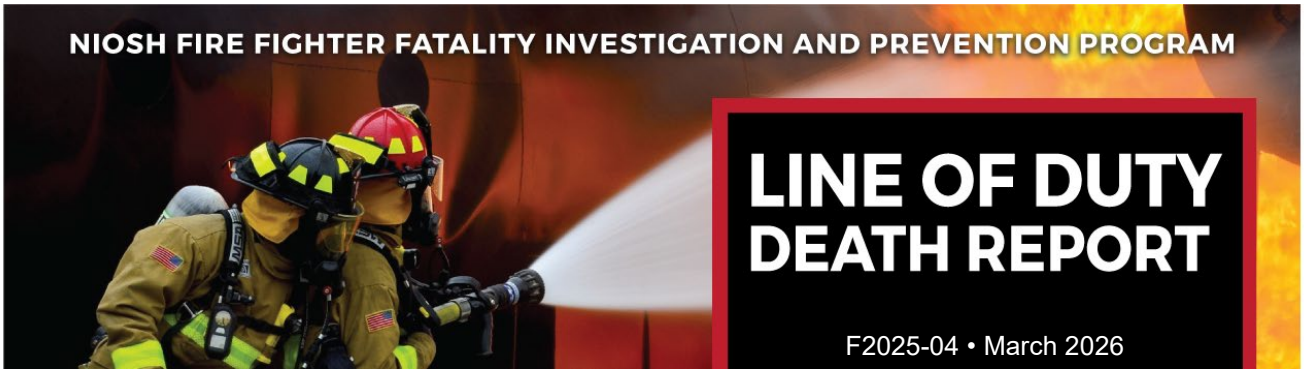


2025-04 46-Year-Old Lieutenant Collapses While Serving as Driver/Engineer at Residential Fire – Maryland

Executive Summary

On October 19, 2024, a 46-year-old Lieutenant (L1) was hospitalized after experiencing a stroke. L1 used the fire department's (FD) shift substitution policy for time off work as he recovered, rather than taking medical leave. He would not report back to work at the fire station until January 8, 2025.

On January 11, 2025, (L1's second shift back to work since October), at 16:55, units were dispatched for a working structural fire of a single-family home. The responding FDs were working as part of an automatic aid agreement. At 1709, a firefighter (FF1) from Engine 3 (E3) witnessed L1 collapse after throwing a ladder and notified his Lieutenant (L2). At 1709, L2 sent a priority radio message to command stating they needed EMS side bravo. Battalion Chief 1 (BC1) acknowledged and stated he saw the member down. Due to the snowy and steep conditions of the scene, L2 and Master FF1 (MFF1) (FD1, E3) pulled the unresponsive and unconscious L1 closer to the street (approximately 20-30 yards from site of collapse) so that the paramedic stretcher could be used. At this point, care was transferred to the awaiting advanced life support (ALS) team who moved L1 onto the stretcher at 1711.

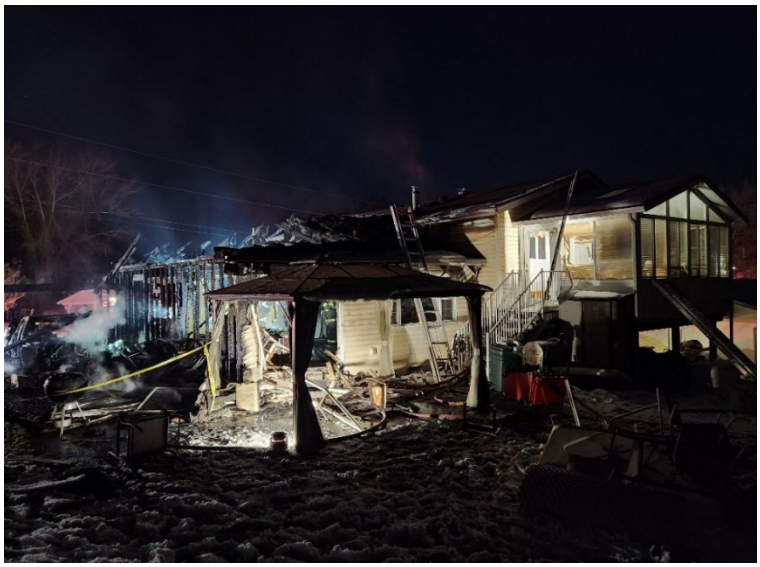


Photo 1. Delta side of structure. *Photo courtesy of fire department.*

The ALS team noted L1 to be unresponsive, not breathing (apneic), and without a pulse. Cardiopulmonary resuscitation (CPR) was initiated on the stretcher. Once connected to a monitor, L1 was observed to be in ventricular fibrillation. The patient was defibrillated with no conversion of ventricular fibrillation. Despite the medical interventions, L1 remained in ventricular fibrillation throughout the majority of transport time to the emergency department, with the exception of brief periods of pulseless electrical activity (PEA). Upon arrival at the hospital, hospital staff continued

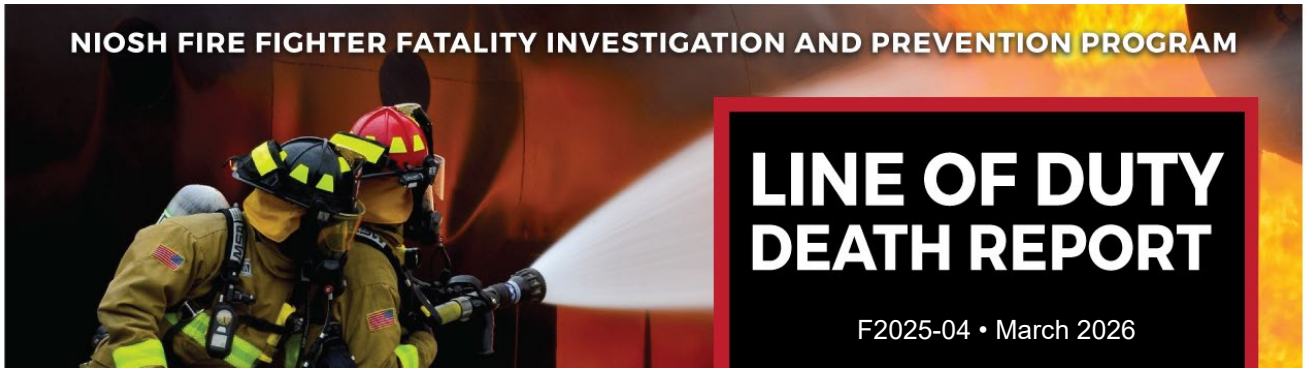
resuscitation efforts. Advanced life support efforts were continued for another 15 minutes after arrival, but L1 never regained a pulse and time of death was declared at 1801.

Review of medical records shows that L1 had a history of surgically repaired coarctation of the aorta, a congenital heart condition. During his hospitalization for stroke, L1 was newly diagnosed with congestive heart failure. Heart failure can lead to an increased risk of sudden cardiac death, and in some cases requires restriction from certain work duties per National Fire Protection Association (NFPA) 1582 occupational medical standards. This diagnosis was never reported to the department's physician, and since L1 used shift substitution rather than medical leave for his recovery, a return-to-work medical evaluation was never conducted. Though it is not possible to determine conclusively if this contributed to the fatality, the lack of a return-to-work medical evaluation by a provider with occupational health expertise was a missed opportunity for promotion of firefighter safety.

