



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

March 22, 2004

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

SUMMARY

On February 26, 2003, a 52-year-old male career Fire Fighter went to the vehicle bay for a brief walk. Approximately one-hour later, he was found lying on the floor, unresponsive with no pulse and no respirations. Cardiopulmonary resuscitation (CPR) was begun and an ambulance was requested. After approximately one-hour of CPR and advanced life support (ALS) the fire fighter was pronounced dead. The death certificate, completed by the Coroner listed "myocardial infarction" as the immediate cause of death, although no autopsy was performed.

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.

- *Conduct periodic medical evaluations to determine the fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*
- *Fire fighters with two or more risk factors for Coronary Artery Disease (CAD) should have an exercise stress test (EST).*
- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting.*

- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*
- *Designate an employee to administer the pre-placement and annual medical evaluations and their outcomes.*
- *Perform an annual physical performance (physical ability) evaluation.*
- *Perform an autopsy on all on-duty fire fighter fatalities.*

Although unrelated to this fatality, the Fire Department should consider these additional recommendations:

- *Provide fire fighters with medical evaluations and clearance to wear SCBA.*
- *Provide adequate fire fighter staffing to ensure safe operating conditions.*

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



Fatality Assessment and Control Evaluation Investigative Report #F2003-40

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

INTRODUCTION AND METHODS

On February 26, 2003, a 52-year-old male career Fire Fighter collapsed after conducting a walk in the vehicle bay. Despite CPR and ALS administered by fellow fire fighters, Emergency Medical Technicians/Paramedics (EMT/EMT-P), the ambulance crew, and in the emergency department (ED), the victim died. On March 5, 2003, NIOSH - Cincinnati contacted the affected Fire Department to initiate the investigation. On December 17, 2003, an Occupational Nurse Practitioner from the NIOSH Fire Fatality Investigation Team traveled to Arkansas to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel spoke with the following:

- Fire Chief
- Crew members
- EMT/Paramedics
- Victim's ex-wife

During the site visit NIOSH personnel reviewed: Emergency medical service (ambulance) incident report

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

INVESTIGATIVE RESULTS

Incident. On February 26, 2003, at approximately 0700 hours, a 52-year-old male career fire fighter (the deceased) began his 24-hour shift at his fire station. No emergency calls were received that day, and the day was spent conducting maintenance of the station (light exertion). At about 2000 hours, after cleaning up supper with the one other on-duty fire fighter, the deceased informed the fellow crewmember that he was going to the vehicle bay for a brief walk. At approximately 2105 hours he

was found unresponsive, lying against the bay access door. The fellow crewmember called 911 to initiate EMS (Emergency Medical Services), retrieved the automatic external defibrillator (AED) from the station's engine and began BLS (Basic Life Support). Initial evaluation found the deceased fire fighter to be cool to the touch, without a pulse, no spontaneous breathing and eyes fixed and dilated. The AED pads were placed on the fire fighters chest and one shock was delivered. The AED then advised the crewmember to continue CPR. EMT/Paramedics from neighboring fire departments began arriving at approximately 2110 hours. These paramedics inserted a breathing tube into the fire fighter's airway (intubation) and placed an intravenous (IV) line into his vein. Three intubation attempts were needed before the fire fighter was successfully intubated. Correct tube placement was confirmed by breath sounds and capnometer.

The ambulance arrived at 2122 hours, and re-evaluation by the ambulance paramedics found the fire fighter to be unresponsive, pulseless, without spontaneous breathing, and his pupils dilated and unreactive to light. The ambulance paramedics connected the fire fighter to a cardiac monitor with a manual cardiac defibrillator. The monitor found the fire fighter in asystole with a period of ventricular fibrillation (both heart rhythms incompatible with life). The ventricular fibrillation was shocked (defibrillated), unfortunately reverting the heart rhythm to asystole (no heart beat). The fire fighter was loaded into the ambulance and departed the scene at 2142 hours. The fire fighter was given ALS medications at the scene and enroute. During the transport to the ED the paramedics utilized an external pacemaker which showed capture but, no carotid pulse could be felt.

