

LINE OF DUTY DEATH REPORT

F2023-02 • January 2024

1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

38-Year-Old Volunteer Recruit Firefighter Dies During SCBA Confidence Training at Fire Academy—California

Executive Summary

On February 19, 2023, a 38-year-old recruit volunteer firefighter (Recruit) suffered a fatal medical event while participating in the county's joint firefighter academy (JFA). The Recruit was in week seven of the 19-week academy participating in the firefighter safety and survival training.

The firefighter safety and survival training was a 24-hour course based on state fire marshal curriculum and included one day of classroom instruction and two days of hands-on skills training. One of the skills taught included having recruits become familiar with their self-contained breathing apparatus (SCBA) in a confidence maze. The maze was designed to simulate obstacles a firefighter might encounter during a fire or building collapse.

The training was being taught at a three-story training tower made of six shipping containers. The training tower had three containers on the first story, two containers on the second story, one container on the third story, and an observation deck on top (Figure 1).

The maze was located on the third story of the training tower which included a walk-in door, two windows, a roof vent, and the maze. The maze was built by academy staff and was three levels within the third-story container, made of plywood and dimensional lumber. Obstacles in the maze include diminishing clearances, small openings, wire, and mattress spring entanglements, collapsed walls/floors, and confined spaces.

The incident occurred on the morning of the second day of skills training, which began at 0700 with physical training (PT), stretching, a safety briefing, instructor roles, and a video. At 0900 hours the recruits were divided into four groups that rotated through five types of self-rescue exercises.

The Recruit had completed the first four exercises, and he was working his way through the maze when he became unresponsive. The maze was designed to allow an instructor to stay in verbal communication and observe the recruits as they navigated through the obstacles. The Recruit was approximately six feet from completing the maze when he had difficulty finding the exit, which was an



Figure 1. The training tower involved in the incident. Photo by NIOSH.

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opening between the middle and bottom levels of the maze. The Recruit told the instructors he was “freaking” because he was having difficulty finding the way out. The instructors reassured him he was ok and told him to relax and breathe as they helped him find the opening to the bottom level and exit. With the assistance of the instructors, the Recruit was in a sitting position with his legs in the opening to the first level, he lowered his SCBA in front of him and proceeded through the opening towards the maze exit (See Figure 4). However, as he transitioned through the opening, he became unresponsive and slumped to the ground on the first level.

The maze instructor immediately told the assistant working with him to open the maze emergency doors (Figure 3) and remove the Recruit from the opening. The maze instructor then alerted the lead instructor who was outside of the incident location. The maze instructor and lead instructor both arrived to find the assistant instructor performing cardiopulmonary resuscitation (CPR) after pulling the Recruit from the maze, CPR was initiated at approximately 1058 hours and the Emergency Communication Center (ECC) was advised of a firefighter down and a request was made for both ground and air advanced life support (ALS) transport due to the remote training location. Approximately 20 minutes later, ALS arrived and assisted with resuscitation efforts at the scene. At approximately 1149 hours, medics and nurses stopped resuscitation efforts and requested the coroner to the incident.

Key Recommendations

NIOSH investigators offer the following recommendations to reduce the risk of sudden death among firefighters training at this, and other fire departments across the country.

- *Key Recommendation #1: Implement a systematic risk assessment for training programs in accordance with NFPA standards.*
- *Key Recommendation #2: Implement procedures for safe exit in accordance with NFPA 1500 Standards as the 3rd story maze’s sole access by exterior ladder did not allow for rapid evacuation in a medical emergency situation.*
- *Key Recommendation #3: Consider implementing physiological monitoring system to protect firefighter health.*
- *Key Recommendation #4: Fire training facilities shall appoint a safety officer to review the planned exercises and actively observe all training activities in accordance with NFPA Standards.*

The National Institute for Occupational Safety and Health (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 Web site at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Introduction

On February 19, 2023, a 38-year-old Recruit suffered a fatal medical event while participating in the JFA. The National Institute for Occupational Safety and Health (NIOSH) received notification of this fatality through the U.S. Fire Administration email updates service on March 13, 2023. NIOSH contacted the affected department to gather additional information and initiate the investigation.