Key Recommendations

NIOSH offers the following recommendations to reduce the risk of firefighter mortality at this and other fire departments across the country. Many of our recommendations cite relevant NFPA standards which are periodically updated. Please note that it is our practice to cite the version of each standard in effect at the time of the fatality.

- *Key Recommendation #1: Ensure that a physician familiar with the essential tasks of firefighting as outlined by the NFPA and the physiologic requirements to complete them safely signs off on return-to-work physicals.*
- *Key Recommendation #2: Evaluate department shift substitution and medical leave policies to ensure they are being applied appropriately.*
- *Key Recommendation #3: Promote effective fireground communication with all mutual aid companies to ensure critical radio traffic is understood and relayed to on-scene personnel for incident stabilization and safety.*
- *Key Recommendation #4: Continuously evaluate staffing and deployment strategy to plan for effective emergency response.*
- *Key Recommendation #5: Work with automatic aid companies to establish a policy for clearing the fire scene following an incident of this nature.*



2025-04 46-Year-Old Lieutenant Collapses While Serving as Driver/Engineer at Residential Fire – Maryland

Introduction

During the investigation, the NIOSH investigators interviewed personnel from Chief to Firefighter ranks, including Local Union leadership from Fire Departments 1 and 2 and the physician lead of Fire Department 1's Occupational Medicine Service.

The NIOSH investigators reviewed the following items:

- Autopsy and Toxicology Report
- Computer Aided Dispatch Report (CAD)
- Dashcam footage of incident
- Department Incident Timeline and Narrative
- Fire Department Medical Standards Policy
- Hospital Records
- Internal Incident Overview Report
- Local Union Contract
- Medical Examiner's Report
- Medical Records
- Occupational Physical Records
- Paramedic Reports
- Primary Care and Cardiology Records
- Shift Schedule
- Training Records
- Witness statements

Fire Department

The Fire Department (FD) is an Accredited Agency serving approximately 500 square miles and over one million people who live and work in their jurisdiction. The FD is a combination of volunteer and career firefighters (FFs). The average annual emergency call volume is over

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120,000. The FD is staffed by approximately 1,250 career personnel, 800 volunteer responders, and 100 professional support staff. The FD staffs 35 fire stations, two rescue stations, and specialized worksites The FD is part of a regional automatic aid system. Many of the operational personnel work a 24/48-hour (24-hours on duty followed by 48-hours off duty) shift with a paid day off (Kelly Day). These personnel typically work nine days/shifts per month.

The FD daily command staff consists of the following units:

Daily Command Staff

1 – Duty Operations Chief

5 – Battalion Chiefs

4– Emergency Medical Services Duty Officers

1 – Safety Officer

2 – Fire and Explosives Investigators

Frontline Fleet

35 – Paramedic Engines

15 – Aerials

6 – Rescue Squads

30 – Ambulances

11 – Medic Units

4 – Advanced Life Support Chase Cars

8 – Tankers (Tenders)

Support Fleet

4 – Brush Engines

13 – Brush Trucks

10 – Operations Boats

3 – Swift Water Rescue Teams

2 – Hazmat Units

2 – Hazardous Materials Decontamination Units

2 – Medical Ambulance Buses

2 – Medical Care Support Units

2 – Technical Rescue Vehicles

2 – Mobile Air Units

2 – Mobile Command Units

The FD follows a hierarchical structure including the ranks of Fire Chief, Division Chief, Assistant Chief, Battalion Chief, Captain, Lieutenant, Master Firefighter, and Firefighter. All uniformed career personnel hold Emergency Medical Technician (EMT) certifications. Some of the FF's also hold Cardiac Rescue Technician-Intermediate (CRT-I) or Paramedic credentials, specialty training in hazmat, water-ice rescue, technical rescue, bomb squad, and instructor certifications. Within a fire station, Captains command all FFs in their assigned station. Lieutenants command individual apparatus and manage the FFs that are assigned to that apparatus. Captains and Lieutenants are frontline supervisors and as such are responsible for leading and managing their assigned personnel. Master FFs also hold leadership responsibilities within each fire station. Promotions require a series of training and development courses.

The Fire Chief is the head of the county department with additional authority over 19 independent volunteer fire-rescue departments, collectively making up approximately 800 volunteer FFs. The fire department is organized into five divisions: 1) Operations, 2) Volunteer Services, 3) Support Services, 4) Human Resources, and 5) Fiscal Management. The FD participates in a local chapter of the International Association of Fire Fighters (IAFF) who have exclusive bargaining rights for FFs classified in the following positions: Fire Fighter-Rescuer II and III, Master Fire Fighter-Rescuer, Fire/Rescue Lieutenant, and Fire/Rescue Captain who are associated with fire suppression, rescue, emergency medical services, special operations, fire and explosive investigations, fire protection and prevention, communications, and/or training. FFs holding the rank of Battalion Chief and above are not members of the bargaining unit. Additionally, there is volunteer representation in the county code for the purpose of negotiating with the Fire Chief who must consult with the association on all major policy changes. The volunteer hierarchy is the same as the career progression, and operational volunteer FFs must also hold the EMT credential. Similar to their career counterparts, many hold additional advanced certifications.

Membership and Training

The hiring process for the FD follows a seven-step process: 1) submit online application, 2) complete an entrance exam (successful candidates will score 70% or higher), 3) complete a Candidate Physical Ability Test (CPAT) consisting of 8 tests which must be completed in 10-minutes or less (3 attempts allowed), 4) background investigation, 5) recruitment advisory committee review, 6) conditional offer of employment, health assessment, and drug screen, and, 7) final employment offer. Individuals may be hired without any formal fire rescue training. Minimum standards training is completed by the agency after the employee is hired.

The Training Academy is approximately 26 weeks and consists of:

- 1 week of administrative sessions
- 10 weeks of fire training
- 10 weeks of emergency medical service training
- 1 week of emergency vehicle training (ambulance)
- 1 week of hazmat and terrorism training
- 1 week of software and computer training
- 1 week of specialized seminars and training

- 1 week of field internship

Each day of the training academy begins with physical training including strength training, running, pushups, etc. Following successful completion of the 26-week training, recruits are assigned to a fire station and transition to probationary employees who are assigned a mentor and continue additional training to reinforce academy training skills. Probation is a twelve-month period with six of those months spent in recruit school and the balance spent in field operations.

Preplacement/Periodic/Return to Work Medical Evaluations

The preplacement medical and physician exam includes, at minimum, urinalysis, vision test, hearing test, chest x-ray, blood work, pulmonary function test, electrocardiogram (EKG), urine/breath alcohol test and drug screen, examination of organ systems, and respirator fit test.

Annual physical examinations are required and are performed by the Human Resources Occupational Medical Services provider. The FD policy states that Candidates and Members must:

1. Cooperate with, participate in, and comply with the medical evaluation process;
2. Provide complete and accurate information to the fire department physician or other authorized medical care provider(s);
3. Immediately report any occupational exposure, e.g., exposures to hazardous materials, toxic substances, infections or contagious diseases, etc., to their supervisor(s); and
4. Immediately report any medical condition to the fire department physician that could interfere with their ability to safely perform essential job task, e.g., illness or injury; use of prescription or non-prescription drugs; pregnancy, etc.

