



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

July 22, 2004

District Chief Dies After Suffering a Heart Attack -Texas

SUMMARY

On October 24, 2003, a 47-year-old male District Chief (DC) responded to a motor vehicle accident (MVA) involving a fire engine and a civilian vehicle. After assisting with unloading fire equipment, he transported three fire fighters with minor injuries to the hospital and returned to his station. He expressed that he “did not feel right and had throat tightness,” and then told his supervisor that he needed to go home. After lying down in the station for approximately two hours, he drove home (approximately 60 miles away). After changing clothes, he drove to his primary care physician’s office where he was diagnosed as having an acute myocardial infarction (MI)(heart attack). He was then treated at the local hospital, then transferred to a regional hospital for an arteriogram and balloon angioplasty (stent placement). Twelve days later, while recuperating at home, he was found unresponsive and an ambulance was summoned. Ambulance paramedics determined that the DC had sustained cardiac and respiratory arrest at an earlier time, and no resuscitation efforts were initiated. The death certificate, completed by the Justice of the Peace, listed “myocardial infarction” as the immediate cause of death. No autopsy was performed.

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:

- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity*
- *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*
- *Provide fire fighters with medical evaluations and clearance to wear SCBA*
- *Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting*
- *Perform an autopsy on all on-duty fire fighter fatalities*

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

District Chief Dies After Suffering a Heart Attack -Texas

Although unrelated to this fatality, the fire department should consider this additional recommendation based on safety and economic considerations:

- ***Discontinue the routine use of annual chest x-rays unless specifically indicated***
- ***Discontinue the routine use of annual electrocardiograms (EKG) unless medically indicated***

INTRODUCTION & METHODS

On October 24, 2003, a 47-year-old male DC was diagnosed as having suffered a heart attack. After medical treatment, including stent placement, and a period of recuperation at home, he suffered an unwitnessed collapse. Due to the evaluation by ambulance paramedics, cardiopulmonary resuscitation (CPR) and advanced life support (ALS) were not initiated and he was pronounced dead at the scene. NIOSH was notified of this fatality on December 3, 2003, by the United States Fire Administration. On December 3, 2003, NIOSH contacted the affected Fire Department to initiate the investigation. On January 12, 2004, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Texas to conduct an onsite investigation of the incident.

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

- Fire Chief
- Assistant Chief
- Chief Training Officer
- Fire Investigator
- IAFF Local President
- Crew members involved in this incident
- Victim's spouse and family

During the site-visit NIOSH personnel reviewed:

- FD incident reports and dispatch records

- FD policies and operating guidelines
- FD training records
- The FD annual report for 2003
- The victim's personnel record maintained at the FD
- The family medical clinic report
- The hospitals' records of the medical treatment
- Death certificate
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident Response. On October 24, 2003, the DC arrived for work at his fire station at approximately 0700 hours. At 0839 hours, Engine 7 was dispatched to a MVA. During the response, at 0844 hours, a civilian vehicle collided with Engine 7, moving the engine off-balance and causing it to overturn. Engine 12, Car 51 (the DC), Car 54 (Deputy Chief), Unit 1, Unit 2, and 702 were dispatched. Units began arriving at the scene at 0846 hours, including the DC. The scene was secured and witnesses were segregated. Engine 7 was righted by a wrecker and crew members, including the DC, began to remove equipment off Engine 7 in preparation of loading it into other FD vehicles. [The Deputy Chief noticed that the DC appeared "distant"]. The Deputy Chief suggested the DC transport the Engine 7 fire fighters to the hospital, where they were treated and released. At 1039 hours, the DC left the hospital and returned to service.

Upon arrival at his fire station, the DC told the Deputy Chief "his throat was tight, he just didn't feel right, and needed to go home." He called his wife at approximately 1200 hours, stating that he had a bad headache and was going to lie down at the station before embarking on the 60-mile drive to his home.

At approximately 1400 hours, the DC left the fire station bound for home. He called his wife at approximately 1500 hours, 19 miles from his house,



District Chief Dies After Suffering a Heart Attack -Texas

and informed her that he was going home to change clothes before heading to his physician's office.