A medical officer and a contract firefighter safety specialist with the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) conducted the investigation. Beginning in August 2023, the firefighter safety specialist conducted a series of telephone, email, and in-person interviews to investigate the incident.

During the investigation, the NIOSH investigators interviewed the following people:

- *Fire Chief*
- *Deputy Fire Chief-Operations*
- *Battalion Chief-Training*
- *Academy Director*
- *Academy Instructors*
- *Coroner*
- *Family Members*

The NIOSH investigator reviewed the following documents:

- *Fire department (FD) hiring requirements and standard operating procedures*
- *FD medical examination policies*
- *Recruit hiring medical examination records*
- *Autopsy and toxicology reports*
- *Students written statements*
- *Academy course syllabus*
- *Self-contained breathing apparatus (SCBA) mechanical evaluation report*

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Fire Department

At the time of the NIOSH investigation, the county volunteer FD had seven fire stations with 64 members. The FD served a population of approximately 22,450 citizens in a geographic area of about 250 square miles and responded to approximately 2,300 calls annually. The FD had the following equipment:

- 5 - Type I engines
- 7 - Type III engines
- 5 - Light rescues
- 4 - Water tenders

The volunteer FD ranks included:

- Volunteer Firefighter
- Volunteer Driver/Operator
- Volunteer Fire Captain

Employment and Training

This FD accepted volunteers who were:

- At least 18 years of age
- Eligible to work within the United States, either as a citizen or through an appropriate work visa
- Able to understand and follow oral/written instructions in English as demonstrated during an oral interview with the company officer and field battalion chief.

Prospective volunteers were also required to attend a minimum of three training meetings of the county FD within a two-month period prior to starting as a fully qualified volunteer firefighter with this FD. Applicants were advised of the county academy process which required the submission of:

- Two letters of reference
- Valid California (CA) driver's license
- Proof of CA vehicle liability insurance
- CA Department of Motor Vehicles printout confirming current vehicle registration
- Pass Live Scan background check
- Be in good physical condition and able to perform the essential job tasks required to be a firefighter
- Pass Candidate Physical Ability Test (CPAT)

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Once the above requirements were complete, applicants had to schedule and pass a medical/physical exam through the county fire staff. The Recruit had successfully completed six of the 19-weeks of the Joint Fire Academy (JFA) training course and was participating in week seven when he died.

Joint Fire Academy

The JFA includes five fire agencies, representing both municipal and volunteer firefighters. The JFA's recruit firefighter training course was a program conducted over a 19-week period, totaling 505 hours of instruction and training. Students who successfully completed the 19-week academy were eligible for volunteer or paid call positions within their sponsor agency. The JFA training days were Monday and Wednesday 1700 to 2200 hours, and Saturday and Sunday 0800 to 1700 hours. Recruits were also required to attend one hour of physical training on weekends before class began. Each sponsoring agency provides instructors to the JFA, and the weekly schedule includes:

- Week 1 – JFA Introduction - Rules of Engagement - Health and Safety - PPE/SCBA
- Week 2 – Fire Extinguishers - Ladders
- Week 3 – Ladders - Fire Hose
- Week 4 – Fire Hose - Water Systems
- Week 5 – Building Construction - Tools - Forcible Entry
- Week 6 – Ropes & Knots - Lighting; Overhaul - Air Monitoring - Search & Rescue - Vent Enter, Isolate, Search
- Week 7 – Utilities - Firefighter Safety and Survival*
- Week 8 – Critical Incident Stress Management - Ventilation
- Week 9 – ICS 200 - Fire Control 3 (Live Fire)
- Week 10 – Wildland - Vehicle Extrication
- Week 11 – Wildland
- Week 12 – Confined Space - Wildland
- Week 13 – Wildland - Hazmat - Auto Fire
- Week 14 – Confined Space - Wildland
- Week 15 – Wildland - Helicopters
- Week 16 – Fire Extinguishers - Ventilation - Skills Practice
- Week 17 – Hydrants - Low angle rescue operations
- Week 18 – Written/Skills Testing
- Week 19 – Clean up - Graduation

*The incident occurred on the third day of week seven during Firefighter Safety and Survival Training.