The FD is responsible for scheduling annual medical evaluations with their contracted occupational medicine contractor. The FD clinic was shut down for many months during the COVID-19 pandemic and struggled to catch up on the backlog after the clinic reopened. The FD reported that due to staffing shortages, they have fallen behind with annual medical evaluations of all members. The FD medical standards for operational members and candidates were last updated October 3, 2016.

FD Policy-01-02 Medical Standards for Operational Members and Candidates dated 10/3/2016 adopts NFPA 1582 by reference but specifically the 2013 edition. FD "adoption by reference and compliance with the provisions of NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, 2013 Edition, with the exceptions of Chapter 8, Annual Occupational Fitness Evaluation of Members, and Annex C, Protocols for Evaluation of Fitness of Members, will establish the necessary requirements to ensure that its firefighter/rescuer personnel, career as well as volunteer incumbents of current positions and candidates, are examined thoroughly and objectively." (p.1)

The Local Union contract section on work-related examinations (section 10.5.A) states: "Before an employee returns to work after an absence which is the result of a job related injury or illness, or has been out 15 or more calendar days as a result of non-job related personal injury or illness the employee must report to the medical clinic for a clearance to return to work medical examination. Employees who are scheduled to report for a return-to-work medical examination shall have the option to be

scheduled by the medical clinic for their examination on a day they are not scheduled to work and be eligible for overtime compensation for the time they are present at the medical clinic. The appointment must be scheduled prior to the employee's next regularly scheduled workday when the medical clinic is open."

L1 had his FD pre-placement medical evaluation as a volunteer with this FD on July 23, 1998. On October 8, 2001, his pre-employment medical evaluation included a statement from his cardiologist, who reported that his EKG had a normal sinus rhythm, though there was evidence of left atrial hypertrophy with a prolonged biphasic P wave. His echo showed a bicuspid aortic valve with no residual coarctation and normal left ventricular function. The cardiologist recommended no restriction on his activity and recommended that he return to the congenital heart clinic in 5 years for re-evaluation.

Wellness/Fitness Programs

The FD has a robust offering of wellness and fitness programs available to all FFs. Services provided through an occupational health contractor include access to an athletic trainer, nutritionist, mental health services, and other specialties as necessary. Fitness equipment is provided and regularly maintained at each fire house with time provided to work out while on shift.

Investigation

On October 19, 2024, a 46-year-old Lieutenant (L1) called out of work due to an undisclosed medical event. L1's crew members received permission from their leadership to visit L1 in the hospital. Utilizing the FD's shift substitution policy to cover his missed shifts, rather than taking medical or sick leave, L1 would not report back to work at the fire station until January 8, 2025.

On January 11, 2025, (L1's second shift back to work since October) at 1655, units were dispatched for a working structural fire of a split-level single-family home. The responding FDs were working as part of an automatic aid agreement with three FDs responding. Weather conditions at the time of dispatch were fair, with a temperature of 35˚F (2˚C), wind speeds from the west-northwest of 20 miles per hour and wind gusts of 35 miles per hour. Although it was not actively snowing during the call, there were approximately 3" of snow on the ground.

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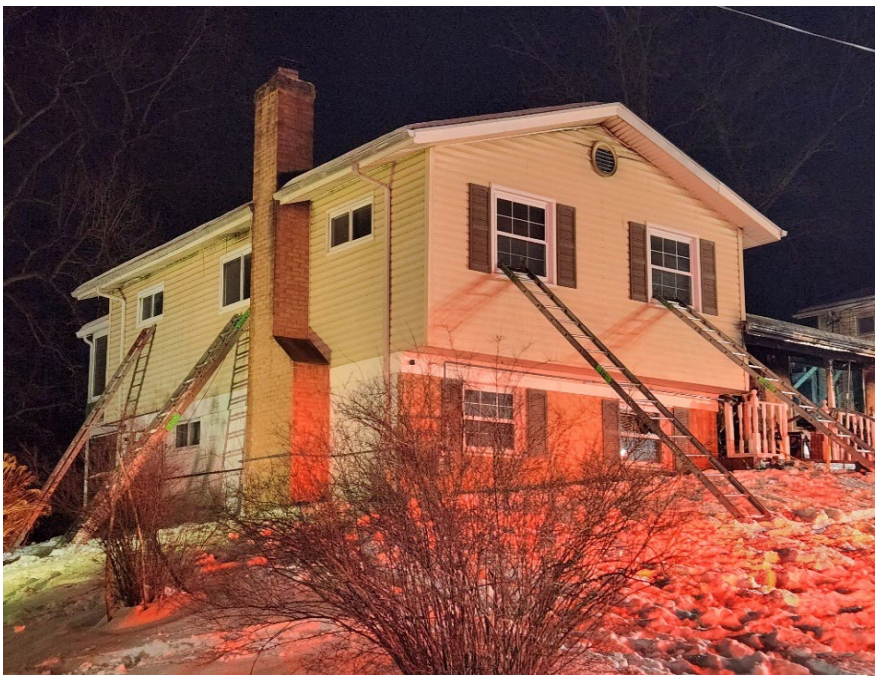

Photo 2. Alpha-Bravo side of structure. *Photo courtesy of fire department.*

Chief 1 (C1) (from FD1) self-dispatched to the event due to proximity to the fire incident and was the first to arrive on scene at 1658. C1 established command and completed a 360-size up. C1 remained at his vehicle with a stationary command near the Alpha-Delta corner of the structure and advised via radio that there was a well-involved fire from the carport extending into the first floor of the split-level home, power lines were down in the front yard of the property and to utilize caution on the Delta side of the house. He further confirmed occupants were outside and accounted for. Engine 1 (E1) (FD2) and Tower 1 (T1) (FD1) arrived on-scene at 1701 and 1702 respectively. T1 was staffed with a three-person crew including L1 who was serving as the driver/engineer, a Captain, and fellow FF. C1 immediately assigned E1 to knock down the fire at the carport before entry is made. At 1703 C1 repeats "I see you got water, knock that fire on the carport before you make entry." At 1704 C1 reports crews entering through the front door, not putting water on the carport fire as ordered. It was later reported that although the crew did not express their concern to C1, they disregarded the command because they wanted to move further from the downed power line. At that time the Delta exposure siding had begun to melt from radiant heat. Additionally, at 1704 Battalion Chief 1 (BC1) from FD 2 arrived on scene and assumed command on the Alpha-Bravo corner. C1 again reiterated that E1 was going interior instead of putting water on the carport. BC1 acknowledged C1.