At his primary care physician's office, he complained of a severe headache, pressure in his throat, aching, shortness of breath on exertion or lying flat, and mild chest pressure radiating to his mid-back region which was worse on deep inspiration. The throat pressure symptom began the previous night. His blood pressure was 113/84 millimeters of mercury (mmHg) and a work-up included a chest x-ray (normal), an electrocardiogram (EKG) which revealed atrial fibrillation with rapid ventricular response and inferior changes consistent with an acute MI. Arrangements were made for a hospital admission for atrial fibrillation and to rule out MI. He was given oxygen, and medications for anti-clotting and treatment for atrial fibrillation. Serial EKGs and cardiac enzymes were diagnostic of an acute MI [creatinine phosphokinase (CPK) levels were 535, 1039, and 986 units per liter (U/L) (normal 21-232 U/L), Troponin I was 4.06, 8.60, and 9.39 nanograms per milliliter (ng/ml) (normal 0.00-0.40 ng/ml), myoglobin was 340, 254, and 118 ng/ml (normal 0.0-170.0 ng/ml), CK-MB (creatinine kinase in the heart muscle) was 38.5, > 80, and 62 U/L (normal <4.3 U/L). He remained in atrial fibrillation though his ventricular response was controlled with digoxin. The next day, the DC was transferred to a regional hospital for invasive therapy of his acute MI, atrial fibrillation, and junctional rhythm.

The next day, he underwent a left heart catheterization, a left ventriculography, and a coronary arteriogram which revealed 100% occlusion of the right coronary artery (RCA), 50% stenosis in the left anterior descending (LAD) coronary artery, and 30-50% stenosis in the circumflex coronary artery. On October 28, he underwent single vessel percutaneous transluminal coronary angioplasty (PTCA) in which four stents were placed. He was released from the hospital on October 29 and returned home to

recuperate. He was prescribed an anticoagulant, a mild blood thinner, and anti-hypertensive medications. According to his wife and family, he was feeling better and recovering well.

On November 5, he was awakened and spoke with his wife prior to her leaving for work at 0745 hours. He did not have any chest pain or any other symptoms suggestive of acute heart-related problems. She tried to call him at approximately 0900 hours but did not get an answer. She drove to her house and arrived along with the DC's mother at approximately 0915 hours. They found the DC unresponsive on the floor. An ambulance was summoned and responded. Ambulance personnel assessed the DC and found him unresponsive, pulseless, and not breathing. It was determined that the DC had sustained cardiac and respiratory arrest at a significantly earlier time and no resuscitation attempt was made. The Justice of the Peace was notified and after arriving on the scene, pronounced the DC dead at 0930 hours.

Medical Findings. The death certificate, completed by the Justice of the Peace, listed "myocardial infarction" as the immediate cause of death. No autopsy was performed.

In September 2003, the DC was diagnosed by his primary care physician as having borderline hypertension (elevated blood pressure) and prescribed diet and exercise. At his next visit, he was prescribed anti-hypertensive medication. One week prior to his death, the DC visited his primary care physician for unrelated symptoms. At that visit, the DC was noted to weigh 246 pounds and was 67 inches tall, giving him a body mass index (BMI) of 38.5 kilograms per square meter (kg/m²). (A BMI 30 kg/m² and greater is considered obese).¹

According to his wife, the DC had returned home from a 3-day hunting trip on October 23. His only

District Chief Dies After Suffering a Heart Attack -Texas

complaint the next day was neck pain, thought to result from lying on a couch. The DC participated 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 career FD was comprised of 234 uniformed personnel and served a population of 114,000 residents, in a geographic area of 84 square miles. There are 12 fire stations where fire fighters work the following tour of duty: 24 hours on-duty, 48 hours off-duty, 0800-0800 hours. Each shift of an engine company is staffed with three fire fighters; each ladder company, two or three fire fighters. Structural fire response includes either four engines or three engines and one ladder. One company acts as the rapid intervention team. The emergency medical service is a third separate City service. The FD provides First Responder resources.

In 2003, the FD responded to 13,157 total calls: 480 structure fires, 54 brush, grass, and wildland fires, 62 rubbish fires, 24 other fires, 2,547 false alarms, 883 hazardous condition calls, 260 hazardous materials responses, 1 mutual aid response, 1,956 other responses, and 6,890 rescue/emergency medical responses.

The day of the incident, the deceased arrived for his shift at 0700 hours. He prepared a room for a meeting and responded to the incident described herein.

Training. The FD requires all new fire fighter applicants to be State-certified fire fighter/emergency medical technicians, submit an application, pass a written examination, a license and criminal history check, a physical ability test (described below), and an oral board interview prior to being ranked. The

applicant must then pass a polygraph examination and an interview with the Fire Chief prior to being given a conditional job offer. The newly hired fire fighter must then pass a pre-placement physical examination prior to being placed on a work shift. Recurrent training occurs on each shift.

The physical ability test consists of the following timed events:

- Climb the aerial ladder extended 70 feet at 70 degrees without any stops or hesitations
- Pull a dry section of rolled hose (weighing approximately 50 pounds) with a 3/4-inch manila rope from the ground to the seventh floor of the drill tower. No stops are allowed.
- Pull a charged 2 1/2-inch fire hose with nozzle attached a distance of 100 feet within one minute
- Carry a 50-foot section of 2 1/2-inch fire hose with nozzle (weighing approximately 75 pounds) attached seven floors up and back down the stairway of the training tower in three minutes
- Remove a 24-foot extension ladder (weighing approximately 78 pounds) mounted with the top beam 6-feet above ground level and lower the ladder to the ground flat on both beams. Pick up the ladder and return it to the mounting brackets.

The State minimum requirement for fire fighter certification is the 468-hour Fire Fighter I and II course and the 40-hour Emergency Care Attendant course. Career fire fighters must be State certified within one year of employment. The State also requires a minimum of 20 hours training for recertification. Annual re-certification is required for hazardous materials; while Emergency Medical Technician and Paramedic recertification is bi-annual. The DC was a certified Fire Fighter II, Advanced Structural Fire Fighter, Driver/Operator, Hazmat Operations, Advanced Structural Crash Fire Fighter, Emergency Services Telecommunicator (Dispatcher), and had 26 years of fire fighting experience.

District Chief Dies After Suffering a Heart Attack -Texas

Pre-placement Evaluations. The FD requires a pre-placement medical evaluation for all new hires. 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
- Chest x-ray

These evaluations are performed by a City-contracted medical clinic, who makes a decision regarding medical clearance for fire fighting duties.

Periodic Evaluations. Annual/periodic medical evaluations are required by this FD for promotions, Hazmat Team, and Dive Team. The components of the evaluation are the same as the pre-placement medical evaluation except a urine drug screen is not conducted. An annual chest x-ray and a check for heart defects is offered voluntarily to all employees. If an employee is injured at work, he/she must be cleared for "return to work" by their primary care physician. If an employee is ill and away from work for two or more shifts, he/she must be cleared for "return to work" by their primary care physician. There are no annual/periodic physical ability tests required by this FD. Exercise (strength and aerobic) equipment is available in the fire stations. There are no health maintenance programs or fitness/wellness programs offered. Medical clearance for SCBA use is not required periodically for all fire fighters.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.² According to the American Heart Association, risk factors for the development of atherosclerosis include increasing age, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes.³ The DC had four of these known CAD risk factors.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.⁴ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁵ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁶ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. The deceased had a known heart attack, CAD, and stent placement within 12 days of his death. Since no autopsy was performed, it is unclear if a stent collapsed, if a thrombus was present, or if another heart attack was the actual cause of death. Atherosclerosis in a coronary artery may cause ischemic heart disease which occurs when the blood flow within a coronary artery 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 and sudden cardiac death.

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.⁷ Some individuals may not experience angina with ischemia,

District Chief Dies After Suffering a Heart Attack -Texas

as evidenced by up to 20% of heart attacks being “silent,” i.e., painless.⁴ He reported having mild chest pressure when he arrived at the primary care physician’s office.