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JFA participants will complete the following courses and receive completion certificates for:

- Look Around, Communications, Exit Routes, and Safety Zones (county course)
- Low-angle Rope Rescue (county course)
- Auto Extrication (county course)
- Firefighter Survival (state course)
- Federal Emergency Management Agency (FEMA) IS-100 Introduction to the Incident Command System
- FEMA IS-200 Basic Incident Command System For Initial Response
- FEMA IS-700 An Introduction to the National Incident Management System
- National Wildland Coordinating Group (NWCG) L-180 Human Factors in the Wildland Fire Service
- NWCG S-130 Firefighter Training
- NWCG S-131 Firefighter Type I Training
- NWCG S-133 Look Up, Look Down, Look Around
- NWCG S-190 Introduction to Wildland Fire Behavior
- Occupational Safety and Health Administration (OSHA) Hazardous Materials First Responder Operations

Entry Level Preplacement Medical Evaluation

A medical examination by the county designated physician was required for all applicants and included:

- Stress electrocardiogram (EKG)
- Substance abuse drug test
- Documented medical and respiratory history
- Vital signs and physical examination
- Vision acuity and peripheral vision testing, including color perception
- Pulmonary function testing performed by a certified OSHA nurse
- Audiometry performed by a certified OSHA nurse
- Physical capacity evaluation performed by licensed physical therapist
- Blood tests including metabolic chemistry panel, hemoglobin & hematocrit, lipid panel, and liver function test panel)
- Microscopic urinalysis
- Tuberculosis skin test
- Additional tests as necessary

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The Recruit passed the preplacement evaluation without any exceptions in November 2022, four months prior to the incident.

Wellness/Fitness Programs

The JFA required all students to participate in a physical fitness program for one hour each morning prior to class. Physical fitness exercises varied each day depending on the physical demand of that day's training activity. According to the JFA staff, the Recruit was considered fit and had no identified physical limitations.

Weather

February 19, 2023, at 1000, it was partially cloudy with a temperature of 68°F with 5 mile per hour southeasterly winds. Humidity was approximately 50 percent, with a heat index of 66.8°F [<https://www.wunderground.com>].

Personal Protective Equipment

All JFA recruits were provided full personal protective equipment (PPE) including structural turnout pants, coat, hood, gloves, and helmet. Each recruit was also issued a SCBA.

Full PPE and SCBAs were required in the maze. However, most recruits navigating their way through the maze had to remove the air pack to fit through the diminishing clearance obstacle. Students were instructed to pull their hoods over their SCBA mask to block out light.

SCBA

The Recruit was assigned a new 3M Scott X3 Air-Pak SCBA with Scott AV-3000 face piece prior to the JFA. At the time of the incident, the Recruit had already removed his regulator and was breathing ambient air because he had used up the 45-minute bottle. The JFA was not using simulated smoke in the maze.

After the incident, the SCBA unit, including air cylinder and mask, was taken by law enforcement to the coroner's office for testing. The coroner worked with the manufacturer, sales representatives and the fire agency for testing and it passed all tests (see Appendix A).

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SCBA Maze

The maze was built inside a shipping container on the third story of the training building. Access from the second story to the third story was by ladder only.

The maze was approximately 80 feet in total distance for students from entrance to exit. It measured 17 feet deep, 8 feet wide, and 9 feet high. It was divided into three levels (Figure 2).

There were two emergency exits in the form of hinged wooden doors, located at the front of the prop at the top and middle levels with skirting at the bottom level to reduce incoming light into the maze (Figures 3 and 4). Emergency exit access was less than 20 feet from any area within the maze. This was within the recommended 50 feet maximum identified by NFPA 1402 *Standards on Training for Fire Facilities and Props, Section 11.3.1 Technical Rescue Training Props*.



