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NIOSH
Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation *December 3, 2001*

Fire Fighter Has Sudden Cardiac Death During Training - Texas

SUMMARY

On December 2, 1998, a 47-year-old male career Fire Fighter was performing aircraft rescue fire fighting (ARFF) training as mandated by the Federal Aviation Administration (FAA). Two teams of two fire fighters entered the Specialized Aircraft Fire Trainer (SAFT) (see photograph) to extinguish the training fire and "rescue" a 150-pound mannequin. As the victim lifted the mannequin and stood up, he had a witnessed collapse. Approximately 54 minutes later, despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered on the scene and at the hospital, the victim died. The death certificate listed "Atherosclerotic Cardiovascular Disease" as the cause of death. The autopsy revealed moderate to severe coronary artery disease (CAD) and a remote myocardial infarction (heart attack).

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac death among fire fighters. These selected recommendations have not been evaluated by NIOSH, but represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or labor/management groups within the fire service.

- ***Provide mandatory annual medical evaluations to fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- ***Incorporate exercise stress tests (EST) into the Fire Department's medical evaluation program.***
- ***Preclude from full-duty fire suppression those individuals with medical conditions that would present a significant risk to the safety and health of themselves or others.***
- ***Clear fire fighters for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.***
- ***Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***
- ***Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).***

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**

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- ***Ensure an ambulance is on the scene when conducting live-fire training.***

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

- ***Provide automated external defibrillators on fire apparatus.***

- ***Provide adequate fire fighter staffing to ensure safe operating conditions.***

INTRODUCTION AND METHODS

On December 2, 1998, a 47-year-old male Fire Fighter lost consciousness after lifting a mannequin during ARFF training. Despite CPR and ALS administered by crew members, the ambulance crew, and in the emergency department, the victim died. On April 17, 2001, NIOSH contacted the affected Fire Department to initiate the investigation. On May 2, 2001, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Texas to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the following:

- ARFF Coordinator
- Crew members on duty with the victim
- Victim's wife

During the site visit NIOSH personnel reviewed

- Fire Department policies and operating guidelines
- Fire Department training records
- Emergency medical service (ambulance) incident report
- Fire Department physical examination protocols
- Death certificate
- Autopsy record
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On December 2, 1998, thirteen fire fighters from the involved Fire Department participated in Federal Aviation Administration (FAA) mandated ARFF training. The fire fighters boarded an airplane at approximately 0730 hours and flew to the training location at another in-state city, arriving at approximately 0830 hours. During the morning hours, fire fighters were briefed on the day's events and provided classroom training. There were four instructors on site: Attack 1, Safety Officer, Fire Control Officer inside, and Resource Sector. Inside the SAFT, four fires would be set: in the cockpit, galley, cabin, and rear lavatory. One Instructor would be at the front of the SAFT and one at the rear. All teams would consist of two fire fighters, and all participants would wear full bunker gear and SCBA. The teams would enter the SAFT, advance a 1¾-inch hoseline, extinguish the fires, and "rescue" the mannequin.

The group ate lunch at 1200 hours and gathered back at the Fire Training Center at approximately 1245 hours. At approximately 1310 hours, the second fire evolution began. The first group of fire fighters from the involved Fire Department, Team 1, entered the SAFT through the over-wing exit and proceeded forward through the cabin to engage fires in the front of the aircraft (galley and cockpit). The second group of fire fighters from the involved Fire Department, Team 2 (including the victim), entered the SAFT just behind Team 1 and proceeded to the rear of the cabin to fight the fire in the lavatory trash can. The victim, acting as backup person on Team 2, tapped his partner on the shoulder and pointed to the fire in the midsection of the cabin. Team 2 moved forward, extinguished the cabin fire, initiated a secondary search for "victims," and located the mannequin approximately 12 feet from the second rear door. The victim proceeded to pick up the mannequin by squatting down behind the mannequin, placing his arms under the mannequin's arms, and wrapping his

arms around the mannequin's chest. His partner assisted the victim in getting the mannequin in a standing position. The victim then took a half step backward, looked at his partner, and fell backwards onto the floor.