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.⁸ 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.⁹⁻¹¹ 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.¹² Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.¹³⁻¹⁶ While at the accident scene, the DC assisted with removing equipment off the wrecked fire engine. This is considered a moderate level of physical exertion.^{8,17} He also transported the injured fire fighters to the hospital. The physical stress of responding to the alarm, performing a moderate level of physical exertion, and transporting the injured fire fighters to the hospital, coupled with his underlying atherosclerotic CAD probably contributed to this fire fighter’s initial heart attack, and then subsequent cardiac arrest, and death.

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 1582.¹⁸ 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)].¹⁸ 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.^{19,20}

Since the deceased had only one CAD risk factor (hypertension) for EST determination, the performance of an EST prior to 2003 would not have been recommended by NFPA 1582, or the AHA. In either case, a mandatory comprehensive wellness/fitness program, including weight reduction, dietary education, and exercise would have benefited this fire fighter.

RECOMMENDATIONS

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to, among other things, 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. The Department is not legally required to follow any of these standards.

Recommendation #1: 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

District Chief Dies After Suffering a Heart Attack -Texas

diabetes.²¹ NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.²² NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, provides the minimum requirements for a health-related fitness program.²³ 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.²⁴ The Fire Department and the Union should review these materials to identify applicable elements for their Department. Other large-city negotiated programs can also be reviewed as potential models. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.²⁵⁻²⁷ 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.²⁸

Recommendation #2: 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,¹⁸ and in the report of the

International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²⁴

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.

The following findings did not contribute to the death of this fire fighter but were identified by NIOSH during the inspection.

Recommendation #3: 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.²⁹ Such employees include fire fighters who utilize SCBA in the performance of their duties. These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved State plans. Texas is not a state-plan state, therefore, public sector employers are not required to comply with OSHA standards. However, we recommend voluntary compliance for safety purposes.

Recommendation #4: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.

NFPA 1500 requires fire department members who engage in emergency operations to be annually

District Chief Dies After Suffering a Heart Attack -Texas

evaluated and certified by the fire department as meeting the physical performance requirements identified in paragraph 8-2.1.22

Recommendation #5: Perform an autopsy on all on-duty fire fighter fatalities.

In 1995, the United States Fire Administration (USFA) published the Firefighter Autopsy Protocol.³⁰ 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.”

Recommendation #6: Discontinue the routine use of annual chest x-rays unless specifically indicated.

According to NFPA 1582, “chest x-rays shall include an initial baseline and shall be repeated every 5 years or as medically indicated.”¹⁸ The chest x-rays being conducted by the Fire Department for promotions, Hazmat, and the Dive Team expose incumbents to unnecessary radiation and represent an unnecessary expense for the Fire Department, and are not recommended by the OSHA Hazmat standard unless indicated.³¹

Recommendation #7: Discontinue the routine use of annual electrocardiograms (EKG) unless medically indicated.

According to NFPA 1582, “periodic resting electrocardiograms have not been shown to be useful but can be reasonable as a member’s age increases.”¹⁸ The stress EKG is a much better tool to identify heart arrhythmias. Therefore, only pre-placement EKGs are recommended unless medically indicated. The EKGs being conducted by the Fire Department represent an unnecessary expense for the Fire Department.

REFERENCES

1. National Heart Lung Blood Institute [2004]. Obesity education initiative. World Wide Web (Accessed March 2004.) Available from <http://www.nhlbisupport.com/bmi/bmicalc.htm>
2. 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.
3. AHA [1998]. AHA Scientific Position, Risk Factors for Coronary Artery Disease. Dallas, TX: American Heart Association.
4. Libby P [2001]. The pathogenesis of atherosclerosis. 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. p.1378.
5. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20 (11 Suppl2): II-38-44.
6. Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. N Eng J Med 326:242-250.

