5</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>6</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>7</sup> This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Blood clots, or thrombus formation, in coronary arteries is initiated by disruption of atherosclerotic plaques.

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Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.<sup>7</sup> 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.<sup>8</sup> At autopsy no thrombus was present, however the deceased did have significant CAD. Establishing the occurrence of a heart attack requires any of the following: coronary artery thrombus, characteristic EKG changes, and elevated cardiac enzymes. Since the latter two could not be performed it cannot be determined if his sudden cardiac death was precipitated by a heart attack.

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.<sup>9</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>10-12</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>13-17</sup> Prior to his death, the victim had responded to a 0230 false alarm call at a local nursing home. It is possible that the stress from waking from sleep to respond to a medical emergency could have precipitated his sudden cardiac death.

The deceased Engineer had an enlarged heart (460 grams) with microscopic evidence of ischemic changes indicative of biventricular concentric hypertrophy consistent with hypertensive heart disease. Given that the Engineer had no prior history of hypertension and a normal blood pressure during the last exam, the exact cause of his cardiac hypertrophy cannot be established.

We commend the fire department for implementing a comprehensive annual medical evaluation, including an EST as recommended by NFPA 1582. Unfortunately this EST was unable to identify his underlying CAD or his risk of arrhythmia. It is unclear if a more strenuous EST could have been able to identify his underlying risk for sudden cardiac death. The American Heart Association recommends the patient exercise until bodily exhaustion or other clinical endpoints (e.g. chest pain, shortness of breath, negative ECG changes, syncope, etc.).<sup>18</sup>

### **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 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: Modify current mandatory preplacement medical evaluations to be consistent with NFPA 1582.***

Guidance regarding the content of 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*<sup>19</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>20</sup> The Department is not legally required to follow any of these standards. Nonetheless, we recommend that the Fire Department be consistent with the above guidelines.

In addition to providing guidance on the content of the medical evaluation, NFPA 1582 provides



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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.<sup>21</sup>

***Recommendation #2: Ensure that fire fighters are cleared for duty, following an injury/illness, by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.***

Physicians providing input regarding medical clearance for fire-fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published by *NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*. To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition, but also of the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties, or guidance documents, such as NFPA 1582. Also, we recommend that all return-to-work clearances

be reviewed by the department contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the department with input from many sources including the employee's private physician.

***Recommendation #3: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

*NFPA 1500, Standard on Fire Department Occupational Safety and Health Program*, and *NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters*, require a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>21,22</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>20</sup> The Fire Department should review these materials to identify applicable elements.

***Recommendation #4: Provide adequate fire fighter staffing to ensure safe operating conditions.***

This finding did not contribute to this fatality, but was identified during the NIOSH investigation. Currently, the FD staffs its engines with three personnel and its ladders with four personnel. NFPA 1710 requires that "on-duty personnel be assigned to fire suppression shall be organized into company units

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and shall have appropriate apparatus and equipment assigned to such companies.”<sup>23</sup> Those companies may respond with two apparatus, depending on the seating configuration of the apparatus to ensure four personnel arrive on scene.<sup>23</sup> Personnel assigned to the initial arriving company shall have the capability to implement an initial rapid intervention crew (IRIC),<sup>23</sup> which requires four personnel (two to enter the structure and two standing by outside). NFPA 1500 recommends that “members operating in hazardous areas at emergency incidents shall operate in teams of two or more.”<sup>21</sup> Under staffing causes those members on-scene to work harder and for longer periods of time. Additionally, it requires the use of extra fire companies in order to meet the demand for manpower. Engine and Ladder Companies should be staffed with four personnel at a minimum.

***Recommendation #5: Discontinue x-ray’s of the Lumbar spine.***

This finding also did not contribute to the death of this Engineer but was identified by NIOSH during the inspection. Guidance regarding the content and scheduling of periodic medical examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters<sup>20</sup>, and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.<sup>21</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, according to NFPA 1582, the pre-employment/pre-placement stress (EKG) tests are not necessary for applicants under the age of 35. Additionally, pre-placement screening radiography (X-rays) of the low back lack clinical and predictive value, while exposing the candidate to unnecessary

radiation.<sup>24</sup> Both these screening tests represent an unnecessary expense for the department.<sup>24</sup>

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