



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation

June 30, 1998

Fire Chief Dies as a Result of a Heart Attack While Fighting a Fire in a Two-Story Dwelling--New York

SUMMARY

On December 1, 1997, a 44-year-old male Fire Chief collapsed while fighting a fire in a two-story brick dwelling of ordinary construction. The Chief was assisting a neighboring fire department that was responding to several emergency calls at different locations in their jurisdiction. The Chief was wearing full turnout gear, including the face piece of his self-contained breathing apparatus, and was participating in physically demanding fire fighting activities when he collapsed. He died shortly after he collapsed. Based upon autopsy results, the cause of death was listed as fatal cardiac arrhythmia.

A three-pronged strategy for reducing the risk of on-duty heart attacks among fire fighters has been proposed by other agencies. This strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high-risk individuals; and 3) encouraging increased individual physical capacity. Steps that could be taken to accomplish these ends include:

- providing fire fighters with lighter-weight protective equipment to reduce the physical demands placed upon fire fighters
- implementing an overall health and safety program such as the one recommended in National Fire Protection Association (NFPA) 1500, Standard on Fire Department Occupational Safety and Health Program
- providing fire fighters with periodic medical examinations
- initiating a wellness/fitness program to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.



Two-story dwelling where fatality occurred.

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. 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:

<http://www.cdc.gov/niosh/firehome.html>

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INTRODUCTION/METHODS

On December 1, 1997, a 44-year-old male Fire Chief collapsed while fighting a fire and afterwards died of cardiac arrhythmia. NIOSH was notified of this fatality on December 2, 1997. NIOSH telephoned the Fire Chief's department and City Manager on December 4 to initiate the investigation. Jane McCammon, Senior Industrial Hygienist, and Thomas Hales, Senior Medical Officer from the NIOSH Fire Fighter Fatality Investigation Team traveled to New York on December 9, 1997 to conduct an onsite investigation of the incident.

NIOSH personnel began the investigation by meeting with and interviewing:

- New York Department of Labor (NYDOL) personnel assigned to the case
- officers and co-workers from the employing Fire department (Department 1)
- the International Association of Fire Fighters (IAFF) local union representative
- the City Manager/Commissioner of Public Safety responsible for Department 1
- the Chief of the neighboring fire department that the deceased Chief was assisting (Department 2).

NIOSH also:

- reviewed existing NYDOL and Fire Department/City investigative records, including incident reports, co-worker statements, dispatch records, past fire fighter clearance summary reports (including both respirator and fire fighter clearance results), Departmental policies and procedures, autopsy results, and the death certificate
- visited and photographed the fire site
- contacted the private physicians of the deceased Chief.

INVESTIGATIVE RESULTS

Fire Scene Response. On December 1, 1997, the Fire Chief of a 25-person career fire department (Department 1) was called to place his department on standby in a neighboring community's fire station as part of a mutual aid program. The neighboring fire department (Department 2) had received calls for assistance at several locations and had already dispatched a number of their units to fight a major fire elsewhere. An Emergency Medical Services (EMS) call came in, and an engine

and medic unit from Department 2 were dispatched to respond. Shortly thereafter, another EMS call in Department 2's coverage area was received. The Chief of Department 1 was dispatched to respond to the second EMS call.

Shortly thereafter, multiple calls reporting a fire at a two-family dwelling (the incident fire) were received. The first call reporting this fire was received at 2103 hours, but was disregarded by dispatch as a fictitious report. Units were dispatched at 2105 hours after other calls were received reporting fire at the same location (including a repeat call from the person initially reporting the fire). The Chief of Department 1 left the EMS location to respond to this structure fire. When the first of the fire fighters arrived at the building it was fully involved and heavy smoke and flames were coming from the front of the building.

Ultimately, two ladder trucks, three fire engines, fifteen fire fighters, and one medic unit were dispatched to this fire location. The two-story dwelling was high on a hill and set back from the street. To access the house from the street, fire fighters had to repeatedly climb and carry equipment up sixteen steps leading to a landing, then up four more steps leading to the front porch landing of the house (see Figure 1).

The Chief of Department 1 was assisting with fire fighting activities as units arrived at the scene. He was in and out of the building, assisting with hoses, and doing whatever was needed concurrent with his role of directing activities of his fire fighters at the scene. He was in full turnout gear and was wearing the face piece of his self-contained breathing apparatus (SCBA). The SCBA and other protective gear he was wearing weighed approximately 60 pounds.

Fire crews positioned one 4-inch, one 2½-inch, and three 1¾-inch hoselines to fight the fire. After a period of interior attack, the Chief ordered everyone out of the building to begin a defensive (or exterior) attack on the fire. After a period of several minutes, the interior attack was reinitiated. After the interior attack was reinitiated, which was approximately 30 minutes into the fire assault, the Chief came out of the building and directed a fire fighter to go to the truck and get an ax. The Chief was standing outside of the building, on the front porch landing. He instructed two fire fighters to remove the remnants of the front door which were catching parts of their gear as they moved in and out of the building. According to witnesses, the Chief then took a deep breath and fell backwards down the four steps to the landing below.

The following time line related to the incident fire was abstracted from Department 2's 911 telephone and fire activity summary report:

Time Activity	Event Summary
2103 hours	Initial fire report received
2104 hours	Fire report received from another location
2105 hours	Apparatus dispatched/box alarm transmitted
2108 hours	Engine 5 and Chief, Department 1 advise that they will respond. (NOTE: There was no reported arrival time for the Chief and Engine 5 in the record.)
2109 hours	Department 2 Battalion Chief at the fire scene, reports fully involved building needs additional assist
2110 hours	Engine #1 arrives at the fire scene
2111 hours	Chief, Department 2 arrives at the fire scene and reports heavy fire condition
2113 hours	Engine #2 arrives at the fire scene
2126 hours	Chief, Department 2 reports that water is being applied to the fire
2138 hours	Chief, Department 2 reports unconscious fire fighter (Chief, Dept. 1)

EMS Response to the Chief's Medical Emergency. Fire fighters, certified as emergency medical technicians (EMT), reached the Chief within seconds and found him unconscious. The EMTs initially thought that the Chief's loss of consciousness was due to a head or neck injury from the fall. Approximately 4 minutes after the Chief collapsed, paramedics arrived at the fire scene. The paramedics' initial evaluation found the Chief unconscious with pupils dilated, and snoring type of respirations. Oxygen was administered by bagging while the neck was stabilized with an immobilizing collar. The Chief was moved onto a transport backboard and carried from the entrance of the burning dwelling to the ambulance waiting on the street below. This took several minutes because the stairs were slippery and covered with ice and snow. While the Chief was loaded into the ambulance his condition was reassessed. He was found to have no respirations or pulse, and cardiopulmonary

resuscitation was initiated. A heart monitor showed ventricular fibrillation for which the Chief received three attempts at electro-cardioversion during the 3-minute trip to the hospital.

Upon arrival in the hospital's emergency department, an intravenous (IV) line was placed and an IV injection of epinephrine was given. A blood sample was drawn for analysis of carboxyhemoglobin content; the result was 0.7% which indicated that he had not been exposed to excessive concentrations of carbon monoxide. The Chief was intubated and placed on 100% oxygen. His clothes were stripped off, and heart monitor electrodes were placed showing a rhythm of ventricular fibrillation. Over the ensuing 15-minute period, electro-cardioversion was attempted three more times. In addition, IV lidocaine, epinephrine, and atropine were administered. The Chief never regained consciousness and was pronounced dead at 2205 hours.

The sequence of events as recorded on the ambulance and hospital reports follows:

Time Activity	Event Summary
<i>2142 hours</i>	Ambulance receives the dispatch call and proceeds to the fire scene.
<i>2142 hours</i>	Ambulance with paramedics arrives at fire scene. Initial evaluation notes the Chief is unconsciousness, pupils dilated, and snoring type of respirations. Oxygen administered while the neck is stabilized with an immobilizing collar. The Chief is moved onto a transport backboard and carried from the building entrance down the slippery staircase covered with ice and snow to the waiting ambulance located on the street below. While negotiating the difficult terrain, paramedics noted that the Chief had stopped breathing.

2147 hours	Chief is loaded onto the ambulance. The Chief's condition was re-assessed where he was found to have no respirations and no pulse. Cardiopulmonary resuscitation was initiated. Heart monitor showed ventricular fibrillation. The ambulance departed for the hospital.
2150 hours	Ambulance arrives at hospital.
2205 hours	Chief, Department 1 pronounced dead

Medical Findings. The death certificate was completed by the medical examiner on December 2, 1997. The immediate cause of death was listed as "fatal cardiac arrhythmia due to hypertensive and arteriosclerotic heart disease as a consequence of collapsing while fighting the fire."

Medical records indicated he had risk factors for coronary artery disease. An autopsy was performed by the medical examiner on December 2, 1997. Pertinent findings are listed below.

- There was no external trauma to the head or neck region.
- There was significant blockage of one of the main coronary arteries. Specifically, the left anterior descending artery showed a 90% focal occlusion. In addition, the right coronary artery and left circumflex artery showed 40 to 60% occlusion throughout. Similar findings were found microscopically.
- The aortic valve was narrowed (stenotic and calcified).
- Microscopic examination of the heart revealed fibrous scarring of a muscle attaching the heart wall to one of the heart valves (papillary muscle). This finding is consistent with previous ischemic damage to the heart.
- The autopsy blood carboxyhemoglobin analysis result of 0.3% again indicated that the Chief was not exposed to excessive concentrations of carbon monoxide prior to his death.

DESCRIPTION OF THE FIRE DEPARTMENT

The fire department involved in this incident (Department 1) employs a Fire Chief, 8

officers, and 16 fire fighters to serve 11,000 residents and an additional 4,000 to 9,000 people who are in their 1.5-square-mile area of coverage during the workday. The longest response run time for the Department is 3 minutes. The Department responded to approximately 1,350-1,450 calls in 1996. Information was not available regarding the nature of these calls. That information was available for calls in 1995. During that year, the Department responded to 1,604 calls, distributed as follows: 16 fires; 1,129 emergency medical service; 91 hazardous material services; 183 general service; 98 false alarms; 36 mutual aid.

In 1976, the Department began downsizing from 33 employees to the current number meaning the four operating crews were downsized from eight people to six people each. Each crew usually operates with a four- to five-person contingent because of leave and training schedules.

Five years prior to this incident, the Chief had initiated mutual aid agreements with four other neighboring fire departments, meaning that all departments come to each others' aid when more people and equipment are needed. The assisting department is called to stand-by at the neighboring department's station in the event of need for mutual aid.

DESCRIPTION OF MEDICAL/PHYSICAL MAINTENANCE SERVICES PROVIDED FOR FIRE FIGHTERS

In New York, an interpretation issued by the Public Employee Relations Board mandates that each municipality must negotiate with the appropriate union to determine the content of required physicals and/or physical maintenance programs for public employees such as fire fighters. At the time of this fatality, according to the union representative, there was no such agreement in place between the IAFF and the municipality.

The municipality had conducted fire fighter and respirator medical clearance testing in the past. The last such testing was conducted on March 31, 1995. This testing was done under a contract with a private testing firm. Scheduling of testing was based upon age and restrictions: fire fighters aged 40 and over, and fire fighters with restrictions were scheduled for examinations annually; fire fighters under age 40 were scheduled biannually. Content of the testing included: an occupational and medical history questionnaire; vital signs; spirometry; a physical examination targeting musculoskeletal, cardiovascular, and respiratory systems; a respirator fit

test; and a resting electrocardiogram for those aged 40 and over.

Records indicate that the Chief had last been tested for these clearances in March 1995. There were no records indicating that the Chief had been tested by the municipality since that date. In October 1997, the Department had requested a proposal to reinstate the clearance testing which would have been scheduled for March 1998. There was no contract for these services in place at the time of this investigation. It is unknown if the components of these medical examinations would have detected the Chief's underlying coronary artery disease.

SERVICE HISTORY OF THE DECEASED FIRE FIGHTER

This man had been serving as a fire fighter with Department 1 since 1977. He received his Emergency Medical Technician (EMT) certification in 1978 and was promoted to Lieutenant in the Department in 1985. He was named Fire Chief in 1993. He was a former member of a local volunteer fire department, and a former member of a local volunteer ambulance service. At the time of his death, he was also a coordinator of the New York State Urban Search and Rescue Team, an adjunct instructor of fire science at a local community college, and a member and/or office holder of a number of professional and community organizations.

DISCUSSION

In 1996 (the last year for which full data are available), nine New York fire fighters died in the line of duty. All but one of the nine were involved in fireground activity at the time of the fatal event. The remaining fire fighter died in a fire vehicle accident. Four of the nine (44%) were victims of heart attacks.¹

These data mirror national statistics for the same time period. Data collected by the National Fire Protection Association (NFPA) indicate that forty-nine percent of on-duty fire fighter deaths occurring nationally in 1996 resulted from heart attacks.² NFPA data also indicate that heart attacks have always been the most common cause of on-duty fire fighter deaths since the agency began collecting data in 1978.

Fire fighting 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.³ Climbing the access stairs from the street level to this building, dragging hoses up those stairs, all done in full turnout gear, has a high energy cost. For example, one study of fire fighters climbing stairs in full equipment found that the fire fighters reached 80% of their maximum oxygen consumption and 95% of their maximal heart rate, and required at least 39 milliliters of oxygen per kilogram of body weight per minute.⁴ Other studies have shown similar results.⁵ These sudden and sometimes prolonged increases in heart rate may trigger coronary artery plaque disruption, leading to artery blockage, causing a heart attack and sudden death.⁶⁻⁸ Exposure to the heat of the fire, the stress of directing and/or carrying out firefighting activities, and chronic exposure to the many components of smoke all present an intense burden and corresponding high oxygen demand on the body and heart of a fire fighter.

The events leading to the incident described in this report closely mirror those described above. The Fire Chief had responded to more than one event and was involved in activities similar to those characterized above as extremely strenuous. There were delays in dispatching the alarm which may have allowed the extent of the fire to increase, and thus place additional physical stress on the fire fighters. Although the municipality had provided fire fighters with medical programs in the past, there was no evidence either that these programs were still in place or that the department had acted on or enforced either the respirator or fire fighter clearance classification provided by the contractor in the past. There were no programs in place to enhance cardiovascular/respiratory fitness of these fire fighters.

RECOMMENDATIONS/DISCUSSION

The following is a list of preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks among fire fighters. These recommendations have not been evaluated by NIOSH, but represent research presented in the literature, consensus votes of Technical Committees of the National Fire Protection Association, or labor/management groups within the fire service.

Recommendation #1: Reduce cardiovascular stress, exposure and safety hazards experienced by fire fighters by providing lighter-weight self-protective equipment, such as self-contained breathing apparatus (SCBA).

Discussion: Protective clothing and respirators worn by fire fighters significantly

increase stress on the cardiovascular, respiratory, and temperature regulating systems of the body, decreasing exercise tolerance time by as much as 95.6%, and increasing heart rates.⁹⁻¹¹ Significant and potentially dangerous cardiovascular stress from wearing fire fighter protective gear has been noted even at low intensities.¹⁰ Such increased stress is attributed to the physiological demands of carrying such heavy equipment, as well as reduced capability for evaporative cooling.

Department 1 personnel indicated that the full turnout gear worn by these fire fighters weighs 60 pounds when dry, and even more when wet. The weight of the full ensemble could be reduced by as much as 16 pounds if fire fighters were equipped with lighter-weight low-profile SCBAs. The department currently uses SCBAs with high-profile cylinders. The total unit weighs approximately 35 pounds. Use of newer technology, such as commercially available SCBAs that weigh 19 pounds when equipped with a 30-minute carbon cylinder, would: 1) reduce physical stress on the fire fighter; 2) provide better physical clearance for fire fighters in close situations; and 3) reduce the need to conduct some fire ground activities without the use of SCBAs, thus reducing fire fighter exposures to products of combustion.

Recommendation #2: Implement an overall health and safety program such as the one recommended in NFPA 1500, Standard on Fire Department Occupational Safety and Health Program.¹²

Discussion: NFPA 1500 provides the framework for a safety and health program for fire departments. The specified goal of the standard is to reduce the probability of occupational fatalities, illnesses, and disabilities among fire fighters. NFPA points out that the standard is meant to be appropriate for voluntary compliance tailored to the needs of each individual department. Formal implementation of the standard, particularly the development of a written plan for compliance with NFPA 1500, should include development of fire service occupational health programs outlined both in NFPA 1500 and 1582 (discussed below).

Recommendation #3: Provide fire fighters with periodic medical examinations as required by the Occupational Safety and Health Administration (OSHA), and recommended by NFPA, and the International Association of Fire Fighters/International Association of Fire Chiefs.

Discussion: OSHA's revised respiratory protection standard¹³ requires that employers provide medical evaluations for employees using respiratory protection. OSHA's Fire Brigade standard¹⁴ also requires that the employer assure that employees who are expected to do interior structural fire fighting are physically capable of performing such duties. Further guidance regarding the content and scheduling of periodic medical examinations for fire fighters can also be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters,¹⁵ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.¹⁶

Applying the above OSHA and NFPA standards involves legal and economic implications and must be carried out in a nondiscriminatory manner. Appendix D of NFPA 1582 provides guidance for fire department administrators regarding legal considerations in applying the standard.

Economic implications go beyond the costs of administering the medical program. Department administrators, unions, and fire fighters must also deal with the personal and economic costs of the medical testing results. NFPA 1500 addresses these issues in Chapter 8-7.1 and 8-7.2. The success of medical programs may hinge on protecting the affected fire fighter. The department should provide alternate duty positions for fire fighters in rehabilitation programs, if possible. If the fire fighter is not medically qualified to return to duty after repeat testing, supportive and/or compensated alternatives for the fire fighter should be pursued by the department.

Recommendation #4: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by implementing a wellness/fitness program for fire fighters.

Discussion: NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being. In 1997, the International Association of Fire Fighters and the International Association of Fire Chiefs joined in 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 with a video detailing elements of such a program.¹⁶ These materials should be reviewed by the Fire department to identify elements that would be feasible and effective in their situation.

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Figure 1. Two-story dwelling where fatality occurred.