The ambulance arrived at the hospital's ED at 2156 hours, at that time the ED's cardiac monitor showed asystole. After checking for proper tube, line, and cardiac lead placement, the attending physician



Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

realized the fire fighter has been in cardiac arrest for more than 55 minutes. At 2200 hours the fire fighter was pronounced dead by the attending physician and resuscitation attempts were discontinued.

Medical Findings

The death certificate was completed by the Coroner, who listed “Myocardial Infarction” as the immediate cause of death. No autopsy was performed. The Fire Fighter had the following risk factors for coronary artery disease (CAD): advancing age (>45 years old), family history, male gender, hypertension, hyperlipidemia, and physical inactivity. The victim was currently prescribed a cholesterol-lowering medication, a blood pressure medicine, a blood thinner, and an anti-arrhythmic agent. The Fire Fighter did not exercise regularly. His last medical evaluation was in December 2003 conducted by his private physician, where no mention was made of clearance for fire fighting duties. At that time he weighed 163.6 pounds and was 72 inches tall, giving him a body mass index (BMI) of 22.2 kg/m² (A BMI between 25 and 29.9 kg/m² is overweight, while a BMI above 30 kg/m² is considered obese.)¹

In April 1987, the deceased was diagnosed with Atrial Fibrillation (a type of heart rhythm disturbance) for which his treatment was unclear. In January 1991, a cardiac catheterization for angina showed a 100% blockage of one of his coronary arteries (distal circumflex) which was treated with a PTCA (percutaneous transluminal coronary angioplasty). The PTCA reduced the artery’s blockage to only 10%. During the cardiac catheterization an ejection fraction (a measure of how well his heart pumps blood) was estimated at 60% (within normal limits).

In December 1994, the deceased again had angina and was admitted to the hospital. An EKG (electrocardiogram), identified an acute myocardial infarction (MI), otherwise known as a heart attack, in the inferior portion of his heart. The EKG also

showed an old MI on the heart’s posterior wall. Another cardiac catheterization found the mid left anterior descending artery had a 50% stenosis, the mid-circumflex artery had a 99% stenosis, the distal circumflex had a 100% occlusion with collaterals, and the right coronary artery (RCA) had a 50% stenosis. After a PTCA, the mid-circumflex was reduced to 20% occluded and the distal circumflex was reduced to 30% occluded with an ejection fraction estimated at 50%.

In February 1995, six weeks after the MI and PTCA, the deceased underwent a submaximal EST. The Bruce protocol was followed and the patient achieved 7 METS (metabolic equivalents) walking for 6 minutes to stage 2 until leg fatigue forced the test to stop. The maximal heart rate was 132 bpm (beats per minute), 75% of the age adjusted maximal target heart rate. The treadmill test was recorded as negative for ischemic EKG or chest pain. He was subsequently cleared fire fighter duty by his cardiologist.

Two months later, in April 1995, the fire fighter again presented with angina. Repeat cardiac catheterization showed a re-occlusion of his mid-circumflex artery (100%) and a new 99% occlusion of his RCA. PTCA reduced his mid-circumflex to 20% occlusion with the RCA disregarded as it was a “diminutive nondominant vessel going to the right ventricle only”. A repeat EST, record regarding medical clearance for fire fighter duties could be found.

In June 1999 the fire fighter presented with symptomatic heart arrhythmias (premature ventricular contractions with bigeminy). Work-up included an echocardiogram which found a mildly dilated left ventricle with an ejection fraction of 40%, and moderate mitral regurgitation (heart valve problem). He was successfully treated with prescription medication (an anti-arrhythmic agent). In July 2001, he developed another type of heart conduction

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

problem (left bundle branch block). Again, no record could be found regarding medical clearance for fire fighter duties.

His last medical evaluation was in December 2002, where his cholesterol and triglycerides were elevated, but his cardiac condition seemed to be stable. According to the fellow crewmembers, the deceased did not complain of angina or any other heart-related illness, the day of, or the weeks preceding, the incident.