Immediately upon T1's arrival, L1 began pulling and throwing ladders. L1 additionally pulled a crosslay (hoseline placement method designed for rapid deployment) and stretched the hoseline prior to returning to ladder work. At 1707, Engine 3 (E3) (FD1) with a crew of 4 arrived on scene, assuming the role of 3rd due engine. Moments later, at 1709, a FF (FF1) from E3 was stretching 300' 1.5" attack line to the Charlie side of the structure when he witnessed L1 collapse after throwing a ladder to the second story and called out to his Lieutenant (L2) (E3) "FF down, we got a man down!" L2 was nearby but did not witness the moment of L1's collapse. L2 observed L1 face down and called out to him but did not receive a response. The immediate assumption, prior to the start of emergency care, was that L1 may have slipped and hit his head. At that time, the identity and FD of the downed FF was unknown because L1 was face down and wearing station gear. L2 ran to L1, rolled him over, and found that it was a fellow member from his station (L1, FD1). At 1709 L2 sent a priority radio message to command stating they need EMS side Bravo. BC1 acknowledged and stated he saw the member down.

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L2 again radioed to confirm "that's correct, ALS (advanced life support) now." L2 remained with L1 and reported hearing snoring-like respirations, clenched posturing, seizure-like activity, and hypoxic coloring. L2 directed FF1 to resume stretching hoseline while Master FF1 (MFF1) (FD1, E3) assisted with L1's incident. At this time, crewmates from Tower 2 (T2, FD1) had arrived on-scene and stepped in to continue stretching the hoseline to the Charlie side so that fire operations were not interrupted.

Per standard procedure, the responding ambulance was positioning their apparatus (approximately 500 feet from the scene) to enable suppression units to continue to approach the scene when they were notified via radio of the downed FF requiring medical attention. The paramedics on-scene did not acknowledge the radio call for ALS; however, BC1 and C1 saw the paramedics running from the ambulance to the scene with stretcher in hand. It is unknown why the radio request for EMS was not acknowledged. Due to the snowy and steep conditions of the scene, L2 and MFF1 pulled the unresponsive and unconscious L1 closer to the street (approximately 20-30 yards from site of collapse) so that the paramedic stretcher could be utilized. At this point, care was transferred to the awaiting ALS team who moved L1 onto the stretcher at 1711. The ALS team noted L1 to be unresponsive, apneic, and without a pulse. Cardiopulmonary resuscitation (CPR) was initiated on the stretcher. The stretcher was promptly moved from the scene, into the ambulance where manual compressions continued and ventilation initiated via a bag-valve mask (BVM). Per state protocol and documented best practices, care was provided on-scene prior to transport (de Graaf, 2019, Goodwin, 2018). Duration of care on-scene was approximately 21 minutes during which time it was reported that multiple FFs assisted the ALS team in the back of the ambulance.

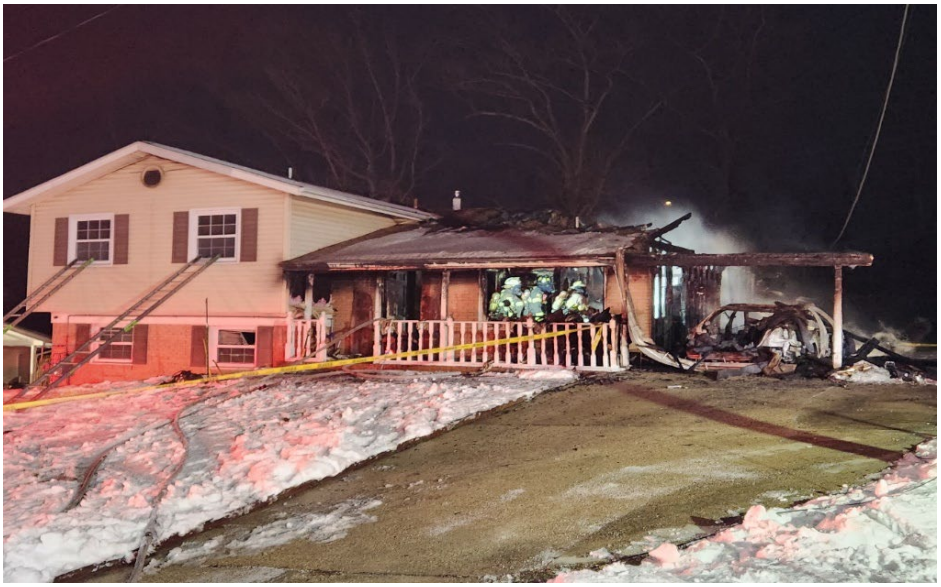

Photo 3. Alpha-Delta side of structure. *Photo courtesy of fire department.*

Once connected to a monitor, L1 was observed to be in ventricular fibrillation. The patient was defibrillated with no conversion of ventricular fibrillation. Compressions and BVM respirations continued and the cardiac arrest with ventricular fibrillation algorithm was initiated. L1 was continuously defibrillated at appropriate intervals with no conversion of ventricular fibrillation. A LUCAS (Lund University Cardiopulmonary Assist System) device was placed on L1 to provide continuous high-quality compressions. An intraosseous needle was placed in L1's humeral head and an I-gel airway device and inline capnography sensor were placed with good ventilations noted. L1 was subsequently administered amiodarone 300mg via intravenous push (IVP), followed by a 2nd dose of amiodarone (150mg IVP over 2 minutes), epinephrine 1:10,000 1mg,

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esmolol 50mg, and sodium bicarbonate ($NaHCO_3$) 50 mEq. Despite the medical interventions, L1 remained in ventricular fibrillation throughout most of the transport time to the emergency department, except for brief periods of pulseless electrical activity (PEA), at which point appropriate protocols for PEA were followed with additional epi 1:10,000 given. On scene, an additional cardiac monitor and defibrillator was obtained during resuscitation efforts at which point dual sequential defibrillation was utilized as appropriate.

During dual sequential defibrillation both monitors utilized 360 joule setting, with one charge administered immediately following the first. Consult was made with the hospital while enroute where the paramedics reported patient (L1) having a cardiac and stroke history, confirmed ALS treatment provided on-scene including 10 defibrillation attempts, 7 rounds of EPI, 450mg of amiodarone (total), sodium bicarbonate 50mEq, IV fluids 1000CC, and esmolol 50 mg. Upon arrival at the hospital, L1 was moved into a room. Once transferred from the stretcher to the hospital bed, hospital staff assumed patient care and continued resuscitation efforts. Advanced life support efforts were continued for another 15 minutes upon arrival, however L1 never regained a pulse and time of death was declared at 1801.

Lieutenant 1 Incident Timeline

Time	Activity	Timelapse from Initial Dispatch
16:56:06	Unit dispatched (T1)	Hr:Min:Sec
17:02:39	T1 arrives on scene, L1 driving	0:06:33
17:03:16	L1 exits driver's seat and pulls first ladder	0:07:10
17:03:49	L1 throws ladder to Alpha-Bravo corner of structure	0:07:43
17:04:28	L1 pulls another ladder out of the truck and places it on the ground next to the truck	0:08:22
17:04:45	L1 secures gas meter on Alpha-Bravo corner of structure	0:08:39
17:05:18	L1 throws second ladder to Alpha side of structure	0:09:12
17:05:46	L1 pulls a crosslay off E1and stretches it to Alpha side of structure	0:09:40
17:07:27	L1 pulls a third ladder and places it next to the truck	0:11:21
17:09:13	L1 places ladder up to second floor of Bravo side of structure	0:13:07
17:09:45	Priority radio message from L2 requesting medic on Bravo side	0:13:39
17:10:01	Priority radio message acknowledged by IC and visual confirmed	0:13:55
17:10:51	L2 and MFF1 drag L1 to the street on the Bravo side	0:14:45
17:11:11	L1 loaded onto cot and taken to ambulance	0:15:05
17:32:11	L1 transported to emergency department	0:36:05
17:46	L1 arrival at emergency department	0:49:54
18:01	L1 time of death	1:04:54

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Medical Findings

The medical examiner noted the cause of death as "cardiovascular disease." Significant findings during the post-mortem examination included cardiomegaly, or enlarged heart, with biventricular dilatation and hypertrophy. The heart showed subendocardial, perivascular, and pericellular interstitial fibrosis and patchy foci of replacement fibrosis in the left ventricular free wall. The aortic valve had fusion of the left and right cusps, meaning it functionally had two cusps, rather than the usual three. Examination of the coronary arteries revealed mild to moderate atherosclerosis, with 40-50% narrowing of the proximal right coronary artery, left main coronary artery, and left anterior descending artery.