His partner moved the mannequin to the side and assessed the victim, who was unresponsive and not breathing. His partner began to remove the victim from the SAFT. Upon seeing this, the Instructor at the rear of the SAFT radioed Dispatch that a fire fighter was down and assisted in removing the victim from the SAFT. Once outside, the victim's SCBA, which still contained air, and bunker gear were removed and reassessment found the victim unresponsive, pulseless, and not breathing. CPR (chest compressions and mouth-to-mouth ventilations) was begun and oxygen was requested. Assisted ventilations were difficult due to the victim's emesis.

Dispatch notified the local Fire Department at 1316 hours and Engine 43, Ambulance 601, 602, and 605 responded. Other fire fighters went to a building approximately 100 yards away to retrieve oxygen and a bag-valve-mask. Engine 43 arrived on the scene and the automated external defibrillator (AED) carried on Engine 43 was attached to the victim to analyze his heart rhythm. The AED indicated that a shock was advised, and one shock at 200 joules was delivered. The AED analyzed again, no shock was advised, and CPR continued.

Ambulance 605 (two paramedics) arrived and found the victim unresponsive, not breathing, pulseless, and cyanotic. Ambulance 601 arrived at 1318 hours and Ambulance 602 arrived shortly thereafter, and ALS was begun. The AED was disconnected and a cardiac monitor was attached to the victim at 1324 hours. His heart rhythm was found to be in ventricular fibrillation, and one shock at 360 joules was delivered. Numerous attempts at intubation were unsuccessful due to the victim's emesis, and assisted ventilations were continued utilizing suctioning, oral airway, bag-valve-mask, and 100% oxygen. After the first round of resuscitation medications were administered, there was no change in patient status. After three additional defibrillations, the victim's heart rhythm reverted to asystole (no heart beat). The victim was placed on a backboard, loaded into Ambulance 601, and transported to a local hospital at 1344 hours. CPR continued throughout the trip to the hospital. The ambulance arrived at the hospital's emergency department (ED) at 1354 hours. ALS protocols were continued in the ED for 16 minutes until the victim was pronounced dead at 1410 hours.

Medical Findings. The death certificate, completed by the Medical Examiner, listed "atherosclerotic cardiovascular disease" as the immediate cause of death. The carboxyhemoglobin level was 1%, suggesting the fire fighter was not exposed to excessive concentrations of carbon monoxide (CO). Pertinent findings from the autopsy, performed by the Medical Examiner, on December 2, 1998, included

- Atherosclerotic cardiovascular disease
- Moderate to severe narrowing of the coronary arteries
- Mild to moderate narrowing of the aorta
- Mild narrowing of the cerebral arteries
- Remote myocardial infarction, multiple, left ventricle

The Fire Fighter had the following risk factors for coronary artery disease (CAD): family history of CAD, advancing age (greater than 45 years old), male gender, and hypercholesterolemia (275 mg/dl). His triglyceride level was 246 mg/dl. The victim was prescribed a cholesterol-lowering medication and aspirin, both of which he took regularly. According to medical records available to NIOSH, in January 1994, the victim had a myocardial infarction

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(MI)(heart attack) and underwent cardiac catheterization which revealed a "possible" 65% obstruction in the right coronary artery. His January 1994 thallium EST was unavailable for review, and his April 1994 thallium EST reported no change from January 1994. He was subsequently returned to duty by his cardiologist. In September 1997, the victim had another MI (heart attack) and underwent subsequent angioplasty and a coronary artery bypass operation. A subsequent thallium EST was performed in December 1997. The victim exercised for 10 minutes on the Bruce protocol, reaching 13.5 metabolic equivalents (METS) and 85% of his maximum heart rate. He had no ischemic changes or ectopic beats, and he had a normal blood pressure response. However, his thallium study showed a small area of persistent ischemia in the extreme apex of the ventricle and questionable uptake in the right ventricle. Despite the persistent ischemia on his EST, he was released to full duty in January 1998 by his cardiologist.