**DESCRIPTION OF THE FIRE
DEPARTMENT**

At the time of the NIOSH investigation, the Fire Department consisted of ten full-time and four part-time fire fighters and served the local Class Index-B airport on a geographic area of 2200 acres. In 2002 the department made 134 total runs. There is one fire station.

Training New fire fighters must have a high school diploma or equivalent, International Fire Service Accreditation Congress (IFSAC) Department of Defense (DOD) Firefighter II or Arkansas Fire Academy (AFA) Firefighter II, Arkansas or National Registry Emergency Medical Technician-Basic (EMT-B) and an Arkansas Firefighter Certification. The victim was certified as an AFA Firefighter II, EMT-B, and at HAZMAT Operations level.

Pre-placement Evaluations The Fire Department does require a pre-placement medical evaluation for new members. The FD specifies the components of the medical evaluation which includes:

- Complete medical history and questionnaire
- Height, weight, and vital signs
- Physical examination
- Vision test

- Audiogram
- Urinalysis
- Urine drug screen
- Blood tests: complete metabolic panel including a lipid profile
- Spirometry (lung function tests)
- Chest X-ray
- Resting EKG
- Skin test for tuberculosis (PPD)

After reviewing this information, the department decides whether the candidate is medically cleared to perform fire fighting duties. There is no pre-placement physical ability test. At the time the deceased fire fighter joined this fire department, there was no pre-placement medical evaluation offered or required.

Periodic Evaluations. No annual medical evaluations or physical ability tests are required by the Department. Fire fighters are encouraged to receive a complete physical examination at their own expense. Medical clearance for SCBA use is not required. If a fire fighter is injured on duty, he/she must be cleared for return to work by his/her personal physician. Strength and aerobic equipment are available at the fire station but there is no mandatory fitness program. There are no wellness programs available.

DISCUSSION

Because no autopsy was performed, a definitive “cause of death” cannot be determined. Possible causes include a heart arrhythmia, heart attack (myocardial infarction), heart failure, or pulmonary embolus. The fire fighter had a history of arrhythmias, with one requiring medication. Both, left bundle branch block and premature ventricular contractions are arrhythmias associated with an increased risk of sudden cardiac death, particularly when present in individuals with CAD.²

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

It is also possible the victim had a heart attack. The term “possible” is used because autopsy findings (thrombus formation), ECG findings, or blood tests (cardiac isoenzymes) are required to “confirm” a heart attack (myocardial infarction). No autopsy was performed therefore no thrombus could be found, the victim had no heart beat to show the characteristic findings of a heart attack, and he did not survive long enough for characteristic cardiac enzymes to become elevated. The fire fighter also had a reduced ejection fraction, thus diagnosing mild congestive heart failure (CHF). A depressed ejection fraction is also a predictor of sudden cardiac death particularly when found with CAD.² Thus, a combination of these factors (CAD, arrhythmias, CHF, and valvular heart disease) all greatly increase the risk for Sudden Cardiac Death (SCD). Finally, although much less likely, it is possible his sudden death was secondary to a pulmonary embolus.

In the United States, coronary artery disease (CAD) due to atherosclerosis, is the most common risk factor for cardiac arrest and sudden cardiac death.³ 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.^{4,5} The victim had five of these risk factors and was diagnosed with CAD in 1991.

To reduce the risk of heart attacks, sudden cardiac arrest and other medical conditions among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Comprehensive Occupational Medicine Program for Fire Departments*.⁶ NFPA 1582 recommends a thorough medical examination to be performed on all members. This standard includes a recommendation that fire fighters with two or more risk factors for CAD (family history of premature [less than age 60] cardiac event, hypertension, diabetes mellitus, hypercholesterolemia [total cholesterol greater

than 240 mg/dL or HDL cholesterol less than 35 mg/dL], and cigarette smoking) be screened for obstructive CAD by an EST.⁶ These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).⁷ Unfortunately, this Fire Department does not currently offer EST or any other periodic physical evaluations to fire fighters.

If the Fire Fighter had been examined by a physician familiar with NFPA 1582, he probably would have been precluded from duty as a firefighter. The NFPA 1582 2000 edition⁸, under which the fire fighter would have been examined, has different standards than the NFPA 1582 2003 edition. According to the 2000 edition, the deceased had one category A condition (a medical condition that **WOULD** preclude a person from performing as a member in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others). The deceased one category A condition was CHF as diagnosed by his reduced ejection fraction on echocardiogram in 1999.

The victim also had, according to this standard, three category B disorders (a medical condition that, based on its severity or degree, **COULD** preclude a person from performing as a member in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others). According to NFPA 1582, all three of his category B conditions would preclude work as a fire fighter due to their severity. These conditions were: 1) history of myocardial infarction with known severe CAD and a lack of exercise stress test data, 2) left bundle branch block because of lack of exercise stress test data, and 3) moderate mitral valve regurgitation because of an abnormal left ventricular function. A physician following the NFPA 1582 guidelines would have precluded the fire fighter from

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

active duty, which may have prevented his sudden cardiac death at that time.

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 they represent published research or consensus votes of technical committees of the NFPA or fire service labor/management groups.

Recommendation #1: Conduct periodic medical evaluations to determine a fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

The purpose of periodic medical evaluations is to ensure that fire fighters have the 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 examinations for fire fighters can be found in NFPA 1582, 2003 edition.⁶ In addition, NFPA 1582 also provides guidance on medical requirements for persons performing fire fighting tasks.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Annex B of NFPA 1582 provides guidance for Fire Department administrators regarding legal considerations in applying the standard. The 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 8-7.2.⁹ 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: Fire fighters with two or more risk factors should have an EST.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend EST for some fire fighters to screen for obstructive CAD.^{6,10} NFPA 1582 recommends EST for those fire fighters with two or more CAD risk factors. According to NFPA 1582, these CAD risk factors are:

- (family history of premature [less than age 60] cardiac event,
- hypertension,
- diabetes mellitus,
- hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL], and
- cigarette smoking).⁶

These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).⁷

The EST could be conducted by the fire fighter's personal 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 Department physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

Recommendation #3: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting.

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. 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 with guidance documents such as NFPA 1582. Lastly, we recommend that all return-to-work clearances be reviewed by a Fire Department contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the Fire Department with input from many sources including the employee's private physician.

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.¹¹ 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.^{9,12} 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.¹⁰ The Fire Department should review these materials to identify applicable elements. Other large-city negotiated programs can also be reviewed as potential models.

Recommendation #5: Designate an employee to administer the pre-placement and annual medical evaluations and their outcomes.

This employee should maintain the confidentiality of the medical records. If this employee is a member of the FD and participating in the Department's annual medical evaluation, a policy should prevent them from administering the program to themselves.

Recommendation #6: Perform an annual physical performance (physical ability) evaluation.

NFPA 1500 requires fire department members who engage in emergency operations to be annually evaluated and certified by the fire department as meeting the physical performance requirements identified in paragraph 8-2.1.¹³

This finding did not contribute to this fire fighter's death, but was identified during the NIOSH investigation.

Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

Recommendation #7: Perform an autopsy on all on-duty fire fighter fatalities.

In 1995, the United States Fire Administration (USFA) published the Firefighter Autopsy Protocol.¹⁴ This publication hopes to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- (2) to help determine eligibility for death benefits under the Federal government’s Public Safety Officer Benefits Program, as well as state and local programs; and
- (3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.”

The following recommendations were unrelated to this fatality, but were safety issues identified by NIOSH during its evaluation:

Recommendation #8: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA’s Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.¹⁵ These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Arkansas is not a State-plan State; therefore, public sector employers are not required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance with the Respiratory Protection Standard.

Recommendation #9: Provide adequate fire fighter staffing to ensure safe operating conditions.