District Chief Dies After Suffering a Heart Attack -Texas

7. Thaulow E, Erikssen J, et al [1993]. Initial clinical presentation of cardiac disease in asymptomatic men with silent myocardial ischemia and angiographically documented coronary artery disease (the Oslo Ischemia Study). *Am J Cardiol* 72:629-633.
8. Gledhill N, Jamnik, VK [1992]. Characterization of the physical demands of firefighting. *Can J Spt Sci* 17(3):207-213.
9. Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. *J Occup Med* 17:247-250.
10. Manning JE, Griggs TR [1983]. Heart rate in fire fighters using light and heavy breathing equipment: Simulated near maximal exertion in response to multiple work load conditions. *J Occup Med* 25:215-218.
11. Lemon PW, Hermiston RT [1977]. The human energy cost of fire fighting. *J Occup Med* 19:558-562.
12. Smith DL, Petruzzello SJ, Kramer JM, et al. [1995]. Selected physiological and psychobiological responses to physical activity in different configurations of firefighting gear. *Ergonomics* 38:10:2065-2077.
13. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. *N Eng J Med* 329:1684-1690.
14. Mittleman MA, Maclure M, Tofler GH, et al. [1993] Triggering of acute myocardial infarction by heavy physical exertion. *N Eng J Med* 329:1677-1683.
15. Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. *N Eng J Med* 311:874-877.
16. Tofler GH, Muller JE, Stone PH, et al. [1992] Modifiers of timing and possible triggers of acute myocardial infarction in the Thrombolysis in Myocardial Infarction Phase II (TIMI II) Study Group. *J Am Coll Cardiol* 20:1049-1055.
17. American Industrial Hygiene Association Journal [1971]. Ergonomics guide to assessment of metabolic and cardiac costs of physical work. *Am Ind Hyg Assoc J* 560-564.
18. NFPA [2003]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582-2003.
19. 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.
20. U.S. Department of Transportation [1987]. Medical advisory criteria for evaluation under 49 CFR Part 391.41 (<http://www.fmcsa.dot.gov/rulesregs/fmcsr/medical.htm>). Conference on cardiac disorders and commercial drivers - FHWA-MC-88-040, December. Available at <http://www.fmcsa.dot.gov/Pdfs/cardiac.pdf>. Accessed May 2002.
21. Plowman SA and Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.
22. NFPA [1997]. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program. Quincy MA: National Fire Protection Association. NFPA 1500-1997.

District Chief Dies After Suffering a Heart Attack -Texas

23. NFPA [2000]. Standard on health-related fitness programs for fire fighters. Quincy MA: National Fire Protection Association. NFPA 1583-2000.
24. IAFF, IAFC. [2000]. The fire service joint labor management wellness/fitness initiative. Washington, D.C.: International Association of Fire Fighters, International Association of Fire Chiefs.
25. Maniscalco P, Lane R, Welke M, Mitchell J, Husting L [1999]. Decreased rate of back injuries through a wellness program for offshore petroleum employees. J Occup Environ Med 41:813-820.
26. Stein AD, Shakour SK, Zuidema RA [2000]. Financial incentives, participation in employer sponsored health promotion, and changes in employee health and productivity: HealthPlus health quotient program. JOEM 42:1148-1155.
27. Aldana SG [2001]. Financial impact of health promotion programs: A comprehensive review of the literature. Am J Health Promot 15:296-320.
28. Unpublished data [1997]. City Auditor, City of Phoenix, AZ. Disability retirement program evaluation. Jan 28, 1997.
29. CFR. 29 CFR 1910.134, Respiratory protection. Code of Federal Regulations. Washington, DC: National Archives and Records Administration, Office of the Federal Register.
30. United States Fire Administration [1995]. Firefighter Autopsy Protocol. Emmitsburg: Federal Emergency Management Agency; USFA, Publication No. FA-156.
31. NIOSH [1993]. Occupational safety and health guidance manual for hazardous waste site activities. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 85-115.

INVESTIGATOR INFORMATION

This investigation was conducted by and the report written by Tommy N. Baldwin, MS, Safety and Occupational Health Specialist. Mr. Baldwin, a National Association of Fire Investigators (NAFI) Certified Fire and Explosion Investigator, an International Fire Service Accreditation Congress (IFSAC) Certified Fire Officer I, and a Kentucky Certified Fire Fighter and Emergency Medical Technician (EMT), is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio.