



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

SUMMARY

On April 28, 2007, a 66-year-old male volunteer Fire Fighter (FF) participated in a “Pack Test;” one of three work capacity tests designed to simulate the physical demands of wildland firefighting. The Pack Test requires an individual to complete a 3-mile walk within 45 minutes, while wearing a 45-pound vest. Successful completion allows fire fighters to participate in federal wildland firefighting operations. The FF began his Pack Test at approximately 1000 hours, and successfully completed the test at 1045 hours.

About 3½ hours later, the FF telephoned a neighbor asking for a ride to the hospital because he was having chest pains. In the hospital’s emergency department, an electrocardiogram and cardiac enzymes confirmed a heart attack. As emergency angioplasty and stent placement of his left anterior descending coronary artery was started, the FF had an arrhythmia and cardiac arrest. Resuscitation was not successful. The death certificate (completed by the coroner) listed “cardiac arrest with electromechanical dissociation” due to “acute anterior wall myocardial infarction” due to “coronary artery disease” (CAD) as the cause of death. No autopsy was performed. The NIOSH investigator concluded that the physical stress of performing the Pack Test about 4 hours earlier

probably triggered the FF’s fatal heart attack.

The NIOSH investigator offers the following recommendations to possibly prevent a similar recurrence and to address general safety and health issues.

- *Check the vital signs of participants before and after the work capacity test.*
- *Utilize a comprehensive medical form such as Standard Form 78 or the Federal Interagency Annual Medical History and Clearance Form for Arduous Duty Wildland Firefighters instead of the Physical Activity Readiness-Questionnaire (PAR-Q) to determine medical clearance for the work capacity test.*
- *Provide pre-placement and periodic medical evaluations to ALL fire fighters consistent with National Fire Protection Association (NFPA) 1582 (or equivalent) to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*
- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of firefighting.*



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

- *Ensure that fire fighters participate in a mandatory wellness/fitness program designed for wildland fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*
- *Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural firefighting.*
- *Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBAs).*
- *Perform an autopsy on all on-duty fire fighter fatalities.*

INTRODUCTION and METHODS

On April 28, 2007, a 66-year-old male volunteer FF died about 4 hours after completing a Pack Test for certification for federal wildland fire fighting. NIOSH was notified of this fatality on May 3, 2007 by the United States Fire Administration. NIOSH contacted the affected Fire Department on May 10, 2007 to obtain further information, and on October 19, 2007 to initiate the investigation. On November 5, 2007, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Idaho to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Fire Chief
- Crew members
- FF's family

NIOSH personnel reviewed the following documents:

- Fire Department annual 2006 response report
- Fire Department standard operating guidelines
- Physical Activity Readiness-Questionnaire (PAR-Q) (<http://uwfitness.uwaterloo.ca/PDF/par-q.pdf>)
- Death certificate
- Hospital records
- Primary care provider medical records

INVESTIGATIVE RESULTS

On April 28, 2007, the FF was scheduled to perform the Pack Test administered by a member of a neighboring fire department, using guidance from the Idaho Department of Lands. He arrived at the designated test location (a paved roadway) at approximately 0930 hours, and parked about ¼ mile from the site. There was one test administrator, and 11 other fire fighters were taking the test. The test administrator reviewed testing procedures, including some “questions and answers” regarding the PAR-Q. The length of the road course equaled 3 miles.



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

There was no emergency medical technician (EMT) or paramedic on-site, but water and other replacement fluids were available.

The Pack Test is the most arduous version of the Work Capacity Test and involves walking a distance of 3 miles within 45 minutes, while wearing a 45-pound vest. The FF was given a weighted vest, and the group of participants gathered together and was briefed on the testing and safety procedures. Each participant completed the PAR-Q. The FF completed the PAR-Q, answering “yes” to three of the health screening questions: (1) did he have a known heart condition and should only do physical activity recommended by a doctor, (2) does he lose his balance because of dizziness or ever lose consciousness, and (3) is his doctor currently prescribing drugs for his blood pressure or heart condition. The test administrator reviewed the form before the test and questioned the FF about his participating in the “Pack Test” and offered the FF the opportunity to perform the “Field Test” (walk 2 miles within 30 minutes while wearing a 25- pound vest). However, the FF wished to participate in the more arduous “Pack Test.” He planned to perform service as a wildland contract fire fighter. It is unclear if the test administrator had any medical experience or had any guidance on when to preclude test participation based on answers to the PAR-Q. The FF had passed a medical evaluation 2 weeks prior for a commercial driver’s license, but did not have specific clearance to perform the Pack Test. The temperature outside was approximately 65° Fahrenheit [NOAA 2007].

The group began the test at about 1000 hours, and the FF completed the course within the allotted time. Toward the end of the walk, he commented to a crew member that he was feeling light-headed. He stumbled, fell, got up, and continued walking, laughing about the incident. He did not complain of any chest pains or other symptoms of heart-related problems. After the test was concluded, the fire fighters drank water and departed the scene around 1100 hours. The FF drove home without incident, although a crew member followed him to ensure that he was alright.

At about 1530 hours, the FF telephoned a neighbor, saying he was having chest pains and needed a ride to the hospital. After driving about 50 miles, they reached the hospital’s emergency department at 1642 hours. Inside the Emergency Department, it was determined through electrocardiogram (EKG) and cardiac enzyme testing that the FF was having a heart attack. The FF related to the physician that the chest pain began as a “dull ache” in his substernal area at about 1000 hours when he was doing a physical test to be a fire fighter, and that he discontinued the test, but the symptoms continued. He did not share this information with the Pack Test administrator earlier in the day, nor did he discontinue the test.

He was taken to the cardiac catheterization lab at 1701 hours where an occluded left anterior descending coronary artery was found. As percutaneous coronary intervention (e.g., angioplasty with stent placement) was started, the FF’s heart rhythm degraded to electromechanical dissociation with no pulse. Cardiopulmo-



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

nary resuscitation and advanced life support treatment were begun, continuing for about 45 minutes without positive results. Resuscitation efforts ended at 1803 hours, and the FF was pronounced dead.

Medical Findings. The death certificate (completed by the coroner) listed “cardiac arrest with electromechanical dissociation” due to “acute anterior wall myocardial infarction” due to “coronary artery disease” (CAD) as the cause of death. No autopsy was performed.

The FF was 71 inches tall and weighed 223 pounds, giving him a body mass index (BMI) of 31.1. A BMI >30.0 kilograms per meters squared (kg/m²) is considered obese [National Heart, Lung, and Blood Institute 2005]. He was diagnosed with hypertension in 1989 but refused treatment until 1996. Over the next 10 years, a variety of anti-hypertensive prescription medications were tried, but the FF’s blood pressure remained poorly controlled. He was also diagnosed with hyperlipidemia (both cholesterol and triglycerides) in 1989 but was never prescribed any medications, and diet was not successful in reducing either his cholesterol or triglycerides. In April 2005, the FF was diagnosed with angina and coronary artery disease (CAD). He underwent successful angioplasty and stenting of his proximal left anterior descending coronary artery. While being maintained on anti-coagulants (Plavix and aspirin), the FF suffered a hemorrhagic stroke six days after angioplasty. Over the ensuing 2 months, his residual left-sided hemiparesis resolved. The FF passed a medical evaluation for a commercial driver’s license 2 weeks prior to

his death. At that time, he had discontinued all his medications except for 1 low dose aspirin two times per week.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, this Fire Department consisted of 20 uniformed personnel, served a population of 200 in a 229-square-mile area, and had 1 fire station. The average age of members is 60 years old. In 2006, the Fire Department responded to 6 emergency calls including: 4 grass fires (including one that burned 27,000 acres) and 2 car fires. The Fire Department also assisted at several control burns.

Membership and Training. The Fire Department requires the following of all fire fighter applicants:

- complete an application
- possess a valid State driver’s license
- be over 18 years of age

The applicant is voted on by the general membership. The successful applicant is accepted into the Fire Department and receives training in-house twice monthly. Additional training for wildland firefighting occurs in the winter and spring and is conducted by a State-certified instructor. There is no State requirement for fire fighter certification.



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

The FF was certified as a Driver/Operator and a Wildland Fire Fighter. He had 3 years of fire-fighting experience with this Fire Department, and had retired from the United States Forest Service with 25 years of experience as a Forester and 20 years as a wildland fire fighter, including 12 years on a Type I Team.

Pre-placement and Periodic Medical Evaluations. No pre-placement or periodic medical evaluations are required by this Fire Department. Medical clearance for SCBA use also is not required. If someone is injured at work, a return-to-duty medical clearance is not required.

Health/Wellness. An annual physical agility test is not required for members. There is no wellness/fitness program, and aerobic and strength training equipment are not available.

DISCUSSION

Coronary Artery Disease (CAD) and the Pathophysiology of Sudden Cardiac Death.

In the United States, CAD (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death [Meyerburg and Castellanos 2005]. Risk factors for its development include increasing age, male gender, heredity, tobacco smoking, diabetes, high blood cholesterol, high blood pressure, and physical inactivity/obesity [AHA 1998; Jackson et al. 2001]. The FF had five risk factors for CAD: increasing age, male gender, high blood cholesterol, high blood pressure, and obesity. Two years prior to his death he was found to have angina and CAD for which he

underwent angioplasty and stenting.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades [Libby 2005]. However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion [Shah 1997]. Patients with severe CAD are at risk for heart attacks. Heart attacks occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply [Fuster et al. 1992]. This sudden blockage is primarily due to blood clots (thromboses) forming on top of atherosclerotic plaques. On cardiac catheterization, the FF had an occluded left anterior descending coronary artery, and had an abnormal EKG and elevated cardiac enzymes; each finding by itself confirming a heart attack.

Blood clots in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, and presence of a local inflammatory process) predispose the plaque to disruption [Fuster et al. 1992]. 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 [Kondo and Muller 1995].

Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks [Willich et al. 1993; Mittleman et al. 1993; Siscovick et al. 1984; Tofler et al. 1992]. The FF had completed the Pack Test within the



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

allotted time and walked an additional ½-mile to and from his vehicle. This activity expended about 7-8 METs, which is considered moderate to heavy physical activity [American Industrial Hygiene Association Journal 1971; Ainsworth 2003; Ainsworth et al. 1993]. Heart attacks in fire fighters have been associated with alarm response, fire suppression, and heavy exertion during training (including physical fitness training) [Kales et al. 2003, Kales et al. 2007, NIOSH 2007]. Given the FF's underlying CAD, the physical stress of performing the Pack Test probably triggered a heart attack and his sudden cardiac death.

Occupational Medical Standards for Wildland Fire Fighters. National Fire Equipment System (NFES) Standard 1596, Fitness and Work Capacity, provides information on fitness, work capacity, nutrition, hydration, the environment, work hardening, and injury prevention for wildland fire fighters [NWCG 1997]. It requires medical clearance for return to work, but not for pre-placement, periodic, or pre-Work Capacity Test. Prior to engaging in moderate physical activity (e.g., wildland fire fighting or the Pack Test) the standard recommends participants complete a health screening questionnaire, known as the PAR-Q. If the participant answers yes to one or more of the seven questions, the form recommends discussing activity restrictions with the participant's doctor. NFES 1596 includes American College of Sports Medicine (ACSM) recommendations to perform a medical examination for persons who are over the age of 40, have heart disease risk factors (smoking, high blood pressure, elevated cholesterol), or are seden-

tary individuals planning a major increase in activity [NWCG 1997]. The FF had all three of these ACSM triggers for a medical evaluation, and checked three items on the PAR-Q. It is unclear if this FF had discussed the risks/benefits of taking the Pack Test with his doctor. The Pack Test Administrator did not question the FF's participation, and did not require a signed letter of participation by the FF's physician.

NFES 1109, Work Capacity Test Administrator's Guide, addresses requirements and recommendations for performing the WCT Pack Test. It does not require a pre-WCT medical examination for all applicants [NWCG 2003]. It does require a completed health screening questionnaire (or medical history) and a medical exam (if indicated). When a medical examination is required, no blood testing for lipid and glucose levels is performed, nor are exercise stress tests considered. NFES does not require the Pack Test participant to provide a medical clearance to the test administrator prior to the Pack Test.

NFPA 1051, Standard for Wildland Fire Fighter Professional Qualifications, addresses medical and job-related physical performance requirements for entry-level wildland fire fighters. It recommends that the jurisdictional authority determine those requirements [NFPA 2007a]. In this case, the jurisdictional authority had not determined the medical performance requirements for either the Pack Test or wildland fire fighting.



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

Occupational Medical Standards for Structural Fire Fighters. NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, establishes medical requirements for structural fire fighters [NFPA 2007b]. It stipulates conducting medical evaluations of candidates prior to training programs or participation in departmental emergency response activities. These requirements could be modified for individuals involved in suppressing wildland fires [NFPA 2007b].

NFPA 1582 currently recommends conducting exercise stress tests on members over the age of 45 with two or more CAD risk factors (hypercholesterolemia, hypertension, smoking, diabetes mellitus, or family history of premature CAD) [NFPA 2007b]. These recommendations are similar to those of the American College of Cardiology (ACC)/American Heart Association (AHA) [Gibbons et al. 2002]. The FF had two risk factors for CAD (hypercholesterolemia and hypertension), therefore an exercise stress test would have been indicated. Currently, the Fire Department does not require annual medical evaluations or exercise stress tests for members. Had the Fire Department been conducting medical evaluation as recommended by NFPA 1582, the FF would have undergone an exercise stress test to determine his medical fitness-for-duty. It is possible his underlying cardiac vulnerability would have been detected, and he may have received preventative cardiac intervention.

RECOMMENDATIONS

The NIOSH investigator offers the following recommendations to prevent a similar episode and to address general safety and health issues.

Recommendation #1: Check the vital signs of participants before and after the work capacity test.

NFES 1109, Work Capacity Test Administrator's Guide, requires that an EMT (or someone with equivalent qualifications) observe candidates during and after the test, and be available to provide emergency medical assistance, if needed [NWCG 2003]. The EMT should take participant vital signs (pulse, blood pressure, and respirations) before and after the WCT to ensure that the participant does not have a precluding condition prior to the test, and that the participant's vital signs return to normal levels after the test.

Recommendation #2: Utilize a comprehensive medical form such as Standard Form 78 or the Federal Interagency Annual Medical History and Clearance Form for Arduous Duty Wildland Firefighters instead of the PAR-Q to determine medical clearance for the work capacity test.

The PAR-Q is a seven question health screening questionnaire designed to identify individuals who should seek medical advice before involvement in moderate activity. A "no" answer to all 7 questions indicates suitability for involvement in an exercise test for moderately vigorous aerobic and muscular fitness training.



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

A “yes” answer to one or more questions requires the individual to talk with his/her doctor before becoming much more physically active, or before a fitness appraisal. However, the PAR-Q does not forbid the individual from taking the Pack Test. The PAR-Q (located in Appendix B of the WCT Administrator’s Guide [NWCG 2003]) and page 42 of the Fitness and Work Capacity [NWCG 1997], is completed by the individual taking the Pack Test, and does not cover all CAD risk factors identified by the AHA/ACC. The WCT Administrator makes the decision whether the fire fighter is fit to perform the WCT, but frequently doesn’t have the medical background or training on when to preclude individuals from taking the Pack Test. The State should require medical clearance prior to the fire fighter performing the WCT using either: 1) “SF-78, Certificate of Medical Examination” [[http://contacts.gsa.gov/webforms.nsf/0/D379ECBDBD3D0D7485256E050067AC4D/\\$file/SF78.pdf](http://contacts.gsa.gov/webforms.nsf/0/D379ECBDBD3D0D7485256E050067AC4D/$file/SF78.pdf)], or 2) “FS Form 5100/6180” (Attachment 1).

Recommendation #3: Provide pre-placement and periodic medical evaluations to ALL fire fighters consistent with National Fire Protection Association (NFPA) 1582 (or equivalent) to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

NFPA 1582 requires fire departments to conduct pre-placement and annual medical evaluations. Guidance regarding the content and frequency of these evaluations can be found in NFPA 1582 and in the International Association of Fire Fighters (IAFF)/International As-

sociation of Fire Chiefs (IAFC) Fire Service Joint Labor Management Wellness/Fitness Initiative [NFPA 2007b; IAFF, IAFC 1997]. However, the Fire Department is not legally required to follow this standard or this initiative. Applying this recommendation involves economic repercussions and may be particularly difficult for small, volunteer fire departments to implement. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, Chapters 8-7.1 and 8-7.2 and the National Volunteer Fire Council (NVFC) Health and Wellness Guide address these issues [NFPA 2007c; USFA 2004].

To overcome the financial obstacle, the Fire Department could urge current members to get annual medical clearances from their private physicians. Another option is having the annual medical evaluations completed by paramedics and EMTs from the local Emergency Medical Service (vital signs, height, weight, visual acuity, and EKG). This information could then be provided to a community physician (perhaps volunteering his or her time), who could review the data and provide medical clearance (or further evaluation, if needed). The more extensive portions of the medical evaluations could be performed by a private physician at the fire fighter’s expense (personal or through insurance), provided by a physician volunteer, or paid for by the Fire Department. Sharing the financial responsibility for these evaluations between fire fighters, the Fire Department, and physician volunteers may reduce the negative financial impact on recruiting and retaining needed fire fighters. The average age of fire fighters is 60. This fire department is located in



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

a very rural area and has difficulty in obtaining and retaining membership.

Recommendation #4: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of firefighting.

Physicians providing input regarding medical clearance for firefighting duties should be knowledgeable about the physical demands of firefighting and familiar with the consensus guidelines published in NFPA 1582, NFPA 1051, NFES 1596, and NFES 1109 [NFPA 2007b; NFPA 2007a; NWCG 1997; NWCG 2003]. To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the private physicians of its members with a copy of these guidelines. In addition, we recommend that all return-to-work clearances be reviewed by a Fire Department- or State-contracted physician. This decision requires knowledge not only of the member's medical condition, but also of the member's job duties. Frequently, private physicians are not familiar with a member's job duties or with guidance documents such as NFPA 1582, NFPA 1051, NFES 1596, and NFES 1109. 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 #5: Ensure that fire fighters participate in a mandatory wellness/fitness program designed for wildland 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 [Plowman and Smith 1997]. NFPA 1500 requires that a Fire Department have a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being [NFPA 2007c]. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days [Maniscalco et al. 1999; Stein et al. 2000; Aldana 2001]. Health promotion programs in the fire service have been shown to reduce CAD risk factors and improve fitness levels, with mandatory programs showing the most benefit [Blevins et al. 2006; Dempsey et al. 2002; Womack et al. 2005]. One mandatory program was able to show a cost savings of \$68,741 due to reduced absenteeism [Stevens et al. 2002]. 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 [City Auditor, City of Phoenix, AZ 1997]. Guidance for implementation and components of a comprehensive wellness/fitness program are found in NFPA 1583, Standard on Health-Related Fitness Programs for Fire Department Members [NFPA 2008], and in the IAFF/IAFC's Fire Service Joint Labor Management Wellness/Fitness Initiative [IAFF, IAFC 1997].

For wildland fire fighters, NFES 1596 and NFPA 1051 address wellness/fitness issues. As mentioned previously, NFES 1596, Fitness and



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

Work Capacity, provides information on fitness, work capacity, nutrition, hydration, the environment, work hardening, and injury prevention for wildland fire fighters [NWCG 1997].

NFPA 1051, Standard for Wildland Fire Fighter Professional Qualifications, addresses medical and job-related physical performance requirements for entry-level wildland fire fighters. It recommends that the jurisdictional authority determine what those requirements shall be [NFPA 2007a]. The State should ensure that local Fire Departments are aware of the physical demands of wildland firefighting, and that the wildland fire fighters participate in a wellness/fitness program designed for wildland fire fighters.

Recommendation #6: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural firefighting.

NFPA 1500 requires Fire Department members who engage in emergency operations to be annually evaluated and certified by the Fire Department as having met the physical performance requirements identified in paragraph 8-2.1 of the standard [NFPA 2007c].

Recommendation #7: Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBAs).

The Occupational Safety and Health Administration (OSHA)'s Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employ-

ees using respiratory protection [CFR 2006]. 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. Idaho is not a State-plan State, and public sector employers are not required to comply with OSHA standards. However, we recommend voluntary compliance to enhance safety and health.

Recommendation #8: Perform an autopsy on all on-duty fire fighter fatalities.

In 2008, the USFA published the Firefighter Autopsy Protocol [USFA 2008]. With this publication, the USFA 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.”



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

REFERENCES

- AHA [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX: American Heart Association.
- Ainsworth BE [2003]. The compendium of physical activities. President's Council on Physical Fitness and Sports: 4(2). Washington, DC.
- Ainsworth BE, Haskell WL, Leon AS, Jacobs DR Jr, Montoye HJ, Sallis JF, Paffenbarger RS [1993]. Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc* 25(1):71-80.
- Aldana SG [2001]. Financial impact of health promotion programs: a comprehensive review of the literature. *Am J Health Promot* 15:296-320.
- American Industrial Hygiene Association Journal [1971]. Ergonomics guide to assessment of metabolic and cardiac costs of physical work. *Am Ind Hyg Assoc J* 32:560-564.
- Blevins JS, Bounds R, Armstrong E, Coast JR [2006]. Health and fitness programming for fire fighters: does it produce results? *Med Sci Sports Exerc* 38(5):S454.
- CFR [2006]. 29 CFR 1910.134, Respiratory protection. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.
- City Auditor, City of Phoenix, AZ [1997]. Disability retirement program evaluation. January 28, 1997.
- Dempsey WL, Stevens SR, Snell CR [2002]. Changes in physical performance and medical measures following a mandatory firefighter wellness program. *Med Sci Sports Exerc* 34(5):S258.
- Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. *N Engl J Med* 326:242-250.
- Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, Mark DB, McCallister BD, Mooss AN, O'Reilly MG, Winters WL Jr. [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). [<http://content.onlinejacc.org/cgi/content/short/40/8/1531>]. Date accessed: January 4, 2008.
- IAFF, IAFC [1997]. The fire service joint labor management wellness/fitness initiative. Washington, DC: International Association of Fire Fighters, International Association of Fire Chiefs.
- Jackson E, Skerrett PJ, Ridker PM [2001]. Epidemiology of arterial thrombosis. In: Coleman RW, Hirsh J, Marder VIJ et al., eds. Homeostasis and thrombosis: basic principles and clinical practice. 4th ed. Philadelphia, PA: Lippincott Williams and Wilkins.
- Kales SN, Soteriades ES, Christoudias SG, Christiani DC [2003]. Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ health: a global access science source*. [<http://www.ehjournal.net/content/2/1/14>]. Date accessed: February 15, 2007.
- Kales SN, Soteriades ES, Christophi CA, Christiani DC [2007]. Emergency duties and deaths from



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

- heart disease among fire fighters in the United States. *N Engl J Med* 356:1207-1215.
- Kondo NI, Muller JE [1995]. Triggering of acute myocardial infarction. *J Cardiovasc Risk* 2:499-504.
- Libby P [2005]. The pathogenesis of atherosclerosis. In: Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, eds. *Harrison's principles of internal medicine*. 16th ed. New York: McGraw-Hill, pp. 1425-1430.
- Maniscalco P, Lane R, Welke M, Mitchell J, Hustling L [1999]. Decreased rate of back injuries through a wellness program for offshore petroleum employees. *J Occup Environ Med* 41:813-820.
- Meyerburg RJ, Castellanos A [2005]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. In: Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, eds. *Harrison's principles of internal medicine*. 16th ed. New York: McGraw-Hill, pp. 1618-1624.
- Mittleman MA, Maclure M, Tofler GH, Sherwood JB, Goldberg RJ, Muller JE [1993]. Triggering of acute myocardial infarction by heavy physical exertion. *N Engl J Med* 329:1677-1683.
- NFPA [2008]. Standard on health-related fitness programs for fire department members. Quincy, MA: National Fire Protection Association. NFPA 1583.
- NFPA [2007a]. Standard for wildland fire fighter professional qualifications. Quincy, MA: National Fire Protection Association. NFPA 1051.
- NFPA [2007b]. Standard on comprehensive occupational medical program for fire departments. Quincy, MA: National Fire Protection Association. NFPA 1582.
- NFPA [2007c]. NFPA 1500: Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.
- NIOSH [2007]. NIOSH alert: preventing fire fighter fatalities due to heart attacks and other sudden cardiovascular events. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2007-113.
- NOAA [2007]. Quality controlled local climatological data, hourly observations table, Boise Air Terminal, Boise, ID. National Oceanic and Atmospheric Administration. [<http://cdo.ncdc.noaa.gov/qclcd/QCLCD>]. Date accessed: November 2007.
- NWCG [1997]. Fitness and work capacity (NFES 1596). 2nd ed (April). By Sharkey BJ. Missoula, MT: U.S. Department of Agriculture, Forest Service, Technology & Development Program, 5100 Fire, National Wildfire Coordinating Group, Publication No. 9751-2814-MTDC.
- NWCG [2003]. Work capacity test administrator's guide (NFES 1109). By Sharkey BJ. Missoula, MT: U.S. Department of Agriculture, Forest Service, Technology & Development Program, 5100 Fire, National Wildfire Coordinating Group.
- National Heart, Lung, and Blood Institute [2005]. Obesity education initiative. [<http://www.nhl->



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

- bisupport.com/bmi/bmicalc.htm]. Date accessed: September 2006.
- Plowman SA, Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.
- Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20 (11 Suppl2):II-38-44.
- Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. N Engl J Med 311:874-877.
- 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. J Occup Environ Med 42:1148-1155.
- Stevens SR, Dempsey WL, Snell CR [2002]. The reduction of occupational absenteeism following two years of firefighter wellness program. Med Sci Sports Exerc 34(5):S194.
- Tofler GH, Muller JE, Stone PH, Forman S, Solomon RE, Knatterud GL, Braunwald E [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.
- USFA [2008]. Firefighter Autopsy Protocol. Emmitsburg MD: Federal Emergency Management Agency; United States Fire Administration.
- USFA [2004]. Health and wellness guide. Emmitsburg, MD: Federal Emergency Management Agency; United States Fire Administration. Publication No. FA-267.
- Willich SN, Lewis M, Lowel H, Arntz HR, Schubert F, Schroder R [1993]. Physical exertion as a trigger of acute myocardial infarction. N Engl J Med 329:1684-1690.
- Womack JW, Humbarger CD, Green JS, Crouse SF [2005]. Coronary artery disease risk factors in firefighters: effectiveness of a one-year voluntary health and wellness program. Med Sci Sports Exerc 37(5):S385.

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, a Kentucky Certified Fire Fighter and Emergency Medical Technician (EMT), and a former Fire Chief, is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio.



Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

Attachment 1



United States
Department of
Agriculture

Forest
Service

File Code: 5100/6180

Date:

Dear Employee's Name

As a USDA Forest Service employee or prospective employee who may be or is currently assigned wildland fire duties, you are required to fill out the Health Screening Questionnaire (HSQ) prior to conditioning for or taking the Work Capacity Test (WCT) at any level. The HSQ must be returned to your local Servicing Human Resource Office. Upon review, you will be notified to either engage in physical activity related to the WCT or to seek further medical review. You may be offered a physical examinations paid for by the Forest Service. To participate in assigned fire duties, you must pass the WCT at the level indicated below in order to ensure that you are physically fit to perform them. If you do not pass the test, your employment may be terminated effective the following day. [Applies to temporary employees only.] Employees taking the WCT are expected to make themselves available for fire assignments.

___ **Arduous level** - requires the individual to complete a 3-mile walk/hike within 45 minutes while carrying a 45-pound pack;

___ **Moderate level** - requires the individual to complete a 2-mile walk/hike within 30 minutes while carrying a 25-pound pack; or

___ **Light level** - requires the individual to complete a 1 mile walk within 16 minutes.

The following material is enclosed and must be reviewed by a licensed physician:

- Physician letter
- Certificate of Medical Examination (Standard Form 78)
- "The Pack Test" information sheet
- Health Survey Questionnaire

Upon completion of examination, you are responsible for returning completed documents in the enclosed envelope to _____ at _____. You have the choice of having this material completed by your own physician or qualified medical provider or by _____, an Agency-designated physician or qualified medical provider. For either choice, the Forest Service will pay for the reasonable and customary costs of this physical examination. Please contact _____ at _____ if you have questions or concerns about any of the above.

Sincerely,

NAME & Title
Enclosures





Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

Attachment 1

 United States Department of Agriculture

Forest Service

File Code: 5100/6180

Date:

Dear Physician or Qualified Medical Provider:

_____ is a USDA Forest Service employee or prospective employee with the _____ National Forest.

This employee is or will be involved in fire management activities and is required to pass a monitored Work Capacity Test (WCT). The Forest Service requires clearance from a licensed physician or other qualified medical provider before he/she begins a 4-6 week course of conditioning in preparation for taking this test. Once that has been completed, the individual will be required to pass the WCT at the following level noted below. Upon successfully passing the WCT, this employee must be physically capable of performing the requirements of this level of activity required in his/her fire position in wildland fire environmental conditions.

___ **Arduous level** - requires the individual to complete a 3-mile walk/hike within 45 minutes while carrying a 45-pound pack;

___ **Moderate level** - requires the individual to complete a 2-mile walk/hike within 30 minutes while carrying a 25-pound pack; or

___ **Light level** - requires the individual to complete a 1 mile walk within 16 minutes.

Please review the enclosed Certificate of Medical Examination (Standard Form 78), the Health Screening Questionnaire, and the "The Pack Test" information sheet, and evaluate this individual's physical condition in regard to the the duties and physical requirements of the physical conditioning exercise, the WCT and position. Please complete, sign and date Parts C and F of the Standard Form 78. In the "Conclusions" block, please note any limiting factors for the individual in meeting the physical requirements of the job and/or the WCT.

The USDA Forest Service authorizes you to bill for the customary and reasonable costs incurred for a standard physical examination. If additional testing is needed beyond the customary examination, please contact _____ at _____ for prior approval.

Please forward the bill to:

Thank you for your assistance.

Sincerely,

NAME & Title
Enclosures



Caring for the Land and Serving People

Printed on Recycled Paper 



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Fatality Assessment and Control Evaluation
Investigation Report • F2007-34

Fire Fighter Suffers a Heart Attack and Dies After Completing Work Capacity Test – Idaho

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In fiscal year 1998, the Congress appropriated funds to NIOSH to conduct a fire fighter initiative. NIOSH initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim. For further information, visit the program website at

www.cdc.gov/niosh/fire/
or call toll free
1-800-CDC-INFO (1-800-232-4636)