



## **Recruit Fire Fighter Suffers Heat Stroke during Physical Fitness Training and Dies Nine Days Later – Florida**

### **SUMMARY**

On May 19, 2005, a 22-year-old male career Fire Fighter Recruit collapsed while completing a class run in formation at the end of a training day. The training activities started at 0700 hours with fire fighter training occurring throughout the day. Frequent self-directed rest breaks were part of the training and a lunch break was taken at noon. At approximately 1600 hours, an instructor led physical training consisting of stretching, light aerobics, abdominal crunches, and a 2½ – 3 mile run.

During the run the Recruit exhibited fatigue and complained of blurred vision, but did not stop until he stumbled and fell approximately 300 to 500 yards from the training offices at approximately 1719 hours. He was transported back to the office by one of the instructor's truck. The training staff started two intravenous access lines (IV), put on oxygen via a non-rebreather mask, elevated his extremities, and removed his clothes as a cooling measure for a possible heat-induced illness. The ambulance arrived at 1729 hours where an assessment found his skin warm, with normal color and moisture. The Recruit was placed on a stretcher and transported to the hospital emergency department (ED).

The ambulance arrived at the ED at 1745 hours where a rectal temperature of 108.6 degrees Fahrenheit (°F) was measured. He was stabilized and transferred to the intensive care unit at 2100 hours. The Recruit never regained consciousness and died nine days later. The final diagnosis from the hospital and the cause of death listed on the death certificate was severe heat stroke with multisystem organ failure. No autopsy was performed.

It is the opinion of the NIOSH investigator that the physical stress of the physical training, combined with the heat and humidity, caused the Recruit's death. NIOSH investigators also concluded that to minimize

the risk of similar occurrences, the FD should take the following steps:

*Formulate and institute a heat stress program.*

*Create a training atmosphere that is free from intimidation and conducive for learning.*

*Use physical training staff who have fitness training instruction and are knowledgeable about all aspects of a heat stress program.*

*Use trail vehicle and/or equip training instructors with portable radios for the off-site runs.*

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

*Phase-in a mandatory wellness/fitness program for 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 fire fighting.*

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/fire](http://www.cdc.gov/niosh/fire)

or call toll free **1-800-35-NIOSH**



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**INTRODUCTION & METHODS**

On May 19, 2005, a 22-year-old male career Recruit Fire Fighter collapsed while completing a formation run at the end of a training day. On May 31, 2005, NIOSH was informed of the death by the U.S. Fire Administration. On June 8, 2005, NIOSH contacted the affected fire department (FD). On August 31, 2005, an Occupational Health Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to Florida to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met and/or interviewed the following people:

- Fire Chief
- Chairman of the FD's investigation committee
- Human Resource Manager
- HIPAA Privacy Officer
- Training staff
- Training class members
- State Fire Marshal's investigators
- Recruit's parents

During the site visit NIOSH personnel reviewed the following documents:

- FD policies and operating guidelines
- FD training records
- FD annual report for 2004
- FD incident report
- FD physical examination protocols
- Ambulance response report
- Hospital records
- Death certificate
- Medical records
- Witness statements
- National Oceanic and Atmospheric Administration (NOAA) weather data
- State Fire Marshal's report

**INVESTIGATIVE RESULTS**

***Incident.*** On May 19, 2005, at approximately 0630 hours, a 22-year-old male career Recruit Fire Fighter reported to the training center for instruction. Formal training for the day started at 0700 hours and included a High Angle drill where recruits had multiple ascents and descents in a three-story rappelling tower and conducted rope and knot exercises. Students were informed by the instructors to take frequent self-directed rest breaks as needed throughout the day, and a lunch break was scheduled for noon. The Recruit made no complaints through the day and ate a full lunch at noon. At approximately 1600 hours PT was initiated. This instructor-led PT included stretching, light aerobics, abdominal crunches, and a 2½–3 mile run. The standard PT run length was one mile on a track on the training grounds. The route for the afternoon run was off the training area but on level terrain. According to the National Oceanic and Atmospheric Administration (NOAA) weather data, the dry bulb temperature at 1556 hours was 79°F. The Recruit, known for being a poor runner, led the run. In a previous PT run he had been forced by fatigue to walk and the training class was told to run in a circle around him until he was able to run again. In this run he again exhibited fatigue and complained of blurred vision to another student, but did not stop until he stumbled and fell approximately 300 to 500 yards from the training offices. Fellow students were told by the instructors to pick the Recruit up; he ran a short distance and collapsed again. After the second collapse the Recruit was picked up and carried inside the gate of the training compound at approximately 1719 hours.

Inside the training compound the Recruit was found to be pale, perspiring profusely and mumbling incoherently. An instructor ran to the office and, at approximately 1720 hours, ordered them to call 911. He next retrieved his truck and drove back to the recruit, where the other instructors assisted him in loading the Recruit and transporting him back to the office.



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Once in the office, the Recruit was moaning and had a decreased level of consciousness. The training staff started two intravenous access lines (IV), supplied oxygen via a non-rebreather mask, elevated his extremities, and removed his clothes as a cooling measure.

The ambulance arrived at 1729 hours and found the Recruit supine on the floor with the training staff getting vital signs (no results in the record). According to the ambulance report, he was assessed and found to have a decreased level of consciousness but oriented and obeying commands' (witness statements say he was never oriented or obeying commands), his skin was warm, with normal color and moisture. No vital sign results could be identified in the record until 1740 hours. The Recruit was placed on a stretcher and transported to the ED. En route to the hospital's ED he had a pulse of 180 beats per minute (bpm), a breathing rate of 40 per minute, a blood pressure of 96/41 millimeters of Mercury (mm/Hg) and became unconscious, although the ambulance report gives no time of the event. His oxygen saturation was 97% (normal), blood sugar was slightly elevated at 168 (normal 70-110) and a cardiac monitor showed supraventricular tachycardia (an abnormal heart rhythm). He vomited en route, he was laid on his side and suction was used to remove the emesis. The ambulance arrived at the ED at 1745 hours.

The ED staff found the Recruit to have a rectal temperature of 108.6°F. He was successfully intubated (breathing tube placed in the airway), and placement was confirmed using a secondary technological test per American Heart Association guidelines.<sup>1</sup> Emergent cooling treatments along with vigorous hydration were instituted until his transfer to the intensive care unit at 2100 hours with a core body temperature of 98.9°F. After a nine day hospitalization, the Recruit never regained consciousness and expired on May 28, 2005. The final diagnosis from the hospital was

severe heat stroke with multisystem organ failure and sepsis with multiple complications.

*Medical Findings.* Because of the clinical course, no autopsy was requested; the death certificate listed multi-system organ failure due to heat stroke as the cause of death. The Recruit had very little recorded medical history. His parents noted that in 2000 he had suffered heat exhaustion following a 4.5-hour high school football practice. He did not seek medical attention at that time and no record could be found to indicate that the FD was aware of this incident. In February 2004, he was seen by his primary care physician (PCP) for a medical examination as a requirement to attend state mandated fire school. The examination followed guidelines of the State's Department of Fire Standards and Training.<sup>2</sup> Although a few premature atrial contractions (PAC) (a relatively common inconsequential heart arrhythmia) were noted on the 12-lead electrocardiogram (EKG), he was medically cleared for FF training. He successfully attended state mandated minimum standards training, which allowed him to make application to many departments. He was certified as FF II by the state.

In February 2005, the Recruit was medically examined for hiring by a city physician. Once again PACs were found on the 12-lead EKG. The examination included a bicycle ergometer aerobic exercise capacity test that had an EKG component. The EKG was of poor quality and unable to be read. He was medically cleared, but the following three conditions were noted: 1) obesity [body mass index was 40.2 kilograms/meter<sup>2</sup> (kg/m<sup>2</sup>), normal is less than 24.9 kg/m<sup>2</sup>]; 2) elevated triglycerides [262 milligrams per deciliter (mg/dl), normal <150 mg/dl], and 3) PAC.

According to family and FD personnel, the FF exercised daily. He had expressed no signs or symptoms of any medical condition to his coworkers or health care providers prior to this incident. He was not taking any medications.



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**DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, this FD consisted of 1201 uniformed personnel serving a population of 885,000 in 847 square miles. There are 58 fire stations.

The FD provides limited advanced life support; all fire fighters hold either Emergency Medical Technician-Paramedic (EMT-P) or EMT-Basic (EMT-B) certification. Fire fighters work the following schedule: alternating 24-hour on-duty and 48-hour off-duty shifts. Shift change occurs at 0700 hours for District Chiefs and 0800 hours for FFs. In 2004, the FD responded to 18,556 emergency calls.

***Training.*** To become a member of the FD, applicants must have a state certification and fill out an application. They agree to have a credit, driving, and criminal history check. A candidate physical ability test created by the FD is administered after the applicant has received approval from his primary care physician. The physical ability test is composed of one timed event with 11 sections. The candidates are then interviewed and ranked. The top applicants are offered employment, and then given a physical examination by the occupational health clinic (discussed below). If the applicants fail the physical examination, the offer of employment is rescinded.

Once hired as a probationary employee, candidates must complete an 11-week training course at the department fire fighter academy that orients them to the department's methods and practices. After 2 weeks they are assigned to a station at which they perform weekend shifts as an observer/trainee. After the completion of the 11-week course, they return full time to a station and serve as a probationary employee until they successfully pass an examination during their 11<sup>th</sup> month. Recurrent training occurs daily on each shift. EMT certification must be renewed periodically; no recertification is required for other portions of the FF training.

According to the final draft report of the State Fire Marshals office, the department fire fighter academy was reported to operate in a rigid manner, with the Chief of Training encouraging a strict and controlling authority. Recruits reported physical exercise was scheduled arbitrarily and of varying intensity based on the instructor. The Recruit had received two counseling statements for an incident of tardiness and for horseplay. The counseling was handled by the class instructor and did not include the academy's administration. His father (a Captain in the FD) had communicated the need to the recruit to correct any disciplinary issues. Although, many in his class felt that he was close to being removed, his position in the academy did not appear to be in jeopardy. But, the Recruit was under intense pressure to complete the academy training due to his family legacy and the counseling statements added to this pressure.

***Pre-placement Evaluations.*** The FD requires a pre-placement medical evaluation for all FF candidates. Components of the evaluation include the following:

- A complete medical history
- Physical examination
- Vital signs including height and weight
- Vision testing (acuity, color, peripheral)
- Audiogram
- Blood analysis: serum chemistry, liver profile, and complete blood count
- Urinalysis (dipstick)
- Illicit drug urine screen
- Chest x-ray
- 12-lead resting EKG
- Exercise Stress Test
- Spirometry (Pulmonary Function Test)
- Tuberculosis skin test (PPD)
- Hepatitis B screening if vaccination is not complete





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These evaluations are performed by the physician in the occupational health clinic, who then makes a decision regarding medical clearance for fire fighting duties. This decision is forwarded to the city human resources division. As mentioned earlier the Recruit's pre-placement examination noted obesity, PAC's and elevated cholesterol. Family and classmates reported that the Recruit had received a letter from the pension board informing him he had to lower his cholesterol or he would lose cardiovascular pension coverage for medical illness. According to classmates and the family, the Recruit had changed his diet but was not taking diet pills or other supplements (e.g. ephedra) to lose weight or reduce his cholesterol.

*Periodic Evaluations.* Annual medical evaluations are required by this FD for all members. The contents of the examination are the same as the pre-placement except that the urine drug screen is conducted periodically, and a cardiac computerized tomography (CT) is conducted annually.

No annual physical ability test is required for members. Exercise equipment (strength and aerobic) is available in the fire stations. A return-to-duty medical clearance is required from the city-contracted physician for duty-related injuries. A return-to-duty medical clearance is required from the FF's PCP for illnesses (depending on the type and length of illness) that prevent FFs from performing their duty. The clearance is provided to the FD and the city occupational health clinic. The clinic reviews the clearance and makes a final determination to the FD. Self-Contained Breathing Apparatus clearance and fit tests are conducted annually. The voluntary health/wellness program consists of educational programs for smoking cessation, weight control, high blood pressure, diabetes, and cholesterol reduction. There is no mandatory fitness program although the department does have a Standard Operating Procedure for fitness training on duty.

## DISCUSSION

*Heat Stroke.* The death certificate reported heat stroke as the cause of death. There are multiple types of heat illness ranging from heat rash to heat stroke.<sup>3</sup> Heat stroke is the most serious, typically occurring when the core body temperature reaches 104°F to 106°F. Time required to develop heat stroke varies based on many factors including temperature, humidity, activity level, age, acclimatization, medications, water consumption, clothing, physical condition, obesity, previous history of heat illness, and predisposing medical conditions. Symptoms typically begin as sweating, dizziness, gastrointestinal distress, and a fast heartbeat, then progress to hypotension, hyperventilation, delirium, seizures, and eventually loss of consciousness/coma. Hallmark signs of heat stroke include multi-organ failure, particularly of the nervous system, the circulatory system, and the liver.<sup>3</sup>

In this incident, conditions (environmental and physical activity levels) were conducive to a heat stroke episode. His obesity and previous history of heat illness were additional risk factors. The Recruit's clinical presentation and subsequent course are consistent with the diagnosis of heat stroke, and his core temperature measurement of 108.6°F confirms the diagnosis.

*Cardiac Abnormality.* The Recruit had an asymptomatic heart abnormality (PAC) identified on his EKG in February 2004 and in February 2005. He was appropriately medically cleared for FF training using consensus guidelines published by National Fire Protection Association 1582, *Standard on Comprehensive Occupational Medicine Program for Fire Departments*.<sup>4</sup> It is likely this abnormality played no part in his death.

## RECOMMENDATIONS

It is likely the Recruit's death could have been prevented. The NIOSH investigators offer the following recommendations to reduce the risk of on-the-job heat stress deaths among fire fighters.



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***Recommendation #1: Formulate and institute a heat stress program.***

A number of guides recommend measures and standards for protection from heat stress injuries. A list can be found in the NIOSH Criteria for a recommended standard, Occupational Exposure to Hot Environments, Revised Criteria 1986, Department of Health and Human Services Publication No. 86-113.<sup>5</sup> This criteria document contains standards and recommendations from the American Conference of Governmental Industrial Hygienists, Occupational Safety and Health Administration, American Industrial Hygiene Association, the Armed Forces, American College of Sports Medicine, and the International Organization for Standardization, some of which were given to the department. Although there are occupation/industry-specific components found in each group's documents, the department should examine all the guides in their updated form to identify policies that fit their unique situation. A program should include heat casualty risk management (identify and assess hazards; develop and implement controls; and supervise and evaluate program)<sup>6</sup>, and include education, surveillance system for early detection, and compliance monitoring.

***Recommendation #2. Create a training atmosphere that is free from intimidation and conducive for learning.***

The purpose of training is to teach fire fighters proper techniques to accomplish an assignment in a safe environment that supports learning. Training exercises should not take a punitive approach.<sup>7</sup> By fostering a positive learning environment, fire departments can capitalize on each individual's analytical skills to become problem solvers within a team organization.

***Recommendation #3: Use physical training staff who have fitness training instruction and are knowledgeable about all aspects of a heat stress program.***

The IAFF and the IAFC jointly 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.<sup>8</sup> The IAFF/IAFC initiative recommends an exercise specialists and peer fitness trainers be used in fitness programs. These specialists should have training on a heat stress program.

***Recommendation #4: Use trail vehicle and/or equip training instructors with portable radios for the off-site runs.***

To ensure prompt response to emergencies, a transport or electronic communication method should be available for physical training conducted off-site.

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

***Recommendation #5: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>9</sup> NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.<sup>10</sup> The IAFF and the IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative is an example of a thorough program.<sup>8</sup> Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.<sup>11-13</sup> A similar cost savings has been reported by the wellness program at the Phoenix Fire Department, where a 12-year commitment has resulted in a significant reduction in disability pension costs.<sup>14</sup>



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

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Programs* 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.<sup>9</sup>

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## INVESTIGATOR INFORMATION

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