There was also a small focus of atherosclerosis at the bifurcation of the right internal carotid artery and the middle cerebral artery, which supplies blood to part of the brain. Neuropathology examination revealed a 0.6 cm lesion in the left inferior frontal gyrus of the brain, consistent with a prior stroke.

Review of L1's medical records showed a history of coarctation of the aorta, a congenital heart abnormality that was surgically repaired in early childhood. The aorta is the large blood vessel leading from the heart's left ventricle, supplying blood to the whole body. "Coarctation" refers to the abnormal narrowing of a section of the aorta. L1's postmortem examination showed residual coarctation, with a vessel diameter of 1 cm at the level of the ligamentum arteriosum, and a vessel diameter of 2.5 cm before and after the area of narrowing.

Throughout his life, L1's condition was intermittently monitored in congenital heart disease clinic. As an adult, he reported no physical limitations resulting from his repaired aortic coarctation.

In 2019, he had his first cardiology visit since 2001, and at that appointment L1 reported undergoing annual exercise stress tests (ESTs) for his work as a FF, which showed no ischemia, only intermittent premature ventricular contractions (PVCs). An in-office electrocardiogram showed left axis deviation, an incomplete right bundle branch block, and a left anterior fascicular block, indicating some abnormalities in the heart's electrical conduction. His cardiologist recommended cardiac magnetic resonance imaging (MRI), and he prescribed a Holter monitor to continuously assess L1's heart rhythm over the next few days.

The Holter monitor recorded ventricular ectopy and an episode of non-sustained ventricular tachycardia. Because of these heart rhythm abnormalities, L1's cardiologist recommended he refrain from strenuous physical activity until the results could be reviewed by another specialist. The cardiology note specified "As [L1] is a firefighter, he is restricted from his usual duty until further notice." Though he had recently undergone his annual EST, he was referred for further stress testing with electrophysiology evaluation.

This follow up stress testing was performed using the Bruce protocol, and L1 achieved 13 Metabolic Equivalency Tasks (METs). The testing showed isolated PVCs at baseline, during exercise, and during the recovery period, but no ventricular tachycardia. His most recent annual EST also showed only PVCs. L1's cardiologist concluded, based on these reassuring EST results and on his echocardiogram showing no residual coarctation and no left ventricular hypertrophy, that L1 could resume work.

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L1's history of surgically repaired congenital heart disease was noted in the documentation of each of his annual medical examinations. L1 was diligent in keeping his cardiology appointments, completing recommended testing, and undergoing annual work physical examinations. Between 2019 and 2023, his cardiac health was reportedly stable, and his annual exams deemed him fit for duty.

In late 2024, approximately 12 weeks before his death, L1 was hospitalized after experiencing a stroke. His hospitalization lasted 5 days and his neurological recovery after discharge appears to have been uneventful. However, during his hospital stay, as part of a standard stroke evaluation, he underwent two echocardiograms, first a transthoracic study and then a transesophageal study for better visualization of the heart. The transesophageal echocardiogram (TEE) showed a left ventricular ejection fraction of 30%, which represents heart function severely decreased from normal. The TEE also showed global heart hypokinesis, or reduced overall heart muscle movement, and mild left ventricle dilation.

These findings were significantly changed from prior echocardiograms, which had been essentially normal with the exception of stable aortic valve abnormalities. During the hospital admission he was started on several medications to address the new diagnosis of heart failure with reduced ejection fraction. He was recommended at discharge to receive another echocardiogram in 4 weeks, and to follow up closely in cardiology clinic.

Return to Work Medical Evaluation Findings

L1 had an appointment with his PCP shortly after hospital discharge to discuss his stroke and new heart failure diagnosis. L1 was scheduled to start taking a direct-acting oral anticoagulant, or blood-thinning medication, the day after this PCP visit. However, he expressed to his PCP that he preferred not to start the anticoagulant because it would impact his work eligibility. Per NFPA 1582, use of oral anticoagulants disqualifies an individual from work in the fire service. It is not clear if he ever began taking this medication as prescribed, and his PCP's documentation says only that he (the PCP) will discuss the issue with the neurology and cardiology teams.

At a second PCP appointment approximately 1 month before L1's death, they again discussed whether anticoagulation was necessary, revisiting L1's concerns about disqualification from his job. It does not appear that a final decision about anticoagulation was made at that visit.

The documentation of these conversations shows that his PCP was aware that there might be medical factors affecting his ability to return to work. However, there was no documented conversation about return-to-work criteria for congestive heart failure. As L1 did not use medical leave but rather relied on shift substitution for time off work as he recovered from his hospitalization, there was no automatic triggering of the medical leave policy that required department-sponsored return-to-work medical evaluation to cover this gap.

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Discussion

Systemic Observations

L1's extended time off work (October 19-January 7) seemed to expose a loophole in the FD's shift substitution program. L1 did not officially report a medical condition to the FD and therefore did not go on sick leave so his time off did not automatically trigger the required return-to-work visit with the FD's medical provider. Although the extent of the medical condition was undisclosed to the FD, the department was aware of a medical event as they had granted crew members permission to visit L1 while in the hospital. The responsibility to report a medical condition, however, is the duty of the employee per Union contract, FD policy, and NFPA 1582 best practices.

The allowance for extended absence without return-to-work medical clearance in this case is cause for concern. Leadership within each fire station functions with autonomy for basic daily operations. Work substitutions are governed by a mix of collective bargaining agreement language, side letters between the Department and the union, and FD policy 519-Work Substitution that was written in 1994. The evidence in this case suggest that there are loopholes in the existing policy that allowed a FF to have an extended absence without formalized documentation.

Additionally, though it is understandable that a FF would hesitate to report a medical condition that would limit or exclude them from ongoing employment, the FD medical policy in effect at the time of L1's death states that "Candidates and Members must immediately report any medical condition to the fire department physician that could interfere with their ability to safely perform essential job tasks."

The FD's medical policy states in Section 7a that the personnel must report to the FD physician for an annual medical evaluation. During interviews we learned that the FD staff schedule their members for these annual evaluations to occur during their shifts, so they do not have to spend off-duty time to complete this requirement. The medical evaluations include the OSHA required medical screening for the respirator fit test and the fit test itself. The FD notes, however, that due to staffing constraints, annual exams do not always occur for every member. For example, L1 did not undergo an annual physical in 2024. When they do occur, labs and other testing appear to be ordered at inconsistent intervals, and recordkeeping is not always thorough. FD leadership has already identified this as an area for improvement, and states that adherence to the annual medical evaluation policy is improving as their staffing levels are improving.

Occupational Medical Evaluation of Cardiac Pathology in Firefighters

Nearly half of all FF duty-related deaths are caused by sudden cardiac death. A study of data gathered at autopsy found that approximately 80% of FFs who suffered duty-related sudden cardiac deaths had atherosclerosis, cardiomegaly (enlarged heart), or both [Smith et al. 2018]. L1 suffered from several cardiac conditions which put him at higher risk of death from cardiovascular causes than the average FF. NFPA 1582 addresses each of these conditions in detail and provides recommendations on the circumstances under which a FF with these conditions should be restricted from work duties [NFPA 2022].

L1 underwent annual medical evaluation for his work and followed up regularly with a cardiologist. For years preceding his death, he was consistently deemed fit for duty. However, at the hospitalization several months before his death, his cardiac health was found to have changed significantly from prior

examinations. A return-to-work evaluation by a medical provider familiar with both the cardiovascular demands of firefighting work and with the NFPA occupational medical standards might have identified that L1 was no longer fit for unrestricted duty, at least until he was further medically optimized. Physicians who are not occupational medicine specialists or who do not have specific expertise in evaluation of FF may not be familiar with the extensive NFPA occupational medicine standards and how to apply them.

This case highlights the importance of return-to-work medical examinations after a significant illness or health event. Importantly, FD policy does place the responsibility to report medical conditions to the contracted physician on the employee, and the Union contract requires a return-to-work evaluation when a FF is out for 15 or more calendar days, but the mechanism through which L1 took off work (shift swaps) did not trigger the automatic referral to the physician upon his return so the medical evaluation did not take place as intended.

Congestive Heart Failure

L1 was newly diagnosed with congestive heart failure (CHF) during his October 2024 hospitalization. His heart had a reduced left ventricular ejection fraction, meaning the left ventricle was not working normally to pump blood to the rest of his body. Heart failure with a reduced ejection fraction predisposes patients to development of arrhythmia, including ventricular fibrillation, as L1 experienced during his cardiac arrest [Tan 2021]. In fact, if the heart's ejection fraction remains low even after optimal treatment with medication, the risk of sudden cardiac death is sufficiently high that patients are recommended to receive an implantable cardiac defibrillator [ACC 2025]. L1 was newly started on several medications for heart failure during his admission and was intended to have a repeat echocardiogram and see a cardiologist soon after his discharge. NFPA 1582 states that FFs diagnosed with CHF can work without restriction as long as certain provisions are met. Every 2-3 years as medically indicated, they must have cardiac imaging demonstrating no structural abnormalities and normal left ventricular function, and they must have a stress test demonstrating no evidence of certain exercise-induced cardiac complications. A cardiologist must sign a statement documenting that the FF with CHF meets these provisions for unrestricted work [NFPA 2022].

Congenital Heart Disease

Per NFPA 1582, FFs with congenital abnormalities of the heart, aorta, or other major vessels can work without restriction unless there are residual complications after surgical treatment, or if the patient never underwent surgical treatment [NFPA 2022]. L1 had his congenital abnormality, coarctation of the aorta, repaired in early childhood. Both the providers performing his annual physical exams and his cardiologists documented many times that he had no residual complications after surgical treatment, based on his good exercise tolerance and his ECG, stress test, and cardiac imaging findings. Therefore, per NFPA guidance, he was appropriately instructed that he could work without restriction imposed by his congenital heart disease.

Coarctation of the aorta, however, is associated with increased risk of heart failure, arrhythmia, and sudden cardiac death, even after surgical repair [Mejis 2021]. As this case demonstrates, a FF's health is not static, and every annual or return-to-work evaluation is an opportunity to identify new or worsening health conditions that could pose a danger both to the individual FF and also to their colleagues in an emergency response situation.

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Arrhythmia

It is not possible to conclusively state the cause of L1's ventricular fibrillation and cardiac arrest. Arrhythmia can arise spontaneously, particularly if the underlying heart muscle is abnormal, as it was in L1's case [Schiau 2021]. Arrhythmia can also be caused by ischemia, or lack of oxygen to the heart muscle, as occurs during a heart attack. At autopsy, L1's coronary arteries had some narrowing with atherosclerosis, but no acute blockage was identified.

NFPA 1582 states that a FF with a history of arrhythmia may work without restriction if they meet certain provisions either annually or at any frequency medically indicated. A FF must have normal cardiac function and no structural abnormalities on imaging, have no toxic arrhythmias and be on no anti-arrhythmic medication, and be free of certain concerning findings on exercise stress test every 2-3 years. A cardiologist must attest to the FF's ability to meet these parameters and perform job tasks [NFPA 2022].

L1's heart rhythm was closely evaluated in 2019, and he was at that time deemed fit for duty, but based on available records, he would not have met the above criteria if he had been re-assessed after his 2024 hospitalization.

Coronary Artery Disease

The contribution of coronary artery disease (CAD) to L1's death is not clear. CAD refers to the presence of atherosclerotic plaque in the arteries delivering blood to the heart. L1 did have coronary artery atherosclerosis on autopsy, but the disease was mild-to-moderate and no acute blockage was identified.

Regardless of its contribution to this specific fatality, CAD is the most common risk factor for sudden cardiac death in the United States. Over years, often decades, atherosclerotic plaque accumulates and eventually can narrow the coronary arteries to the point where blood flow is restricted, preventing the heart muscle from receiving sufficient oxygen [Libby 2013]. This can manifest as episodes of chest pain, or angina, which often occur when the heart's oxygen demand increases during exertion. If the coronary arteries are severely obstructed, a myocardial infarction, or heart attack, can result. CAD is of particular risk to FFs as stress and strenuous physical exertion are inherent to their work.

NFPA 1582 recommends that, starting at age 40 years of age, all FFs should have an annual resting electrocardiogram (EKG). Additionally, annual cardiac risk assessment should be performed, using either the 2-year Framingham risk table or the 10-year risk calculator created jointly by the ACC/AHA. Screening with either of these two methods should begin at age 40 for asymptomatic FFs with no known history of atherosclerotic cardiovascular disease (ASCVD).

If a FF has a 2-year 2-4% risk of ASCVD or a 10% to <20% risk of ASCVD over the next 10 years, the FF should undergo symptom-limiting exercise stress testing (EST) with imaging [e.g. echocardiography, technetium (^{99m}Tc) sestamibi study] to at least 12 METs (Metabolic Equivalency Task)*.

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If EST with imaging is positive, the FF should be referred to a cardiologist for further evaluation. Consult NFPA 1582 2022 version Chapter 9, Table 9.7 to determine restrictions on essential job tasks.

NFPA 1582 also recommends ASCVD risk assessment under other circumstances, including for FFs under 40 years old with a high risk of ASCVD, those with insulin-dependent diabetes, etc.

*Note that this is different from the routine EST used to assess FFs' aerobic fitness.

Operational Observations

Importantly, those interviewed from mutual aid departments reported an overall very good working relationship. Of concern, however, reports disclosed that poor communication on the fireground with mutual aid companies has become a recurring issue. In this case, there appeared to be a lack of regard for C1's command. Specifically, the instructed task to take an exterior attack approach to darkening down the carport was not followed and the priority call for EMS was not acknowledged. It was later disclosed that the crew felt they would be too close to downed power lines and decided amongst themselves to take an interior approach, though command reported there was room to work safely. This concern could have been radioed to command to increase visibility and firefighter accountability on scene. It is unknown why the call for EMS was not acknowledged.

Concern was also expressed with FD2's radios and technological issues that exist. FD2 utilizes lapel mics designed for law enforcement and FD2 reported that they are not always reliable during fire operations. Although this issue does not appear to have played a role in this line-of-duty-death, it is an operational concern that could be addressed to improve safety and communications amongst the mutual aid departments.

A Safety Officer (SO) from FD1 was listening to the radio traffic and after brief consultation with leadership, ultimately decided to respond to the incident scene when he heard the call for EMS for a downed FF. At 17:18 the SO arrived on-scene and immediately checked in with the command post to begin documenting details. Although it had not been worn during this incident, the SO promptly gathered and secured L1's gear and personal protective equipment. The SO completed a thorough size-up of the incident scene and day's events which were recorded in detail. The SO was the one to clear the scene that evening. The SO took L1's gear and PPE and secured it in a locked area which he would then inventory, visually inspect, label, and photograph. At the request of the family, L1's gear was transferred to the family liaison for use at the funeral. The following days, the SO spent time at the fire stations, debriefing, talking to members, and began to document actions taken on the evening of the call, reviewed dashcam video of the incident, reviewed dispatch reports of the incident, and developed an incident timeline. Using C1's dashcam footage, the SO prepared an incident timeline specific to L1's actions on-scene including times, tasks, and routes of travel.

Contributing Factors

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. L1 died after experiencing ventricular fibrillation, and the medical examiner cited "cardiovascular disease" as his cause of death. It is not possible to determine definitively that adherence to the following

recommendations would have prevented this fatality, but they are being provided here as a reminder of good practice.

Recommendations

NIOSH offers the following recommendations to reduce the risk of firefighter mortality at this and other fire departments across the country. Many of our recommendations cite relevant NFPA standards which are periodically updated. Please note that it is our practice to cite the version of each standard in effect at the time of the fatality.

Recommendation #1: Ensure that a physician signs off on return-to-work evaluations.

Discussion: NFPA 1582 Section 3.3.6 defines a Fire Department Physician as "A licensed doctor of medicine or osteopathy who has been designated by the fire department to provide professional expertise in the areas of occupational safety and health as they relate to emergency services." Section 4.2.2. states "When medical evaluations are conducted by a physician or medical provider other than the fire department physician, the evaluation shall be reviewed and approved by the fire department physician." The lack of a return-to-work medical evaluation in this case was a missed opportunity for prevention. The FD may want to explore updating policies to state what specific conditions must be reported and timelines for reporting said conditions. For example, what conditions need to be reported to the occupational physician, even if the member is not out of work? Or, if a member has a stroke, how long can they remain out of work before reporting that condition to the physician? In general, how much time do they have to report a condition, and how do they know which conditions need to be reported?

Per NFPA 1582, there is a duty to report which means FFs are required to be transparent about their medical conditions, especially if they could influence their ability to perform essential job duties. The purpose of this reporting is so that medical professionals can make informed decisions for the safety of the FF and others. In this case, the FD did have a return-to-work policy in place, but it was not followed by the employee or enforced by leadership. Additionally, the employee did not report new medical conditions. Our records review indicates that the new conditions experienced by L1 could have disqualified him from active duty. Both actions carried a risk to both L1 and his crewmates.

Recommendation #2: Consider evaluating department policies regarding shift substitutions to ensure proper use of the program.

Discussion: Shift substitutions, or swaps/trades/exchanges, are common in the fire service but can be complicated from an employer standpoint if parameters are not explicitly defined. The Fair Labor Standards Act under the U.S. Department of Labor, allows for shift substitutions for public employers to permit employee flexibility without regard for payroll purposes. Much of the FLSA's stance on shift substitutions are at the discretion of the employer. It would be prudent for any FD that allows shift substitutions to clearly define the appropriate use case for requesting substitutions and the number of recurring substitutions permitted. A direct, written policy could ensure equitable treatment of all FFs, and ensure serious medical conditions do not go unrecognized when shift substitution is used in place of medical leave.

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In this case, L1 utilized shift substitutions for approximately 12 weeks; a medical leave may have been the more appropriate mechanism for securing time off work in this situation. The consequence of utilizing shift substitutions was that L1's time off did not automatically trigger scheduling of medical clearance prior to return to work. The Collective Bargaining Agreement Article 10 Section 5 Work Related Examination, states that, "Before an employee returns to work after an absence which is the result of a job related injury, illness or has been out 15 or more calendar days as a result of non-job related personal injury or illness the employee must report to the FD Occupational Medical Services for a clearance to return to work medical examination." Any employee out for 15 or more calendar days must report to the FD's medical office for return-to-work clearance. Furthermore, the FD policy requires the immediate reporting of any medical condition that could interfere with the ability to safely perform essential job tasks to the contracted physician.

This case exposes a weakness where a serious medical condition could go undocumented and ultimately unknown. The FD could further evaluate what medical conditions are required to be reported to the FD and the timeline for disclosing this information. Utilizing NFPA 1580, Standard for Emergency Responder Occupational Health and Wellness, as a guide, FDs can compile a list of medical conditions that are important to report for the health and safety of FFs. It is important to remember that medical emergencies may affect not only the individual with the medical condition, but also the safety of an entire crew during emergency operations as both focus and job tasks will be altered to respond.

Furthermore, those in leadership within individual fire stations may benefit from ongoing education focusing on the importance of, and rationale behind, medical and return-to-work policies. Although L1 was ultimately responsible for reporting his own health condition to the FD physician, he was off work for 12 weeks without documentation or accountability. His immediate leadership chain was aware of the hospitalization, so even without L1 self-reporting, enforcement of the medical policies which the FD and Union have in place could have occurred. Refresher training that covers member accountability and the reasoning for said policies may be useful.

Recommendation #3: Promote effective fireground communication with all mutual aid companies to ensure critical radio traffic is clearly understood and relayed to on-scene personnel for incident stabilization and safety.

Discussion: Specific instances where communication may have impacted this incident include the Incident Commander (IC) (Chief 1) instructing the E1crew to knock down the fire in the carport before making entry. This is a tactical and strategic decision which was identified by the IC to ensure the main body of fire was knocked down and decrease the radiant heat emitting from this fire which was beginning to melt the siding of the Delta exposure (another single-family home). Additionally, L2 reported a FF down and while BC1 acknowledged this radio traffic immediately, the ambulance crew did not acknowledge. While this did not appear to impact patient care, closed-loop communication is helpful.

Information received while enroute can assist local fire departments in decision-making and understanding possible hazards, situations, and threats. FDs and local Public Safety Answering Points may consider the benefits of developing policies and embracing technology that is user friendly in the

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field to incorporate near instant information sharing. The use of computer aided dispatch (CAD) systems, mobile data terminals, and other third-party software designed for pre-incident preplanning could be utilized to assist FDs with real time data and information to enhance on-scene situational awareness. While the IC ensures tasks are appropriately assigned, it is essential that communications shared via radio (and face-to-face) are heard and acknowledged in a very timely manner by personnel operating on scene. Dispatchers often provide a safety net by ensuring critical information is relayed if crew members on scene miss radio traffic. There is an inconsistent application of technology across the regional automatic aid partners.

The response to this incident included personnel from different fire rescue agencies. This response model and resource deployment strategy has been formalized via regional automatic aid agreements. It is important that communication equipment is reliable, and interoperability is routinely evaluated by all partners in automatic aid agreements. It is also important to ensure that crew members carry out assigned tasks and practice closed-loop communication. There are many incident command and situational awareness trainings opportunities available to include online and in-person deliveries. Examples include Mastering Fireground Command - Calm the Chaos, National Fire Academy, Situational Awareness Matters, and UL Fire Safety Academy. “In the fire service, working together with other departments isn’t just important, it’s essential.

Recommendation #4: Continuously evaluate staffing and deployment strategy to plan for effective emergency response.

Discussion: As communities can increase in population and density rises, it is essential for fire rescue agencies to remain communicative and evaluative to support daily operations. While automatic aid agreements and utilization of volunteer personnel can help support daily operations, reliability can become challenging. There are resources available, including the International Association of Fire Chiefs Recruitment and Retention Toolkit. Additionally, there are many resources available that help illustrate the impacts staffing can have on personnel’s health and safety, as well as crew size effectiveness. These resources include peer reviewed journal articles via the International Fire Service Journal on Leadership and Management, Volume 15 – Effects of Crew Size on Firefighter Health and Safety as well as Volume 18 – A Framework to Address Health and Safety in the Fire Service.

At the time of this incident, the tower apparatus that L1 was driving was staffed by 3 personnel. Crew size and the overall number of firefighters assigned to the entire incident directly influence operational decisions and effectiveness. Crew size also has a significant influence on both the pace and amount of work that is performed, ultimately contributing to the time to exhaustion [Moore-Merrell, 2021]. Typically, discussion and standards for crew size are focused on operational needs; however there is also a need to address crew size as it relates to firefighter health and safety, as the arduous work of firefighting can lead to great physiological stress [Moore-Merrell, 2021]. Furthermore, it is important to note that when utilizing the NFPA 1710 *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* recommendations for crew size, these are the minimum recommendations, not the ceiling for staffing. Per Moore-Merrell 2021, the minimum on duty crew size for an engine and truck are 4 people for an effective response.

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Research conducted on crew size reported significant reductions in performance and safety when operating with fewer members than NFPA 1710 recommends; additionally, they reported that 5-member crews were able to provide a more coordinated approach for search and rescue and fire-suppression tasks than crews with fewer members [Averill et al., 2010, 2013]. Further research on the topic examined cardiac strain in relation to crew size, reporting working heart rates of the engine crew declined with an increase in crew size (from 3-4 person and 4-5 person), concluding that heart rates are higher with smaller crews and therefore the crews experience greater cardiovascular strain than larger crews working the same size fire [Barr et al., 2014, Moore-Merrell, 2021].

Of note, since the time of the incident, the FD has increased the staffing of the ladder truck that L1 was assigned to, from 3 members to 4 members. The FD reports that plans are in development to increase staffing on all fire apparatus to 4 members.

While reviewing staffing, the FD may also consider more strategic deployment of Incident Safety Officers (ISO). NFPA 1550 *Standard for Emergency Responder Health and Safety* outlines how an ISO can integrate with the Incident Command System to play an integral part of the command staff as well as in day-to-day operations for proactive measures.

The FD currently staffs one 24-hour Safety Officer (SO) for each of the three shifts. The SOs cover the entire county and are not automatically dispatched to incidents. SOs may self-dispatch to any incident in the county, at their discretion. The internal standard is for the SO to self-dispatch, at minimum, to all full assignments or working incidents. The SOs do not typically participate in out-of-county/jurisdiction incidents but responses are evaluated on a case-by-case basis.

SOs can facilitate communication with dispatchers, on-scene personnel, receiving hospital staff, and ensure notifications are made when injuries and fatalities occur. Timely notification can be challenging with the modern-day speed of information sharing. There are many responsibilities that are oftentimes assigned to the SO. With an added SO on each shift, there may be opportunity to further formalize the role and add embedded safety and accountability on emergency incidents. Some responsibilities may include designated infection control officer, assist with incident documentation and drafting after-action reports, confirm personnel are wearing all necessary PPE, ensure rehabilitation and decontamination areas are established on scene, build partnerships with local fire departments, hospitals, and coalition partners, report incident changes to IC, and discontinue operations if deemed unsafe.

There are several SO trainings opportunities available, including online and in-person deliveries. Examples include Fire Department Safety Officers Association (Incident Safety Officer, Health & Safety Officer, and 5 Reads), National Fire Academy, and Public Safety Training & Development.

Recommendation #5: Work with automatic aid companies to establish a policy for clearing the fire scene following an incident of this nature.

Discussion: Although there is no single NFPA standard that addresses the issue of who should be the responsible party for clearing the scene following a firefighter serious injury or medical emergency, there are multiple standards that address the general topic that can be referenced when developing

policy. NFPA 1321 Standard for Fire Investigation Units addresses securing the scene and initial assessment by fire investigation units, NFPA 1500 Standard on Fire Department Occupational Safety, Health, and Wellness Program provides basic framework for effective clearing of an emergency scene, and NFPA 921 Guide for Fire and Explosion Investigations, while focused on the investigation process, provides a systemic approach to securing the scene to preserve evidence (NFPA 2025, NFPA 2021, NFPA 2024).

In this particular case, there does not appear to have been an issue with securing evidence or the scene, however confusion was expressed about what the post-incident protocol was, specifically who (which FD) was responsible for each action. Utilizing the NFPA recommendations and departmental policies, the fire departments involved in the mutual aid agreement should ensure all responding personnel understand and are proficient in departmental, individual, Safety Officer, and Incident Command responsibilities following an on-scene incident.

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Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program's Medical Team based in the Division of Field Studies and Engineering in Cincinnati, Ohio. This investigation was conducted, and this report co-authored by Alexandra Barger, MD, MPH, Andrea Wilkinson, MS, ATC/LAT, and Lindsay Judah, DPA. Dr. Barger is a board-certified internal medicine physician. Ms. Wilkinson is a fire service health scientist, certified athletic trainer, and exercise physiologist specializing in tactical athletes. She is also an honorary Lieutenant for the Hanover Park Fire Department in Illinois. Dr. Judah is a Division Chief, a Fire & Emergency Services consultant, and graduate professor.

Disclaimer

The information in this report is based upon dispatch records, audio recordings, witness statements, and other information that was made available to the National Institute for Occupational Safety and Health (NIOSH). Information gathered from witnesses may be affected by recall bias. The facts, contributing factors, and recommendations contained in this report are based on the totality of the information gathered during the investigation process. This report was prepared after the event occurred, includes information from appropriate subject matter experts, and is not intended to place blame on those involved in the incident.

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