Figure 2. SCBA maze with three levels. Arrows pointing to middle level open emergency door and raised drape to bottom level. Photo by NIOSH.



Figure 3. Maze with closed emergency access doors to middle and top levels and skirting lowered at bottom level. Photo by NIOSH.



Figure 4. Cross section of the maze showing direction of movement and red oval indicates location where the Recruit collapsed. Blue arrows indicate hose line recruits used as a guide. Photo by NIOSH.

There were two instructors inside the maze building; a primary instructor and an assistant instructor. There was no safety officer. The primary instructor was inside the maze and provided direct supervision of recruits. Students entered the maze on the right side of the bottom level and would proceed to the rear corner while the primary instructor maintained visual and verbal contact with them. The assistant instructor was located outside of the maze itself and assisted with the coordination of recruits entering the maze and with emergency situations, if needed.

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There were no significant obstructions in this first section as the recruits entered and a hoseline was used as a guide for the recruits to follow the correct path as they went through the maze. Recruits encountered different obstacles such as diminished clearance, mattress springs, debris, inclines, and declines (Figures 5–8).



Figure 5. View from top to middle level. Photo by NIOSH.



Figure 6. Diminished clearance. Photo by NIOSH.



Figure 7. Decline to top of bottom level. Photo by NIOSH.



Figure 8. Middle level to bottom level that leads to exit with location of Recruit's collapse indicated by red oval. Photo by NIOSH.

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Investigation

On February 19, 2023, at approximately 1100 hours, a 38-year-old Recruit firefighter died while participating in the JFA SCBA confidence maze training exercise. The incident occurred on the third day of firefighter safety and survival training during week seven of the 19-week academy.

The day started with PT at 0700 hours. Since the training exercises scheduled for the day were considered to be moderately strenuous, the recruits did stretches as a light workout beforehand. At 0800 the recruits assembled for a safety briefing, overview of the morning's exercise including instructor responsibilities and procedures for rotating through the five exercises along with a training video. The recruits were then divided into four companies that rotated through five firefighter safety exercises. All recruits wore full structural firefighter turnout gear and SCBA as they participated in each exercise for the first time. The exercises included:

- 1) Window hang from first story (low exertion exercise): Each recruit went through a rotation once and learned to hang out of a window on the first story by a single arm and leg awaiting rescue.
- 2) Window hang with safety from second story (low exertion exercise): Similar to first story window hang, but on the second story while on safety line.
- 3) Ladder to window (medium exertion exercise): Each recruit deployed a ladder just below the window to rescue a firefighter.
- 4) Ladder bail (medium exertion exercise): Each recruit learned to exit headfirst from window onto rescue ladder.
- 5) Blinded SCBA confidence maze (medium exertion): Each recruit had their facemask covered with a hood to simulate darkness. There was no smoke, (simulated or real) as they navigated through a maze containing several obstacles that may be encountered during a structure fire or building collapse. Although not extremely demanding physically, being blinded while trying to navigate confined spaces while wearing an SCBA on air can add to psychological stress that can impact air consumption rates [Bustos et al. 2023; Li et al. 2023b].

The Recruit had successfully completed the first four exercises prior to the entering the maze as his fifth exercise without any problems. The maze instructors stated that they did not observe any distress or concern by the Recruit as he began the maze exercise.

The Recruit entered the maze at approximately 1030 hours wearing full PPE and SCBA with a full 45-minute cylinder on air. His hood was pulled over his facepiece to add darkness for the exercise. The instructors stated that while frustrated, the Recruit did not seem overwhelmed as he navigated through the obstacles. Like most recruits, he had to remove his SCBA harness and cylinder to proceed through the diminishing clearance portion of the prop, but he remained on air. About halfway through the maze, he ran out of air and had to disconnect his regulator. From that point, he left his mask on and was breathing ambient air through the regulator opening.

The instructors noted that fifteen of the classmates who completed the maze before the Recruit were able to do so in 15–20 minutes while still on air, and some of the classmates made it through without the personal alert safety system (PASS) going off.

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With his SCBA and regulator removed, the Recruit continued through the maze pushing his SCBA in front of him. The instructors stated that it never appeared as though the Recruit had difficulty breathing with a donned mask and disengaged regulator, even with his hood covering the regulator opening. He interacted and talked with the instructors as he continued through the maze passing through the diminished clearance, hanging wires, and mattress springs obstacles without sounding anxious or short of breath. He began having difficulty finding the path when he was nearing the end of the maze and could not find the exit of the maze, which was an opening from the middle level to the first level. Although this section of the maze had fewer obstacles, the Recruit could not orient himself and stated he was having difficulty as he tried to find the opening to the lower level and exit. The instructors tried to reassure him that he was almost out and to relax and just breathe. As they reassured him, they physically guided him to the opening that led to the lower level and exit.

The Recruit was still breathing ambient air as he sat on the floor of the middle level compartment with his legs hanging in the opening that led to the bottom level. He lowered his SCBA to the assistant instructor through the opening below who was assisting him to the exit. As he started to transition himself through the opening, he became quiet. The maze instructor asked him if he was ok, and there was no response. The Recruit became unresponsive as he was transitioning from the middle level to the bottom level as identified in Figures 4 and 8. The maze instructor noticed the Recruit was now slumped halfway through the opening. The instructor removed the Recruit's helmet and mask and heard agonal breathing, so he yelled to the assistant to remove him from the maze. When the assistant opened the maze emergency door at the middle level. He found the Recruit in a kneeling position on the bottom level with his arms in resting on the middle level and his head hanging between his arms. After moving the Recruit's position in the opening, the assistant instructor was able to remove him from the bottom level.

As the maze instructor went outside to notify the lead instructor of the incident and retrieve medical equipment, the assistant instructor removed the Recruit from the maze. After removing the Recruit, the assistant instructor noticed cyanosis around the Recruit's mouth. When the lead instructor arrived to investigate, CPR had already been started by the assistant instructor. First aid equipment and the automated external defibrillator (AED) were brought to the maze, and the ECC was called to request both air and ground ALS transport since there was no ALS capability available onsite.

Due to access issues, a ladder system had to be set up before the Recruit could be lowered by a stokes basket to the second story (Figure 9). As other recruits set up the ladder slide system, instructors continued CPR and BLS, including a supraglottic airway as the Recruit was not breathing and did not have a detectable pulse.

Initially, the AED did not indicate a shockable rhythm. The ALS ground ambulance was on scene when the Recruit was lowered to the ground. The AED unit noted that CPR was interrupted less than ten seconds as he was lowered to the second story. An air transport nurse and ALS medic arrived and



Figure 9. Ladder slide demonstration showing how the Recruit was lowered to the second story of the tower. Not from actual tower. Photo courtesy of Lee & Associates.

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assisted in treatment. Intraosseous access was obtained, and epinephrine and sodium bicarbonate were administered at which time the AED indicated a shockable rhythm, with one shock administered. At approximately 1149 hours, the ECC was notified that resuscitation efforts were halted by ALS nurse and medics when the recruit's time of death was noted, and the coroner was requested.

Table 1. Incident Timeline (some times are approximate)

10:56 Recruit down, academy instructors notified, CPR started
10:58 Radio call to ECC for firefighter down, request ALS ground and air ambulance
10:58 ECC dispatches additional engines, FD staff and ambulances to scene
11:00 Academy recruits and staff begin building ladder slide to remove victim
11:06 Air ambulance accepts mission
11:10 Engine arrives at scene
11:12 Air ambulance en route
11:14 Ground ALS ambulance arrives
11:17 Recruit lowered to ground via ladder slide
11:18 Ground ALS ambulance crew take over patient care
11:29 Air ambulance arrives at scene, administers medication and AED shock
11:49 ECC advised that medics/nurse called the resuscitation efforts and requested coroner

Cause of Death

The medical examiner listed the cause of death as sudden unexplained death during blinded training exercise involving a confined space and self-contained breathing apparatus. Other significant conditions were myocardial arteriosclerosis with patchy mild perivascular fibrosis, dilated left ventricle and prolapsed mitral valve. The Recruit did not receive any significant trauma, nor was there evidence of electrocution, hyperthermia, or asphyxia from impingement. The toxicology report indicated no evidence of carbon monoxide or ketoacidosis.

Medical Findings

The Recruit was 38 years old, 5'10" tall, and weighed 172 lbs., with a body mass index (BMI) of 24 which is in normal range [CDC 2022]. His pre-hire medical exam was completed three months prior to the incident with no noted medical concerns and overall health was good. His stress EKG was 12.8 METS, maximum heart rate of 162 and resting heart rate of 93 beats per minute (bpm).

Discussion

The coroner's report stated that the most likely mechanism of death was cardiac arrhythmia triggered by the physical and/or psychological stress of the exercise. Physical and psychological stress of training in confined spaces such as the SCBA confidence maze has been documented. One study

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indicated that heart rate during self-contained breathing apparatus confidence course (SCBACC) can produce physiological strain greater than circuit training and similar to live fire training (LFT) [Wilkinson et al. 2020]. In this study, SCBACC resulted in a sustained heart rate at 100% of age-predicted maximal values and should be considered as physiologically stressful as LFT. Exposure to extreme heat and physical exertion during fire suppression activates platelets, increases thrombus formation, impairs vascular function, and promotes myocardial ischemia and injury in healthy firefighters. These findings may explain the association between fire suppression activity and acute myocardial infarction in firefighters. Wearing an SCBA also elicits thermoregulatory, metabolic, and psychological stress. Cardiovascular stress can lead to sudden cardiac arrest (SCA) when the heart suddenly fails to pump blood. If the individual does not survive, the term sudden cardiac death (SCD) is used. These events mostly occur in patients with structural heart disease (that may not have been previously diagnosed), particularly coronary heart disease (CHD) [Hunter et al. 2017; Li et al. 2023a; Li et al. 2023b].

SCD is the leading cause of death among U.S. firefighters. About 90% of SCD incidents are attributed to CHD and normally occur in those over 45 years old. The most common underlying pathologic reason for SCD in firefighters less than 45 years of age was CHD, often with cardiomegaly [Yang et al. 2013].

This Recruit was 38 years old and had no known history of heart disease, but his autopsy showed myocardial arteriosclerosis with patchy mild perivascular fibrosis, dilated left ventricle and prolapsed mitral valve. Perivascular fibrosis is the deposition of connective tissue around the vessels. This can impair blood flow to the heart muscle and has been associated with enlargement of the heart (dilated left ventricle). A prolapsed mitral valve is when the valve flaps don't close completely, and the blood flows backwards when the heart contracts. This can be caused by enlargement of the ventricle. These findings indicate that the Recruit had underlying heart disease that may have made him more likely to have an arrhythmia and SCD during the physiological stress of maze training. The Recruit had completed a pre-hire stress test and reached 12.8 METS, indicating that he was capable of performing strenuous activities. This result would have passed an annual NFPA physical for a member 40 years of age or older with an estimated intermediate risk 10-year risk of atherosclerotic cardiovascular disease (ASCVD) using the 10-year Heart Risk Calculator which requires a member to perform at ≥ 12 METS on an exercise stress test [AHA/ACC 2018; NFPA 2022].

There was one lead instructor and ten instructors involved with the firefighter safety and survival training that day. Two of those instructors were present at the SCBA maze. One maze instructor was assigned inside the maze allowing for direct communication of the recruits as they worked their way through the maze. The other instructor assisted with the coordination of the recruits as they began and finished the course.

Although there was an Incident Commander (IC) who was also the safety officer, there was not a dedicated safety officer assigned to the SCBA course as recommended by NFPA 1404. This was also noted as a factor in an earlier firefighter fatality that involved SCBA confidence training in a maze [NIOSH 2022].

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Recommendations

Recommendation #1: Implement a systematic risk assessment for training programs in accordance with NFPA 1500 Standard on Fire Department Occupational Safety, Health, and Wellness Program and NFPA 1561 Standard on Emergency Services Incident Management System and Command Safety.

Discussion: An incident action plan (IAP) was available with basic safety message stated on the ICS 208 form. The formal written plan shared with instructors and recruits stated all injuries should be reported to the IC/Safety Officer. The IAP did not identify a specific course of action in the event of a medical incident or injury occurring during training. The IAP did not identify a risk assessment of the specific exercises being taught, including the SCBA confidence course. NIOSH recommends that a written risk assessment or IAP be completed for all hands-on fire training, and that instructors and participants be informed of the risks and the plans/procedures prior to the start of the training event. In addition, all instructors should be adept at recognizing students that may be presenting signs and/or symptoms of potential risk, such as increased air consumption, confusion, disorientation, inability to follow directions, etc.

The plan should consider potential risk or injury to all members and the actions that can be taken to mitigate those risks. Training scenarios can include many risks, including but not limited to:

- Musculoskeletal injuries (e.g., strains and sprains)
- Overexertion, which might lead to heat-related illnesses
- Falls
- Cardiac events

The emergency medical capabilities that should be considered include, but are not limited to, the following:

- The provision of pre-placed equipment and supplies (e.g., defibrillators, backboards, emergency kits)
- The availability of emergency medical services (EMS) staffing
- The availability of transport capabilities

For non-live fire training exercises, fire departments shall conduct a risk assessment to determine the appropriate emergency medical capabilities to be available at the training site.

Recommendation #2: Implement procedures for safe exit in accordance with NFPA 1500 Standard on Fire Department Occupational Safety, Health, and Wellness Program.

Discussion: NIOSH recommends in NFPA 1500, page 19 Chapter 5.1.10, “training programs for all members engaged in emergency operations shall include procedures for the safe exit and accountability of members during rapid evacuation, equipment failure, or other dangerous situations and events”.

In this incident, the maze was on the third story of the training facility with no access by stairs. A ladder was in place for the recruits to access the third story, but the single ladder was not sufficient to

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extricate the Recruit. A system had to be built and CPR had to be stopped for approximately ten seconds to lower him to the ground.

Recommendation #3: Consider implementing physiological monitoring system to protect firefighter health.

Discussion: There are real-time physiological monitoring systems currently available to monitor the health of firefighters during training and real incidents. Although real-time monitoring of recruits during training exercises is not required by NFPA 1584, these systems may help identify recruits in distress and facilitate their early removal to medical care before they experience a catastrophic medical event. While the science is not exact, studies indicate that they can be useful to assess the potential risk of sudden cardiac death [Bustos et al. 2023; Li et al. 2023a].

Recommendation #4: Fire training facilities shall appoint a safety officer to review the planned exercises and actively observe all training activities in accordance with Standard for Fire Service Respiratory Protection Training NFPA 1404.

Discussion: NIOSH recommends following guidance in NFPA 1404 which states that “a safety officer shall be appointed for all respiratory protection evolutions.... The safety officer has the authority, regardless of rank, to intervene and control any aspect of the operations when, in his or her best judgement, a potential or actual danger, accident, or unsafe condition exists. The safety officer shall provide for the safety of all persons on the scene, including students, instructors, visitors, and spectators. The safety officer shall not be assigned to other duties that interfere with safety responsibilities” [NFPA 2018].

In this incident, a safety officer was not assigned to the SCBA confidence course maze. Although, the Recruit did not alert the instructors that he was having difficulty, he had completely used the air from his 45-minute bottle before getting halfway through the maze, while the other recruits were completing the maze while still on air. Rapid breathing with increased air consumption can be an indicator of stress or medical distress. This may have been an indicator that a student is having a medical issue and consideration should be given to stopping the exercise to appropriately evaluate the recruit.

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Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiac/Medical Team, in Cincinnati, Ohio. Co-author TJ Welch is a Firefighter Safety Specialist that has worked in volunteer, industrial and municipal fire departments. Mr. Welch is a State Certified Fire Officer, founding member of the California Incident Command Certification System, and chaired the CICCSC committee on Physical Fitness Standards. Dr. Robert Harrison MD, MPH (California Department of Public Health) provided medical consultation, and Laura Styles, MPH (Public Health Institute) also contributed to this report.

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Appendix A

SCBA Test Results



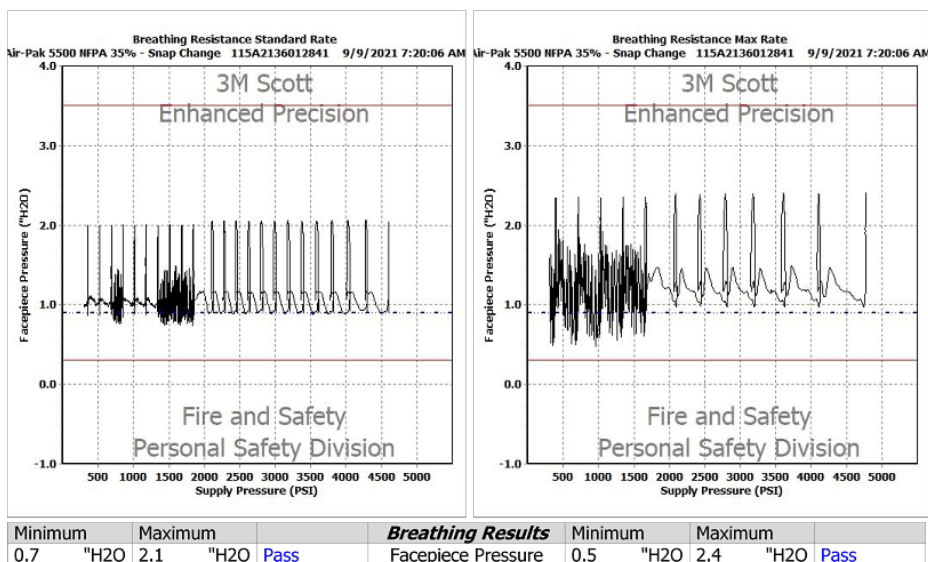
Posi3 USB Test Results Functional Test

9/9/2021 7:20:06 AM

Scott
Air-Pak 5500 NFPA 35% - Snap Change
Unit ID: 115A2136012841

Posi3 USB serial # U07611 - Calibration was up to date when the test was performed

Auxiliary IDs		Functional Tests			
Regulator	115S2136011247	Exhalation Pressure	Pass	1.9	"H2O
Reducer	115S2133015064	Facepiece Leakage	Pass	0.1	"H2O
Project Number	692545	Positive Pressure	Pass	0.9	"H2O
		Primary Lockup	Pass	98.0	PSI
		Primary Creep	Pass	-0.4	PSI
		Air Saver Switch Activation	Pass	-4.2	"H2O
		Transfer	Pass	1856	PSI
		Secondary Lockup	Pass	160.5	PSI
		Secondary Creep	Pass	-0.5	PSI
		High Pressure Leakage	Pass	28	PSI
		Secondary Pr. at High Cylinder	Pass		
		Purge	Pass	210	L/min
		Alarm Activation Pressure			
		5500 Vibralert (35%)	Pass	1856	PSI
		Gauge Accuracy			
		5500 Numbers	Pass		
		2000 PSI	Pass	3000 PSI	4000 PSI
		Pass 2256	Pass 3089	Pass 4078	



Tested by : Kristen Miller
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Appendix B

Training Tower



Figure B1. ALPHA SIDE. Photo by NIOSH.



Figure B2. BRAVO SIDE. Photo by NIOSH.



Figure B3. CHARLIE SIDE. Photo by NIOSH.



Figure B4. CHARLIE/DELTA VIEW. Photo by NIOSH.