According to his spouse, the victim did not complain of any symptoms of angina or heart attack 2 days prior to his death. The day prior to his death, the victim worked a 24-hour shift and did not report any symptoms of angina or heart attack to his crew members. On the day of the incident, the victim reported feeling badly to a crew member just prior to their aircraft ride to the training site. The crew member advised him to stay home and take the training later, but the victim preferred to accomplish the training at that time.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 3,269 uniformed personnel and served a population of 1.9 million residents in a geographic area of 618 square miles. There are 87 fire stations, including 3 ARFF stations at two Class B airports.[1] The emergency medical service is part of the Fire Department. Fire fighters work the following schedule: 24 hours on duty, 0630 hours to 0630 hours; 24 hours off duty; 24 hours on duty; then off duty for 5 days. Ten times each year the fire fighter must work an additional day, called a "debit day," typically occurring on the second or fourth day during the 5-day-off schedule. Fire fighters average a 46.7-hour work week.

In 2000, the Fire Department responded to 168,368 calls: 89,068 rescue/medical calls, 31,972 false alarms, 31,956 assist/service calls, 3,379 structure fires, 3,036 motor vehicle fires, 2,516 hazardous materials responses, 2,476 hazardous condition calls, 2,153 rubbish fires, 1,478 wildland fires, 174 other fires outside of structures, 120 mutual-aid calls, 26 other vehicle fires, 14 other fires. The ARFF stations responded to 2,709 calls: 1,839 medical calls and 870 other calls including aircraft fires, false alarms, wildland fires, vehicle fires, and service calls.

The day prior to the incident, the victim worked a 24-hour shift and had responded to one medical call in the airport terminal.

Training. The Fire Department requires all new career fire fighter applicants to complete the following prior to a conditional job offer: must be age 21-35, complete 60 accredited semester college hours with a cumulative GPA of 2.0 or higher OR 1 year of active duty military service with an honorable discharge, reside within a 100-mile radius of City Hall for the past year, pass a pre-hire medical screening, a physical ability test, a reading/math comprehension test, background interview and check, and a polygraph examination. If the conditional job offer is accepted, the applicant must then pass a medical exam and a drug test prior to becoming a fire fighter trainee.

The fire fighter is then sent to the City Fire Academy for the 31-week recruit training course, which consists of 640 hours toward Fire Fighter Level I and II certification, weight training, a physical fitness test, and 240 hours of emergency care-ambulance (ECA) training. All fire fighters are required to complete the State ECA and fire certification examination. Fire fighters are then assigned to a station where they are placed on a 12-month probationary period. There are four levels of fire fighter certification: Basic, Intermediate, Advanced, and Master. Once fire fighters graduate from the academy and complete their probationary period, they are certified as a Basic Fire Fighter. The Intermediate Fire Fighter designation requires 4 years of service and 6 semester hours of Fire Science or 96 hours of completed courses at the National Fire Academy. The Advanced Fire Fighter designation requires fire fighters to complete 8 years of service and 6 additional hours of Fire Science or 96 hours of completed courses at the National Fire Academy. The Master Fire Fighter designation requires fire fighters to have 12 years of service and 60 semester hours which include 18 semester hours of Fire Science or an associate's degree in Fire/Science Technology.

Fire fighters assigned to ARFF or hazardous materials (Hazmat) units receive specialized training to the required levels. Recurrent training occurs daily on shift. The State minimum requirement for fire fighter certification is the 469-hour Fire Fighter course and the 40-hour ECA course. The State requires a minimum of 20 hours training for annual fire fighter recertification. Annual fire fighter recertification is required for ARFF and Hazmat; ECA recertification is required bi-annually. If a Fire Department member has been assigned to a position not directly responsible for structural fire fighting and is reassigned to such a position of responsibility, the member will receive refresher training, including a "live burn," and meet all the minimum standards relating to structural fire fighting. The victim was certified as an Advanced Fire Fighter and an Aircraft Rescue Fire Fighter, and had 23 years of fire fighting experience.

Preemployment/Preplacement Evaluations. The Fire Department requires a preemployment/ preplacement medical evaluation for all new hires, regardless of age. Components of this evaluation include the following:

- A complete medical history
- Vital signs
- Physical examination
- Blood tests: chemical profile (SMAC 20) and complete blood count (CBC) with reticulocyte
- Pulmonary function test (PFT)
- Audiogram
- Vision screen
- Urinalysis

This evaluation is performed by the City physician. Once this evaluation is complete, the physician makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the City's personnel director.

Periodic Evaluations. Periodic medical evaluations and examinations are only offered by this Department to fire fighters who are promoted. The content includes the following:

- Audiogram
- Vision screen
- Blood pressure/pulse
- Urine drug screen

If an employee is injured at work, or is off work for four or more shifts during the year, the employee must be "cleared" by his/her private physician, but the final "return to work" determination is made by the City's Risk Management department. If the employee is injured off duty, and is off work for four shifts or more during the year, the employee must be evaluated by his/her private physician and the "return

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to work" clearance is given to his/her Station Captain, who makes the final determination. Exercise (strength and aerobic) equipment is available in fire stations but is provided by the fire fighters. There is no written physical fitness program; however, the Fire Department has a voluntary fitness/wellness program.

The victim was last cleared for return to work by his private physician in 1998.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.[2] Risk factors for its development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.[3,4] The victim had four of these risk factors (age over 45, male gender, family history of CAD, and high blood cholesterol), and had CAD as determined by his heart attack in 1994 with subsequent cardiac catheterization.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.[5] However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.[6] 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.[7] This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. While no thrombus was noted during the autopsy, atherosclerotic plaques were noted.

Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.[7] 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.[8,9]

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.[10] 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.[11-13] 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) due to the insulative properties of the personal protective clothing.[14] Furthermore, fire fighting can result in severe fluid loss which decreases both blood volume and stroke volume (the amount of blood pumped from the heart).[15] Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.[16-19] The victim, wearing full bunker gear and breathing air from an SCBA (weighing a total of approximately 35 pounds), had entered the burning SAFT, assisted with fire extinguishment, then lifted the 150-pound mannequin. This is considered a heavy level of physical exertion.[13,20-21]

To reduce the risk of heart attacks and sudden cardiac arrest among fire fighters, the National Fire Protection Association (NFPA) has developed guidelines entitled "Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians," otherwise known as NFPA 1582.[22] NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity

test.[22] NFPA 1582 also recommends a thorough examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year). The Fire Department requires a preemployment/preplacement medical examination for all new hires, and a medical examination for promotions, but does not require periodic medical evaluations for all fire fighters.

NFPA 1582 also lists medical conditions that **should** (Category A) or **could** (Category B) preclude individuals from performing fire fighting activities.[22] Appendix A notes that persons with coronary artery disease, including history of myocardial infarction and coronary artery bypass surgery, are considered Category B, and that persons at mildly increased risk for sudden incapacitation are acceptable for fire fighting. Mildly increased risk includes the absence of exercise-induced ischemia by exercise testing. However, since ischemia was identified on his last EST, the victim's medical conditions would be considered Category B (conditions that would have precluded him from fire fighting duties).

RECOMMENDATIONS

The following recommendations address health and safety generally. It is unclear if any of these recommendations could have prevented the sudden cardiac arrest and subsequent death of this Fire Fighter. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but represent published research or consensus votes of Technical Committees of the NFPA or labor/management groups within the fire service.

Recommendation #1: Provide mandatory annual medical evaluations to fire fighters 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 Medical Requirements for Fire Fighters and Information for Fire Department Physicians,[22] and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.[23]

Recommendation #2: Incorporate exercise stress tests (EST) into the Fire Department's medical evaluation program.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend at least biannual EST for fire fighters.[22-23] They recommend that these tests begin at age 35 for those with CAD risk factors and at age 40 for those without CAD risk factors. The EST could be conducted by the fire fighter's personal physician or the City's physician. If the fire fighter's personal physician conducts the test, the results must be communicated to the City physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Recommendation #3: Preclude from full-duty fire suppression those individuals with medical conditions that would present a significant risk to the safety and health of themselves or others.

NFPA 1582 lists medical conditions that **should** (Category A) or **could** (Category B) preclude individuals from performing fire fighting activities.[22] We recommend that fire departments adopt these recommendations and share this Standard (NFPA 1582) with physicians responsible for these decisions.

Recommendation #4: Clear fire fighters for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.

Physicians providing input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published in NFPA 1582. To ensure private physicians are aware of these guidelines, we recommend that the City physician provide them with a copy of NFPA 1582. In addition, we recommend the City physician not automatically accept the opinion of the employee's private physician regarding return to work, depending on the victim's condition and injury/illness, and the job duties of the victim. The final decision regarding medical clearance for return to work lies with the City physician with input from many sources including the employee's private physician.

Recommendation #5: 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 is associated with other risk factors, namely obesity and diabetes.[24] NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.[25] 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.[23] The Fire Department and the Union should review these materials to identify applicable elements for their Department. Other large-city negotiated programs, such as Tulsa, Oklahoma, can also be reviewed as potential models.

Recommendation #6: Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.[26] 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 following this standard, and a copy of the OSHA medical checklist has been provided to the Fire Department.

Recommendation #7: Ensure an ambulance is on the scene when conducting live-fire training.

The FAA requires that all aircraft rescue and fire fighting personnel at a full certificate airport participate in at least one live-fire drill every 12 months.[27] NFPA 1500 requires that any training involving live fire-fighting exercises shall be conducted in compliance with NFPA 1403.[25]

NFPA 1403 requires that emergency medical services be available on site to handle injuries.[28]

At this incident, no medical equipment was immediately available.

Recommendation #8: Provide automated external defibrillators (AEDs) on fire apparatus.

This finding did not contribute to this fatality, but was identified during the NIOSH investigation. Preservation of human life is the primary responsibility of the fire department during fires and other emergencies. Fire departments should be prepared to perform rescue work and provide emergency care for those injured.[29] Such injuries include cardiac arrest. Most of the sudden cardiac deaths in the United states result from ventricular fibrillation. The chain of survival from cardiac arrest includes (1) early access to the emergency medical system (EMS and 9-1-1 system), (2) early CPR, (3) early defibrillation when indicated, and (4) early advanced emergency treatment.[30] AEDs have caused the cardiac arrest survivability rate to increase from 7 percent (CPR performed only) to 26 percent. When defibrillation is provided within 5-7 minutes, the survival rate is as high as 49 percent.[31] To provide emergency medical care, adequate supplies and equipment should be available to treat bleeding, fractures, cardiac arrest, etc. Placing AEDs on fire apparatus, including ARFF vehicles, in addition to those defibrillators carried on ambulances, would allow the Fire Department to provide a greater level of emergency medical care to the public.

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

This finding did not contribute to this fatality, but was identified during the NIOSH investigation. Currently on each shift, two ARFF personnel staff the ambulance and one ARFF person staffs the ARFF vehicle, depending on the function of the vehicle. The primary objective of ARFF personnel at the scene of any aircraft accident is to control and extinguish the fire to enable safe evacuation of the aircraft. NFPA 403 recommends that "during flight operations, sufficient trained personnel be readily available to staff the rescue and fire-fighting vehicles and to perform fire-fighting and rescue operations."[32] Rescue operations should begin as soon as conditions permit and often are a simultaneous function during the fire fighting phase that requires considerable coordination. One rescue team method consists of four ARFF personnel equipped with full protective clothing and positive pressure SCBA. Two of the persons are handline operators and precede the other two, who are equipped with appropriate hand-held tools needed for forcible entry, extrication, and making access to hidden fuselage fires behind panels, floors, and compartments.[33] Understaffing causes those members on the scene to work harder and for longer periods of time and impacts the safety and survivability of aircraft passengers. ARFF companies should be staffed with two personnel at a minimum, provided that at least two ARFF vehicles respond to the same emergency, providing a total of four ARFF personnel at the scene. Otherwise, ARFF vehicles should be staffed with four personnel.

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INVESTIGATOR INFORMATION

This investigation was conducted by and the report written by Tommy N. Baldwin, MS, Safety and Occupational Health Specialist. Mr. Baldwin is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component, located in Cincinnati, Ohio.