Currently on each shift, two ARFF (aircraft rescue fire fighting) personnel staff the ARFF vehicle, depending on the function of the vehicle. The primary objective of ARFF personnel at the scene of any aircraft accident is to control and extinguish the fire to enable safe evacuation of the aircraft. NFPA 403 recommends that “during flight operations, sufficient trained personnel be readily available to staff the rescue and fire-fighting vehicles and to perform fire-fighting and rescue operations.”¹⁶ Rescue operations should begin as soon as conditions permit and often are a simultaneous function during the fire fighting phase that requires considerable coordination. One rescue team method consists of four ARFF personnel equipped with full protective clothing and positive pressure SCBA. Two of the persons are handline operators and precede the other two, who are equipped with appropriate hand-held tools needed for forcible entry, extrication, and making access to hidden fuselage fires behind panels, floors, and compartments.¹⁷ Understaffing causes those members on-scene to work harder and for longer periods of time, and impacts the safety and survivability of aircraft passengers. ARFF companies should be staffed with two personnel at a minimum, provided that at least two ARFF vehicles respond to the same emergency, providing a total of four ARFF personnel at the scene. Otherwise, ARFF vehicles should be staffed with four personnel.

REFERENCES

1. National Heart Lung Blood Institute. NHLBI Obesity Education Initiative. Available at <http://www.nhlbisupport.com/bmi/> Accessed January 2004.
2. Meyerburg RJ, Castellanos A [2001]. Cardiac arrest and sudden cardiac death. In: Braunwald E, Zipes DP, Libby P, eds. Heart Disease. 6th Edition. Philadelphia: W.B. Saunders Company. pp. 890-931.



Airport Fire Fighter Suffers Sudden Cardiac Death at Fire Station - Arkansas

3. Meyerburg RJ, Castellanos A [2001]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. In: Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 15th Edition. New York: McGraw-Hill. pp. 228-233.
 4. American Heart Association (AHA) [1998]. AHA scientific position, risk factors for coronary artery disease, Dallas, TX.
 5. Jackson E, Skerrett PJ, Ridker PM [2001]. Epidemiology of arterial thrombosis. In: Coleman RW, Hirsh J, Marder VJ, et al., eds. 4th ed. Homeostasis and thrombosis: basic principles and clinical practice. Philadelphia, PA: Lippincott Williams and Wilkins.
 6. NFPA [2003]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582-2003.
 7. American College of Cardiology/American Heart Association [2002]. ACC/AHA 2002 guideline update for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). Gibbons RJ, Balady GJ, Bricker JT, et al., eds. Bethesda, MD.
 8. NFPA [2000]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582-2000.
 9. NFPA [1997]. Standard on fire department occupational safety and health program. Quincy MA: National Fire Protection Association. NFPA 1500-1997.
 10. IAFF, IAFC [2000]. The fire service joint labor management wellness/fitness initiative. Washington: International Association of Fire Fighters, International Association of Fire Chiefs.
 11. Plowman SA, Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.
 12. NFPA [2000]. Standard on health-related fitness programs for fire fighters. Quincy MA: National Fire Protection Association. NFPA 1583-2000.
 13. NFPA [1997]. Standard on fire department occupational safety and health program. Quincy MA: National Fire Protection Association. NFPA 1500-1997.
 14. United States Fire Administration. Firefighter Autopsy Protocol. Emmitsburg: Federal Emergency Management Agency; USFA, Publication No. FA-156, 1995.
 15. 29 CFR 1910.134. Code of Federal Regulations. Occupational Safety and Health Administration: Respiratory Protection. Washington, DC: National Archives and Records Administration, Office of the Federal Register.
 16. National Fire Protection Association. NFPA 403, Standard for Aircraft Rescue and Fire-Fighting Services at Airports. Quincy: NFPA; 1998.
 17. National Fire Protection Association. NFPA 402, Guide for Aircraft Rescue and Fire-Fighting Operations. Quincy: NFPA; 2002.
- INVESTIGATOR INFORMATION**
- This investigation was conducted by and the report written by J. Scott Jackson, RN, MSN, Occupational Nurse Practitioner. Mr. Jackson is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio.