1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

Lieutenant and Probationary Firefighter Die after experiencing Thermal Degradation of Self-Contained Breathing Apparatus Facepiece Lenses – Maryland

Executive Summary

Two firefighters died after experiencing an unexpected hostile fire event at an occupied single-family rowhome on October 19, 2023. A 31-year-old career probationary firefighter (E29 probationary) died after conducting interior firefighting operations. A 26-year-old career firefighter (E29 lieutenant), died on October 24, 2023, at a local burn center from serious injuries sustained working at the fire. Both firefighters were engaged in an interior fire attack during their response. The single-family residential structure was an approximately 1,800 square foot, two story ordinary constructed rowhome, located second from the end of the group. At approximately 1539 hours, the local communications center received a 9-1-1 call reporting a fire in the rear of the structure. At 1541 hours, the communications center dispatched box alarm 46-40 to a dwelling fire. Engine 29 (E29), Engine 45 (E45), Engine 52 (E52) as the Rapid Intervention Team (RIT), Engine 20 (E20), Engine 44 (E44), Truck 25 (T25), Truck 16 (T16), Battalion Chief 5 (BC5), Battalion Chief 3 (BC3), and Safety Officer 4 (SO4) were dispatched. Box alarm 46-40 included fire companies not normally assigned to this box alarm as a few of the normally assigned fire companies were out of service for training or already assigned to incidents. Engine 46, Squad 40, and Truck 12 all requested permission from the battalion chief to be assigned to the box alarm.

Side Alpha post fire event.
(Courtesy of Fire Marshal Office.)

E29 arrived on-scene at 1544 hours on side Alpha and E29 lieutenant reported fire showing from the rear (side Charlie) and assumed incident command (IC). E29's probationary firefighter stretched a 150' 1 ¾-inch attack line to side Alpha to make an interior fire attack. At 1545 hours, BC5 arrived on-scene and upgraded

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the box alarm to a working fire assignment to add additional resources to the box. BC5 assumed IC and announced the staging location for incoming fire companies. E52 arrived on-scene and assumed RIT on side Alpha. IC provided a situation report to the communications center and incoming fire companies at 1547 hours reporting a two-story porch front, second from the end of the group, with heavy fire on side Charlie with extension. IC established the incident command post (ICP) on side Alpha. Upon arrival of E46 on side Alpha, IC requested E46 to stretch an attack line to side Charlie and stop the fire spread. At 1549 hours, T25 informed the IC that the truck company had no access to side Alpha and positioned near the intersecting corner.

At 1549:18 hours, E29 lieutenant transmitted "Mayday, Mayday, Mayday". The IC immediately acknowledged the Mayday when a second Mayday transmission was broadcasted from E29 lieutenant at 1549:35 stating "Mayday, Mayday, Mayday, first floor". The IC requested the location of E29 lieutenant and requested a RIT task force assignment from the communications center. The IC requested that BC3 have E46 start flowing water into the structure from side Charlie. BC3 acknowledged the request and informed IC that they had heavy fire on three dwellings on side Charlie and requested the location of the Mayday. IC requested a second alarm assignment from the communications center while visible fire was venting out of a side Alpha window which had fixed metal security bars. At 1552 hours, the E29 lieutenant was removed from the structure via the side Alpha door and was soon followed by E29 probationary at 1555 hours. Both E29 lieutenant and E29 probationary received advanced life support (ALS) care and were transported to a local trauma center. E29 probationary was pronounced deceased in the emergency room while E29 lieutenant was admitted to intensive care for treatment before succumbing to his injuries on October 24, 2023.

Contributing Factors

- *Strategy and tactics for exterior fires extending into the interior of a structure*
- *Thermal degradation and failure of Self-Contained Breathing Apparatus (SCBA) facepiece lenses and EBSS (Buddy Breather Whip)*
- *Recognition of fire dynamics*
- *Use of thermal imaging (TI) camera to observe changing fire conditions and escape routes*
- *Interior structural firefighting experience.*

Key Recommendations

Fire departments should:

- *Develop policies that address both strategy and tactics as they relate to exterior fires, vertical fire spread, and horizontal extension into a structure*
- *Consider upgrading or replacing current SCBAs to meet the 2013 or more recent edition of the NFPA 1981 or NFPA 1970 (1981) standard*

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- *Train firefighters in fire dynamics, recognition of flow paths, and tactics to reduce the potential of working in the exhaust portion of a flow path*
- *Ensure proper training for firefighters on the use and limitations of TI devices as they relate to interpreting fire dynamics*
- *Consider level of experience, tacit knowledge, skill familiarity, and the need for close supervision when assigning tasks with higher potential for injury to probationary firefighters.*

For further information, visit the program website at www.cdc.gov/niosh/firefighters/fffipp/ or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Introduction

On October 19, 2023, a 31-year-old career probationary firefighter (E29 probationary) and a 26-year-old career firefighter (E29 lieutenant), holding the rank of lieutenant, responded to an occupied single family rowhome fire. Within minutes of arrival, both firefighters experienced an unexpected hostile fire event leading to thermal degradation of both their structural firefighting turnout gear and SCBA facepiece lenses, and EBSS (Buddy Breather Whip). On October 23, 2023, the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. Two investigators representing the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) traveled to Maryland to investigate this incident between November 5 and 16, 2023.

The NIOSH investigators met with the fire chief and staff, fire investigation bureau personnel, conducted a site visit, and conducted interviews with fire officers and firefighters that responded to box 46-40. The NIOSH investigators also met with the Special Agent from the local Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) field office, the communications center, and conducted inspection of the hose, nozzle, and apparatus both deceased firefighters were using and operating at the time of incident. The NIOSH investigators inspected and photographed the deceased firefighters' personal protective equipment (PPE). NIOSH investigators also reviewed the training records of specific personnel involved in the incident and reviewed the department's standard operating procedures and professional development model.

Fire Department

The career fire department involved in this incident provides fire and emergency medical services (EMS) to an area approximately 92 square miles in size. This area includes 11 miles of waterway. The department is staffed by 1,600 full-time civilian and sworn members across 39 stations. The department is led by a fire chief who is assisted by an executive fire chief. The remainder of the executive staff consists of three assistant chiefs who manage the Operations, Community Risk Reduction, and Safety Member Services divisions.

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The operations assistant chief supervises four deputy chiefs, who are the shift commanders assigned to each of the four operational shifts. Additionally, the deputy chiefs respond to incidents which escalate beyond a standard box alarm assignment. The department is divided into six operational battalions supervised by a battalion chief for each 24-hour tour of duty. The department is staffed with 32 engine companies, three squad companies, 17 truck companies, one heavy rescue company, and two fire boats. Additionally, the department has six EMS district officers, 21 ALS transport medic units that are staffed by at least one paramedic, and seven basic life support (BLS) transport ambulances that are staffed with two firefighter/Emergency Medical Technicians (EMTs).

The city is divided into predetermined box areas which are geographically located within a station's first due territory and are numbered using the engine in the station's number as a prefix. For example, box 46-40 indicates that Engine 46 would normally be the first due engine to this box assignment. All companies are staffed with four members led by either a captain, lieutenant, or a senior firefighter in an acting lieutenant capacity plus an apparatus operator/driver and two firefighters. Suppression personnel work an eight-day work cycle, consisting of a 24-hour shift, 24-hours off duty, followed by a 24-hour shift, followed by 120 hours (five days) off duty.

The rank structure is firefighter, apparatus driver/operator (pump operators and emergency vehicle drivers), lieutenant, captain, battalion chief, deputy chief, assistant chief, and fire chief. The fire department has a written Manual of Procedure (MOP), which is available to all department members within their stations.

Training, Education, and Professional Development

The fire department maintains an education and training division to ensure that each member of the fire department receives the appropriate instruction and certification needed to effectively perform their duties and prepare for advancement. The department operates a training academy where recruits attend a 10-month non-resident academy. The recruit class is required to complete EMT Basic; NFPA 1001, *Standard on Fire Fighter Professional Qualifications* [NFPA 1001 2019]; Hazmat Awareness and Operations; and an emergency vehicle operations course. Recruits receive Pro Board® certification for Fire Fighter I, Fire Fighter II, Hazmat Awareness, and Hazmat Operations through the Maryland Fire and Rescue Institute.

Upon graduation from the 10-month academy, recruits are assigned to a suppression company where they work at their initial suppression assignment for 10, 24-hour shifts. Once they have completed the 10 shifts at their suppression assignment, they are detailed to a company with the opposite firefighting discipline (truck or engine) for four, 24-hour shifts. Probationary firefighters are assigned a suppression training task book with specific tasks that must be checked off by the recruit's supervisor. Once the task book is completed, it is submitted to the battalion chief for review and approval. Since the occurrence of the incident described in this report, the fire department has begun to place recently graduated recruits from the fire academy as the fifth firefighter on apparatus for a period to assist with mentoring.

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The fire department utilizes internal processes for the professional development of apparatus driver/operator, company officer, and battalion chief including those who serve in acting positions. This process validates the knowledge, skills, and abilities of personnel through national certifications offered through either Pro Board® or the International Fire Service Accreditation Congress as well as internal training task books. The department requires academic knowledge at the collegiate level with pre-established course hours beginning at the rank of lieutenant. Fire department personnel are required to take annual firefighter safety/survival and bailout refresher training at the fire academy.

The fire academy hosts varying fire companies from across the city on a weekly basis to deliver continuing education and training. Weekly trainings include engine and truck multi-company drills as well as specific truck company training. Battalion chiefs and battalion technicians are also provided weekly training which includes the use of a simulation lab for practice of incident management and managing Mayday scenarios.

Apparatus, Staffing, and Communications

The following apparatus were assigned on the initial box alarm assignment. A standard box alarm assignment within this jurisdiction includes five engine companies, two truck companies, two battalion chiefs, and a safety officer. It would be common with battalion chief approval for fire companies to request to be assigned to a box alarm. In this incident Engine 46, Squad 40, and Truck 12 all requested permission from the battalion chief to be assigned to the box alarm.

Table 1. Responding apparatus to box alarm 46-40 and personnel staffing

Apparatus	Personnel Staffing
Engine 29 (E29)	4
Engine 45 (E45)	4
Engine 52 (E52)	4
Engine 20 (E20)	4
Engine 44 (E44)	4
Truck 25 (T25)	4
Truck 16 (T16)	4
Battalion Chief 5 (BC5)	2
Battalion Chief 3 (BC3)	2
Safety Officer 4 (SO4)	1
Engine 46 (E46)	4
Squad 40 (SQ40)	5
Truck 12 (T12)	4

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The fire department operates a city-wide fire communications center utilizing a Motorola P25 digital communications system. Table 2 shows the personnel on fire apparatus.

Table 2. Example, E29 P1 would identify the E29 Company Officer

Portable Radio Apparatus Position	Functional Role
P1	Company Officer
P2	Apparatus Operator/Driver
P3	Firefighter
P4	Firefighter

The computer aided dispatch (CAD) system has preestablished dispatch recommendations for reported structure fires throughout the department's boundaries. Apparatus arriving order determines the fire companies' role upon arrival through established policy.

Table 3. Initial box alarm assignments for 5 Engine/Squad Companies - 2 Truck Companies - 1 Ambulance - 2 Battalion Chiefs - 1 Safety Officer

Arrival Order	On-Scene Role
1st Due Engine/Squad	Secures water source and positions side Alpha
2nd Due Engine/Squad	Covers the hydrant of 1st Due Engine/Squad
3rd Due Engine/Squad	Rapid Intervention Crew
4th Due Engine/Squad	Secures water source and positions side Charlie
5th Due Engine/Squad	Covers the hydrant of 4th Due Engine/Squad
1st Due Truck Company	Covers side Alpha
2nd Due Truck Company	Covers side Charlie

Additional apparatus was assigned upon alarm escalation including: 1 Engine/Squad – 1 Truck Company – Air Unit – Shift Commander.

Personal Protective Equipment

At the time of incident, both deceased firefighters were wearing their department issued structural firefighting turnout gear including coat, pants, hood, helmet, gloves, and boots that met the current requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2018 edition [NFPA 1971 2018]. All components were within their 10-year life cycle. Both the lieutenant and probationary firefighter were also carrying a Motorola APX 6000 portable radio and a SEEK Thermal FirePro X TI device. The fire department had provided a SEEK TI device for every riding position within the department in May 2023, a few months before the incident. It is unknown if either E29 probationary or E29 lieutenant used the TI device during the incident. In this incident, the fire department was using SCBAs that were approved by NIOSH and certified as meeting the NFPA 1981 standard on *Open-circuit SCBA for Emergency Services*, 2007 edition by a

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third-party certification body. NIOSH investigators examined and photographed the PPE of both firefighters at a fire department facility.

Probationary firefighter PPE Inspection

Upon visual inspection of E29 probationary' s PPE, extensive thermal degradation was noted to the outer shell of the turnout coat. This was noted more specifically to the left where the horizontal retroreflective trim was burned away from the PPE garment. Burn holes were observed near the left shoulder/arm/back areas with visible exposure to the inside moisture and thermal layers. The helmet suffered thermal degradation both on the outside and inside of the helmet shell. E29 probationary' s protective hood was noted as having significant charring near the neck and ear areas. The pants were noted as being dirty from debris with very little to no thermal degradation.

E29 probationary' s SCBA was found to be damaged with thermal degradation noted to the SCBA frame, air supply hoses and facepiece. During inspection, the SCBA facepiece lens was found to be severely melted, deformed, with holes completely burned through on both the right and left sides and melted to the second stage regulator. Figures 1 and 2 represent the recorded SCBA cylinder data at the time of incident with the blue line representing the cylinder pressure while the red line indicates breathing/flow rate.

Photo 2 and Photo 3. E29 Probationary firefighter's Helmet (left photo) and SCBA Facepiece Lens (right photo).
(Courtesy of NIOSH.)

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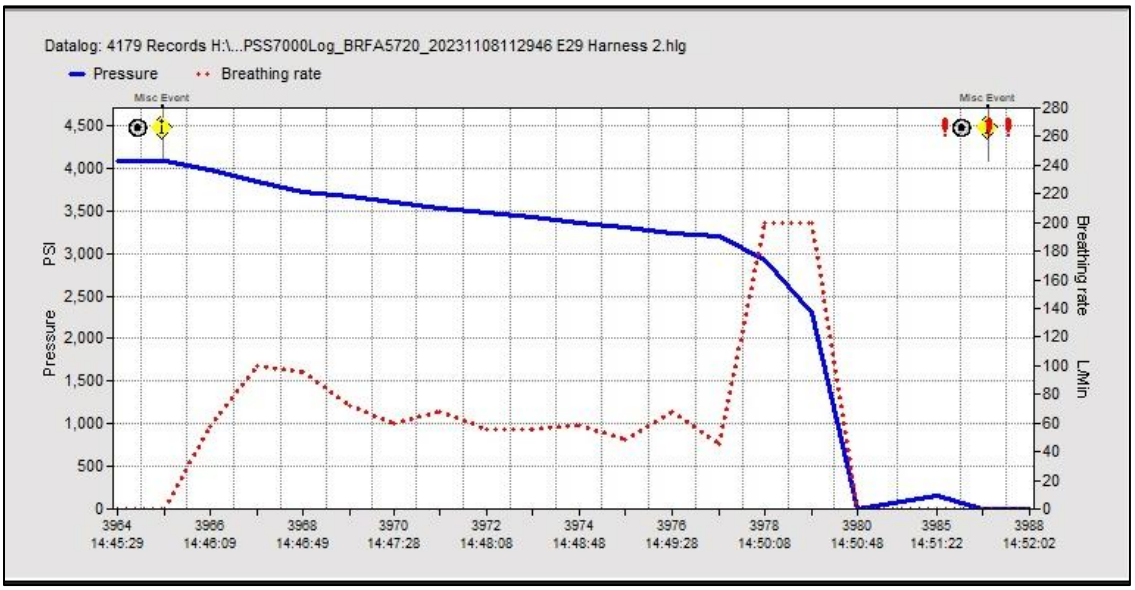

Figure 1. E29 Probationary Firefighter SCBA air loss rate during event.
Note: Due to time drift of the internal SCBA clock the times represented are roughly sixty minutes behind.
(*Courtesy of the fire department.*)

Lieutenant's PPE Inspection

Upon visual inspection of E29 lieutenant's PPE, extensive thermal degradation was noted to the outer shell of the lieutenant's coat more specifically to the right where the horizontal retroreflective trim was burned away from the PPE garment. Burn holes were observed on the back of the coat with damage to the retroreflective trim and visible exposure to the inside moisture and thermal layers. The helmet suffered thermal degradation both on the outside and inside of the helmet shell with damage to the helmet chin strap. E29 lieutenant's protective hood was noted as having charring near the neck and ear areas with holes in the hood. The bunker pants were noted as being dirty from debris with very little to no thermal degradation.

E29 lieutenant's SCBA was found to be damaged with thermal degradation noted to the SCBA frame, air supply hoses and facepiece. The SCBA cylinder had a green padding/foam material melted to the cylinder, which is assumed to be from nearby furniture during the event. During inspection, the SCBA facepiece lens was found to be severely melted, deformed, with a hole completely burned through on the right side.

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Photo 4 and Photo 5. E29 Lieutenant's Helmet (left photo) and SCBA Facepiece Lens (right photo).
(Courtesy of NIOSH.)

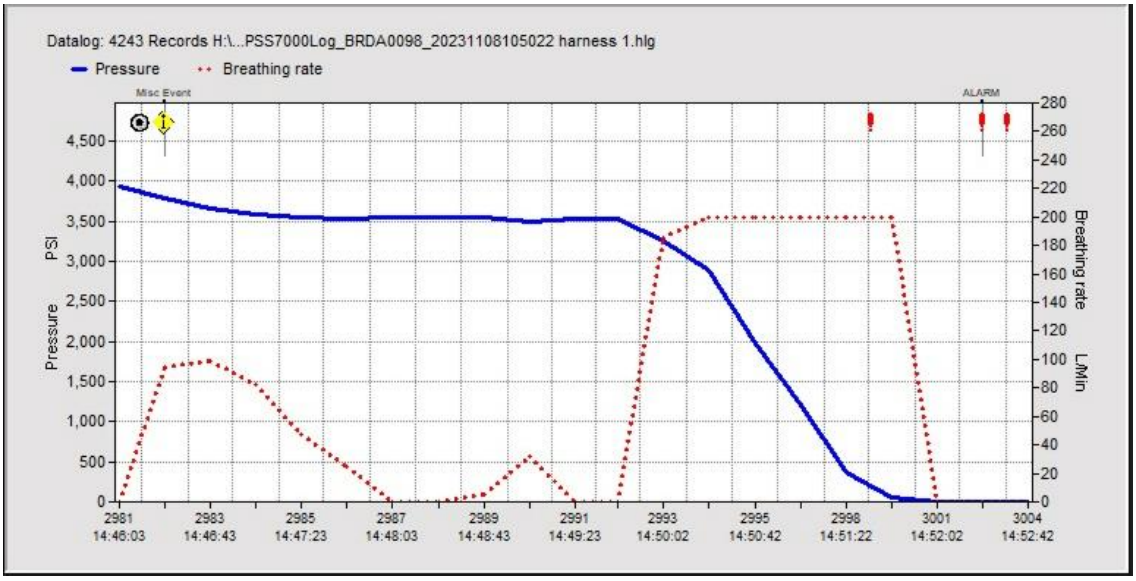

Figure 2. E29 Lieutenant SCBA air loss rate during event.
Note: Due to time drift of the internal SCBA clock the times represented are roughly sixty minutes behind.
(*Courtesy of the fire department.*)

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Weather and Road Conditions

The weather on October 19, 2023, at 1454 hours had cloudy skies. The temperature was 71°F with winds S at 13mph. The humidity was 44% with zero precipitation [Weather Underground 2024]. Based upon neighborhood wind data (lower wind speed) coupled with the impact of nearby buildings fire modeling conducted by UL FSRI indicated that the fire was not significantly impacted by the wind.

Structure

This single-family two-story rowhome was situated along a residential street consisting of 23 other rowhomes spanning a block in length. The interior of the impacted rowhome measured 13’ in width and 40’ in length with an 8’ front porch and side Charlie porch measuring 11.5’ wide by 15.6’ in length. This single-family rowhome was built in 1901 using ordinary construction. The interior walls were lath and plaster and in some areas were covered with a combustible wall paneling. The ceiling consisted of lath and plaster with typical ordinary construction and had a common drop ceiling noted in parts of the first floor. In 2002, a rear deck was added to side Charlie and enclosed into a porch. The rear deck was constructed with 4x4 post, 2x4 studs, and 2x8 joists of nominal size for the era. This rear deck (enclosed porch) was permitted at the time of construction.

The roof was flat with minor sloping for runoff and consisted of a normal exterior weather finishing. NIOSH investigators were limited in being able to examine the entire structure, including the basement due to structural collapse of the building. For this report, side Alpha is orientated to the north followed by side Bravo to the east, side Charlie to the south, and side Delta to the west. Sides Bravo and Delta were rowhome exposures that later encountered fire spread and extension but played no significant role in the investigation.

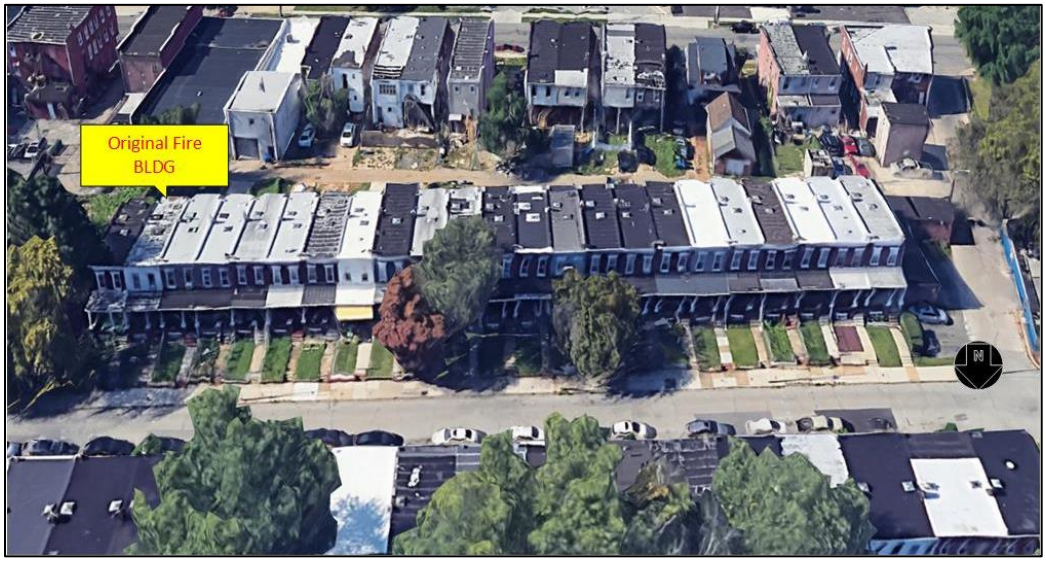

Photo 6. Aerial view of rowhomes in the block.
(Courtesy of Google Earth.)

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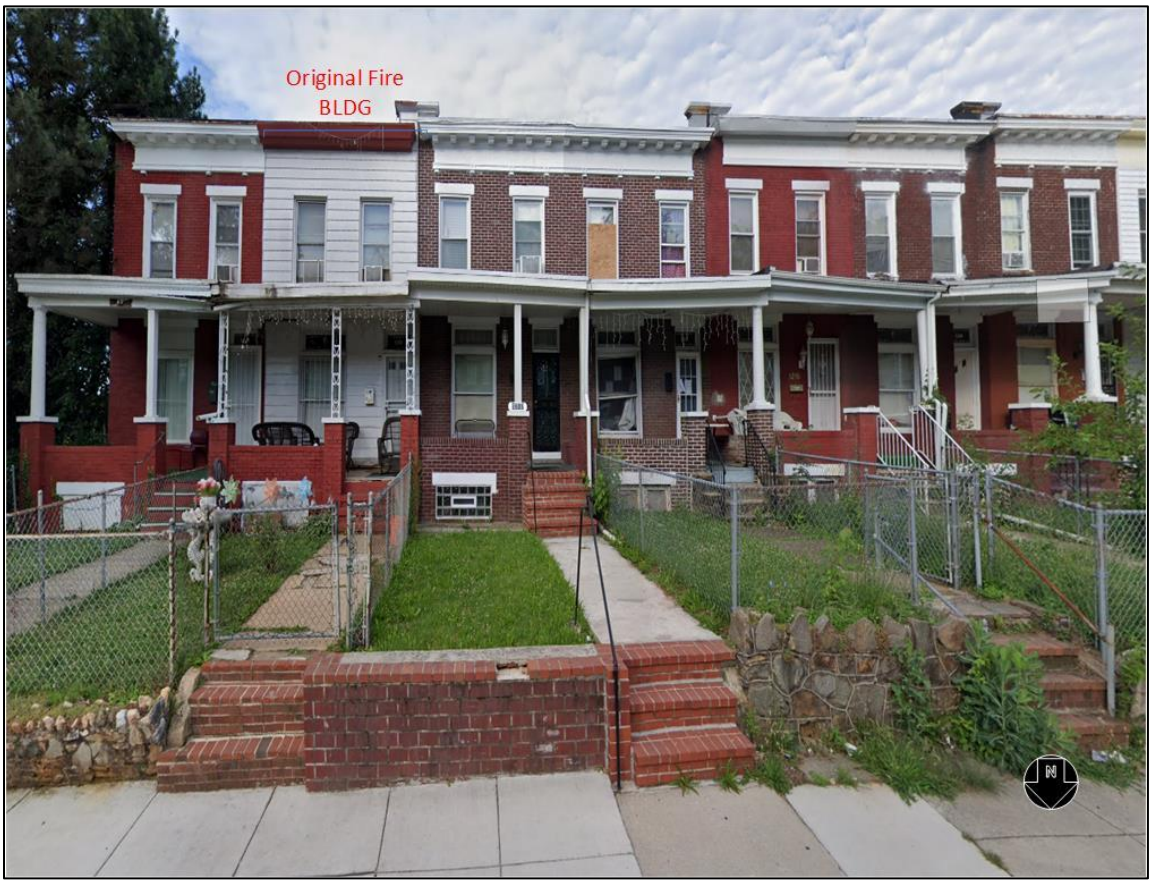

Photo 7. Side Alpha Street view of original fire building.
(Courtesy of Google Earth.)

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First Floor Diagram **Second Floor Diagram**

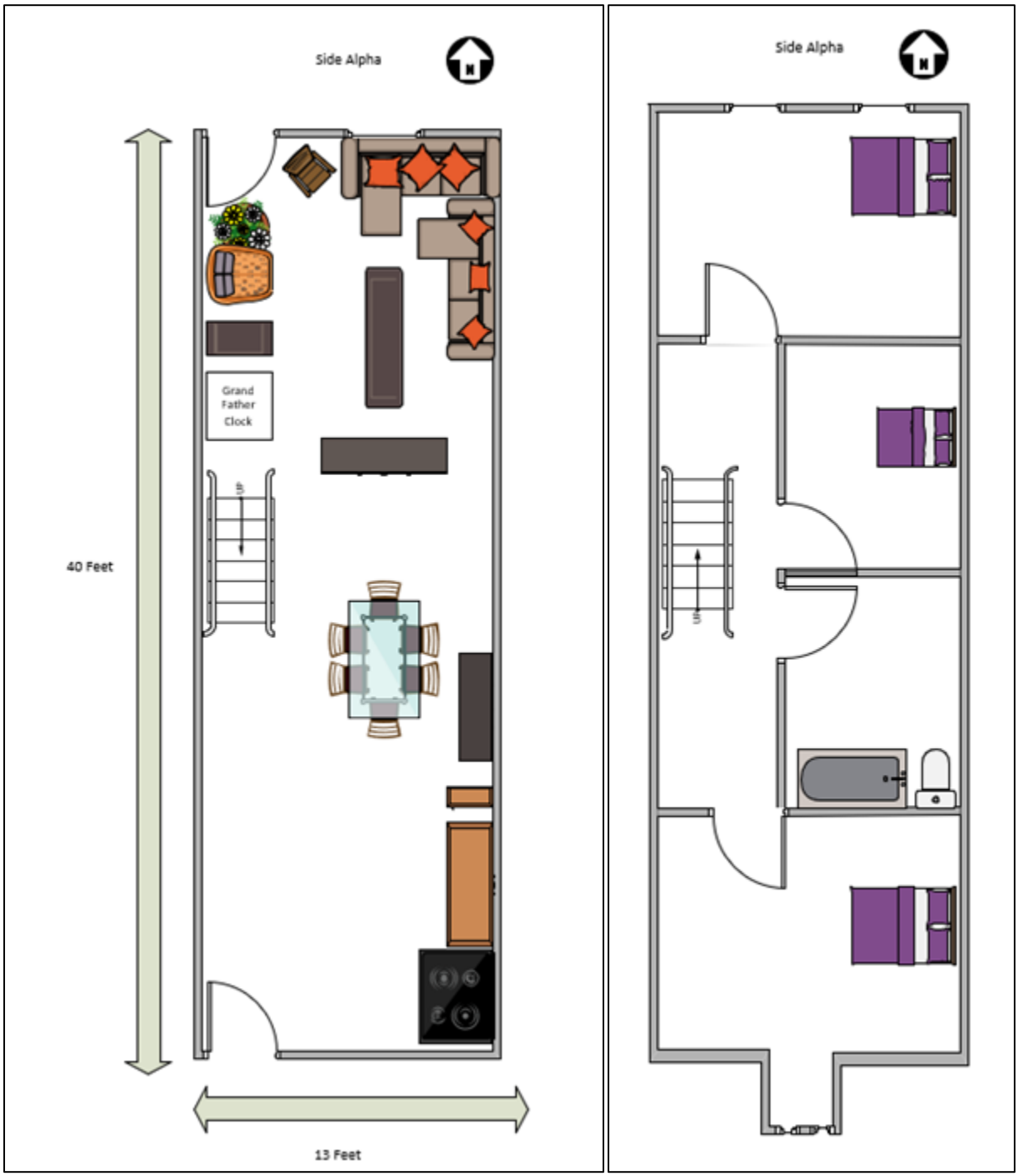

Diagram 1. First and Second floor layout NOTE: Furniture location and type is approximate and not exact *(Courtesy of NIOSH.)*

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Timeline

The following timeline is a summary of events that occurred as the incident evolved. Not all incident events are included in this timeline. The times are approximate and were obtained by examining the dispatch records, audio recordings, witness statements, and other available information. This timeline also lists the changing fire behavior indicators and conditions reported, as well as fire department response and fireground operations. The timeline is not intended, nor should it be used, as a formal record of events.

Time	Fireground Operations, Response, and Details
1541 hours	• E29, E45, E52, E20, E44, T25, T16, BC5, BC3, SO4 dispatched for a structure fire to box 46-40 • Initial box alarm assignment included apparatus not normally assigned to that box. SQ40, E46, and T12 requested permission to take the box after dispatch
1543 hours	• BC5 reported a large smoke plume is visible while enroute
1544 hours	• E29 spotted primary hydrant and completed a forward lay of 4-inch supply line to side Alpha past the address • E29 on-scene with a two-story, middle of the group with fire showing from the rear (side Charlie) • E29 lieutenant assumed IC
1545 hours	• BC5 on-scene and upgraded box 46-40 to a working fire assignment, assumed IC, and announced the staging location for incoming apparatus • Working fire assignment added Air Flex 1 (AF1), Deputy Chief 5 (DC5), and the Fire Investigation Bureau (FIB12) but didn't add any additional fire companies to the box since the IC had approved additional companies "taking the box" upon the initial dispatch
1546 hours	• E52 on-scene and assumed RIT on side Alpha
1547 hours	• IC established the ICP on side Alpha • IC reported two-story middle of the group second from the end with heavy fire on side Charlie with extension.

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Time	Fireground Operations, Response, and Details
	IC also confirmed the address that was on fire to the communications center
1548 hours	• SQ40 requested local police to respond and clear traffic out of the staging area • IC to E29 "have you reached the back of that dwelling yet?" • IC to E46 – "knock down the exterior fire (side Charlie) and stop the horizontal fire spread"
1549 hours	• T25 to IC – "T25 has no access to side Alpha" • Narrow street, companies on-scene and a charged 4-inch supply line blocked access for the first due truck company
1549:18 hours	• E29 Lieutenant – "Mayday, Mayday, Mayday"
1549:23 hours	• IC acknowledged the Mayday
1549:35 hours	• E29 Lieutenant – "Mayday, Mayday, Mayday first floor"
1549:39 hours	• IC to the Mayday – "What is your location?"
1549:52 hours	• E29 Lieutenant transmits – "29 I can't get out"
1550 hours	• IC requested a RIT Task Force be added to the box alarm from the communications center • IC instructs on-scene personnel to limit radio traffic to emergency traffic only
1550:23 hours	• IC to E29 Lieutenant – "need a report of your location" • No answer from E29 Lieutenant
1550:42 hours	• IC to BC3 – Need E46 to start dumping water into the structure from side Charlie

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Time	Fireground Operations, Response, and Details
	• BC3 acknowledged and reported heavy fire on three dwellings on side Charlie and requested the location of the Mayday
1551 hours	• IC requested a second alarm for box 46-40
	• Communication center dispatched the RIT Task Force and Second Alarm units • E21, E13, E8, E30, E43, E4, T8, T1, T5, M15, BC2, BC6, SO2, EMS5, PIO, AF1, Fire Investigator • IC to E29 Lieutenant – Need a report • SQ40 P3 – Mayday, "at the front door we need a saw to get the bars off the windows, bars off the window, Mayday" • Fire out a window on side Alpha and security bars were covering the window opening
1552 hours	• T12 to IC – Bars removed from the side Alpha window • T12 observed firefighters down inside the window in the living room • SQ40 to IC – we have one firefighter removed and need a medic • E29 lieutenant is removed from inside through side Alpha front door • IC to Medic 11 – Report to side Alpha • Medic 11 was still enroute to the scene
1553 hours	• IC to all units on-scene – Focus fire attack on the exposures • Both vertical and horizontal fire spread is observed to attached exposures on sides Bravo and Delta
1554 hours	• T12 P1 to IC – Located second firefighter just inside the front door to the left near a couch on side Alpha • T12 P1 requested that Engine companies keep flowing water as they worked to extricate the probationary firefighter from E29

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Time	Fireground Operations, Response, and Details
1555 hours	• SQ40 P1 to IC – Both crew members from E29 have been removed from the structure • E29 lieutenant and probationary firefighter are removed to side Alpha and treated and transported by EMS to local trauma/burn facilities
1557 hours	• IC to all units on-scene – Standby for a PAR • IC confirmed that all four crew members of E29 were accounted for, and Mayday cleared

Investigation

On October 19, 2023, the local communications center received 9-1-1 calls indicating a rowhome was on fire across the alley from neighbors. The communications center dispatched E29, E45, E52 as the RIT company, E20, E44, T25, T16, BC5, BC3, and SO4 to box alarm 46-40 at 1541 hours. At 1542 hours E46, SQ40 and T12 requested permission from BC5 to be assigned to the box alarm. Both E46 and SQ40 were returning from EMS recertification training during the box alarm assignment but were able to clear their scenes and received permission from BC5 to take the box alarm. At 1543 hours, the communications center advised BC5 and responding apparatus that they had received another call indicating a different address nearby. BC5 acknowledged the information and advised that a smoke plume was visible in the sky from the area.

At 1544 hours, E29 approached the scene from the south traveling north and spotted the primary hydrant. E29 completed a forward lay of approximately 400 – 500'of 4-inch supply line down the street, just past the address on fire. E29 positioned on side Alpha reporting a two-story, middle of the group rowhome, with fire showing from side Charlie, and assumed incident command. Both E29 lieutenant and E29 probationary turned on their SCBAs at 1545 hours and stretched a preconnected 1 ¾-inch attack line to side Alpha of the structure. BC5 arrived on-scene and assumed IC, upgraded the box alarm to a working fire assignment, and established the ICP in the street on side Alpha at 1545 hours. The working fire assignment added Air Flex 1 (AF1), Deputy Chief 5 (DC5), and on-duty fire investigators from the Fire Investigation Bureau (FIB12).

SQ40 arrived second due and positioned near the primary hydrant. The crew from SQ40 reported to side Alpha and deployed a 250' 1 ¾-inch backup attack line from E29 and assisted with getting kinks removed from both E29 and SQ40 attack lines as E29 lieutenant and E29 probationary prepared to make entry into the structure. The occupants of the rowhome had self-evacuated, and the side Alpha door was unlocked. No fire was visible on the porch or when the side Alpha door was opened. E20 arrived on the scene and covered E29's hydrant by relay pumping the 4-inch supply line while the crew of E20 deployed a 200' 1 ¾-inch attack line from E29 to the side Delta exposure unit to stop the horizontal fire extension from "walking the block." E52 arrived on-scene at 1546 hours and positioned at a nearby intersection and reported to side Alpha and assumed the RIC.

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Per department policy, E52 looked for the closest truck company to retrieve a rapid intervention kit. However, no truck companies were on the scene. The department has rapid intervention kits on all apparatus within the city. A third 150' preconnected 1 ¾-inch attack line was deployed to side Alpha from the front bumper of E29. At 1547 hours, the IC provided a situation report to the communications center that they had a two-story, middle of the group, second from the end, with heavy fire on side Charlie with extension. The IC also confirmed the address and actual rowhome that was on fire.

E46 positioned on side Alpha near the east alleyway and completed a forward lay from a second hydrant upon arrival to the scene. At 1548 hours, IC instructed E46 to stretch to side Charlie and knock down the exterior fire and stop the horizontal fire spread. E46 stretched a 400' 1 ¾-inch attack line to side Charlie via the east alleyway. IC requested a situational report from E29 lieutenant on the progress being made into the structure.

As T25, T16, and T12 were nearing the incident scene, T25 informed command that they had no access to side Alpha at 1549 hours. T25 positioned on the main road to the east due to supply lines, narrow streets, and civilian vehicles being parked on the street. T12 entered the alley to the east of the fire building from the south and T16 positioned in a parking lot to the east that gave ladder access to the building. T12 noted as they approached side Charlie that the rear enclosed porch of the fire building was still standing with vertical fire extension into the roof and was spreading horizontally.

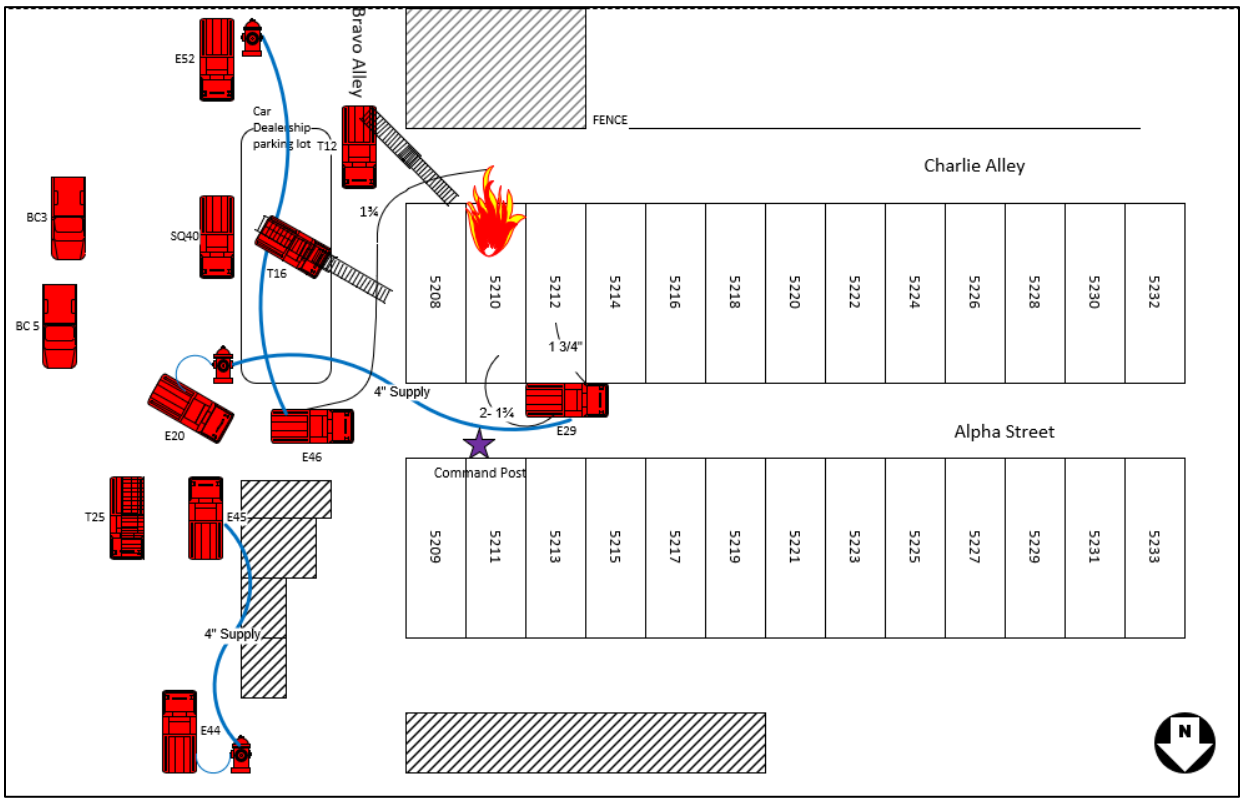

Diagram: 2 Apparatus and initial attack and supply line placement.
(Courtesy of NIOSH.)

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As BC3 was arriving, E29 lieutenant declared "E46 - Mayday, Mayday, Mayday" at 1549:18 hours. IC immediately acknowledged the Mayday and requested the location of E29 lieutenant and E29 probationary. E29 lieutenant was normally assigned to E46 and mistakenly identified his apparatus for the day during the initial mayday call. At 1549:35 hours, a second Mayday was transmitted noting "E29, Mayday, Mayday, Mayday, first floor". IC again requested the location of when E29 lieutenant transmitted "29 can't get out" and the transmission ended. IC requested a RIT task force assignment be added to the box alarm at 1550 hours from the communications center which would add additional resources to respond to the scene. IC requested that BC3 assigned as Charlie Division have E46 start flowing water into the structure from side Charlie. Charlie Division acknowledged the request and informed the IC that side Charlie had heavy fire on three dwellings in the rear and one line working but needed additional attack lines.

Table 4. On-Scene Fire Company Assignment Post Mayday

Company	Assignment
E29	Interior Fire Attack with 1 ¾-inch attack line side Alpha
SQ40	Backup 1 ¾-inch attack line side Alpha
BC5	Incident Command side Alpha
E20	Pumping the hydrant to supply E29 - Interior Delta exposure 1 ¾-inch attack line
E52	RIT side Alpha
E46	2nd supply line – Exterior Fire Attack with 400' 1 ¾-inch attack lines side Charlie
BC3	Side Charlie Division Supervisor
E45	3rd supply line – side Charlie fire attack
E44	Pumping the hydrant to supply E45 – side Charlie fire attack
T25	Roof Division
T12	Mayday operations and interior operations
T16	Mayday operations and interior operations

At 1551 hours, the IC requested a second alarm assignment to box 46-40 and requested a report from E29 lieutenant with no response. SQ40 P3 transmitted a Mayday message after the window break, indicating that fire was venting out the side Alpha window and there were fixed metal security bars on the window. It is unknown if the side Alpha window failed or was broken by a firefighter from E29. SQ40 P1 made entry through the front door on side Alpha and could hear yelling but withdrew back to the door to secure a handline. SQ40 P1 observed an attack line flowing water into the side Alpha window hitting the fire from the exterior. SQ40 P1 made entry again into the structure searching for the crew of E29. T12 being unable to access the side Charlie alley due to live wires being down reported to side Alpha and was assigned the rescue group leader by IC. Charlie division requested additional attack lines to side Charlie and was instructed by the IC to start utilizing the second alarm companies as they arrived.

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T12 P1 and members of SQ40 worked to remove the security bars off the side Alpha window where E29 probationary was observed by T12 P1 standing inside the window with both hands on the bars before disappearing in the smoke. At 1552 hours, T12 P1 informed IC that the security bars were removed, and he had members of E29 down, inside the structure. T12 P1 entered the window headfirst keeping his feet locked onto the windowsill searching for E29 probationary. SQ40 P1 continued to search just inside the front door when the E29 lieutenant was located at 1552 hours on the floor. E29 lieutenant was pulled to the front door by his SCBA and treated by members of the RIT team and other fire companies. SQ40 P1 confirmed with E29 lieutenant that one firefighter was still inside the structure.

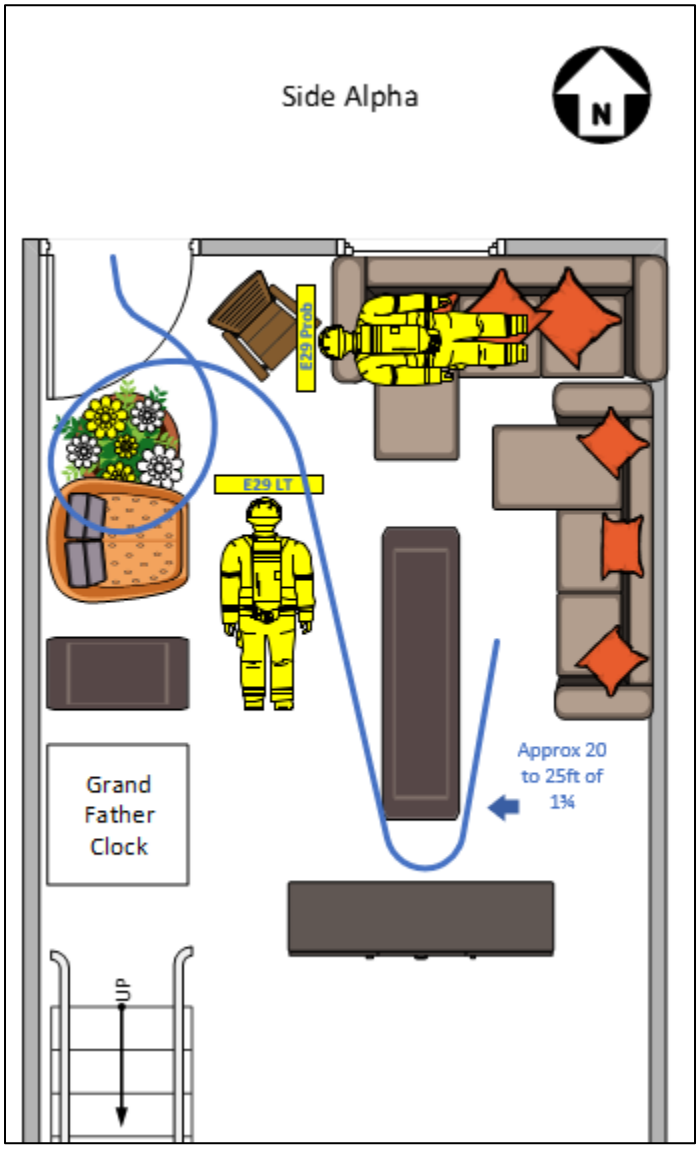

Diagram 3. Approximate location the probationary firefighter and lieutenant were located on the first floor. *(Courtesy of NIOSH.)*

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At 1554 hours, T12 P1 advised IC that he had located E29 probationary near the front door laying on a couch and was trying to extricate him. T12 P1 requested manpower and for companies to keep flowing water into the structure. T12 P1 attempted to extricate E29 probationary by pulling on his SCBA, which broke free from his body. T12 P1 was able to position E29 probationary with assistance from other members inside the structure and extricate him to the front porch. At 1555 hours, SQ40 P1 informed IC that both firefighters had been removed from the structure. Both firefighters were transported to a local trauma center where E29 probationary was pronounced deceased in the emergency room. E29 lieutenant was later transferred to a local burn center where he succumbed to his injuries on October 24, 2023.

Fire Origin and Cause

After investigation by the local ATF office, the cause of the fire for box 46-40 was undetermined and ruled accidental in nature.

Cause of Death

The local medical examiner listed the cause of death for both firefighters as accidental and related both to smoke inhalation and thermal injuries.

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. NIOSH investigators identified the following items as key contributing factors in this incident that ultimately led to the fatalities:

- Strategy and tactics for exterior fires extending into the interior of a structure
- Thermal degradation and failure of SCBA facepiece lenses and EBSS (Buddy Breather Whip)
- Recognition of fire dynamics
- Use of thermal imaging camera to observe changing fire conditions and escape routes
- Interior structural firefighting experience.

Recommendations

Fire departments should:

Recommendation #1: Develop policies that address both strategy and tactics as they relate to exterior fires, vertical fire spread, and horizontal extension into a structure.

Discussion: In this incident, the fire began in an enclosed porch addition that was added to the structure using wood frame construction. The enclosed porch was attached to side Charlie and provided a room/porch to the side Charlie entrance door. This enclosed porch provided the opportunity for rapid vertical fire growth to the second floor, cockloft, and roof while also rapidly spreading horizontally into the rowhome traveling from side Charlie towards side Alpha. Fire extension had also

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spread horizontally to each of the rowhomes on either side of the original fire building. E29 approached the scene from side Charlie and positioned on side Alpha.

Exterior fires with both vertical and horizontal progression can present a hazard to arriving personnel. It is common that the additions of exterior porches and rooms to a preexisting structure are constructed with typical building materials that have known combustible characteristics like wood framing, vinyl siding, sheathing, and insulating materials. In this incident, the main structure consisted of a non-combustible exterior finishing but, the wood frame exterior porch was connected to the exterior of the structure. Upon arrival of E29, the fire was well developed beyond the initial stage on side Charlie.

Photo 8 and Photo 9. Side Charlie exterior porch (left photo) and Side Charlie exterior porch frame (right photo).
(Courtesy of NIOSH.)

It is the responsibility of the first arriving company or chief officer on-scene of an exterior fire to be mindful to the many factors involving fire dynamics when considering the appropriate strategy for the incident. NFPAs 1700 *Guide for Structural Firefighting, Chapter 9* [NFPA 1700 2021] outlines several factors to evaluate or consider including:

- *Reading smoke and fire conditions* – Based on volume, velocity, color, and density
- *Fuel load* – Increased fuel loads may increase higher heat release rates
- *Openings* – Windows, doors, and structural openings that may provide a pathway for fire extension
- *Assessing flow path* – Air and gases move from higher pressure to lower pressure, using doors and windows within a structure

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- *Weather conditions* – Wind driven fires is a primary weather-related hazard
- *Accessibility of the structure* – Apparatus placement, water supply, and access for fire attack and ground ladders
- *Fire progression* – 360-degree walkaround predictions should be made to predict fire spread while considering fire dynamics and outcomes of fire attack and ventilation
- *Fire control positioning* – Location of the seat of the fire, survivability profiling, and access.

The author of "Outside-In Fires: Effective Response," wrote that "A fire burning on the exterior of a structure must have water applied to it as quickly as possible for success in preventing or controlling its spread to the structure's attic and void spaces" [Cotter 2016]. Research on exterior fires conducted by UL Fire Service Research Institute (UL FSRI) confirms that tactics involving exterior fires should include the rapid extinguishment of exterior fires before committing to the interior of a structure. More information can be found at Residential Attic and Exterior Fires| FSRI Safety Academy [FSRI 2024].

Consequently, when first arriving company or chief officers arrive on-scene and observe active and well-developed fire on the exterior of a structure that is spreading vertically, horizontally, or both with survivable space within the structure, consideration should be given to a transitional attack. NFPA defines the transitional attack or exterior fire control as "the application of a fire stream from the exterior of a structure to improve conditions prior to interior fire control" [NFPA 2021]. The transitional attack can be utilized using a variety of attack lines, blitz attack line flowing greater than 300 gallons per minute, or aerial master stream.

Recommendation #2: Consider upgrading or replacing current SCBAs to meet the 2013 or more recent edition of the NFPA 1981 or NFPA 1970 (1981) standard.

Discussion: In this incident, both E29 lieutenant and E29 probationary suffered extensive thermal degradation of the SCBA facepiece lenses and suffered damage to air supply hoses. At the time of the incident, the fire department used NIOSH Approved® SCBAs that were certified as meeting the NFPA 1981 standard on *Open-circuit SCBA for Emergency Services*, 2007 edition by a third-party certification body. NIOSH first recognized and noted in FFFIPP report 2009-11 TX (*Career Probationary Fire Fighter and Captain Die as a Result of Rapid-Fire Progression in a Wind-Driven Residential Structure Fire – Texas*) the need for additional research into thermal performance as it relates to the SCBA [NIOSH 2010]. This report recommended that both research and standard setting organizations should: "conduct research to more fully characterize the thermal performance of SCBA facepiece lens materials and other PPE components to ensure SCBA and PPE provide an appropriate level of protection."

Since 2009, several NIOSH Fire Fighter Fatality Investigation and Prevention Program reports suggest that:

- Certain SCBA facepiece lens materials may be failing before other components of the firefighter's SCBA and personal protective equipment ensemble.
- Facepiece lenses of SCBAs certified to the 2007 or earlier editions of the NFPA 1981 standard may undergo thermal degradation when exposed to intense heat and energy while operating in

> the modern flow path. This may include bubbling, crazing, severe deformation, or holes developing in the lens.

In 2010, the fire service, SCBA manufacturers, and research organizations convened at the Emergency First Responder Respirator Thermal Characteristics workshop to discuss the trend of SCBA facepiece thermal degradation and to explore the possibilities of future thermal testing that could be done to improve the thermal assault to the SCBA facepiece lens. The SCBA is a primary part of the firefighters PPE and with advances in PPE design, firefighters became better protected from increasing temperatures and an increase in heat-release rates of modern furnishings inside a structure fire.

Perhaps the most vulnerable component of the SCBA ensemble is the polycarbonate lens in the facepiece. Exposure to high heat flux conditions can cause damage to the facepiece. Heat flux is the measure of the rate of heat transfer to or from a surface area. The units typically used for heat flux are kilowatts per square meter. For points of reference: bright sunshine provides about 1 kW/m2, the heat flux used in the 15 kW/m2 is the NFPA SCBA lens radiant heat test, and 20 kW/m2 is the approximate heat flux to the floor when flames roll across an 8 ft tall ceiling, also considered the beginning of the transition to flashover. The heat flux to an object engulfed in flames can range from 60 to more than 150 kW/m2 [Madrzykowski 2017]. Between 2002 and 2011, NIOSH investigators, with the help of the FFFIPP Medical team and numerous medical examiners found evidence that SCBA facepiece lenses likely degraded while the fire fighters were still breathing air.

Medical findings such as carboxy hemoglobin results and autopsy examinations involving airway thermal injuries supported a theory of death occurring by exposure to extreme heat and not an out of air event occurring prior to the lens being degraded. These findings in separate firefighter fatality incidents (when the firefighters were caught in high heat-release situations) indicated that they may have been a contributing factor to the firefighter's deaths.

As a result of the Respirator Thermal Characteristics workshop, the National Institute of Standards and Technology (NIST) conducted a series of tests (breathing manikin-laboratory burn test as well as breathing manikin-live testing during structural fire test burns) as part of a study to measure radiant heat fluxes as it relates to thermal assault to the SCBA facepiece lens. This study was funded through a partnership between the USFA and U.S. Department of Homeland Security.

In 2011, NIST completed live fire experiments in vacant townhomes located in an urban environment with uniformed furnishings. Part of the experiment was to correlate the differences between legacy heat-release rates when compared to modern heat-release rates. The findings of the live fire experiment revealed that many current SCBA facepiece lenses could be prone to bubbling, loss of visual acuity, deformity, and in one case a hole burned through the facepiece lens.

During the live fire testing and experimentation five SCBA manufacturers products were tested. It should be noted that this experimentation did not mean that the tested SCBA facepiece lenses failed (as they met the current testing and consensus standards in effect at the time they were certified) but, should be interpreted that the modern heat-release rate in a modern fire environment was releasing more energy than the level being originally tested to [Mensch 2011]. Findings of this report included:

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- Brand of facepiece not a factor
- Shape (facepiece) may be a factor
- Airflow provided cooling internally to the facepiece
- Degradation is unavoidable once polycarbonate lenses reached glass transition temperatures becoming soft and pliable
- Heat Flux always involved peak levels.

A 2012 NFPA and NIOSH Safety Alert, along with research by the National Institute of Standards and Technology and other entities, helped establish the *Lens Radiant Heat Test* and the *Elevated Temperature Heat and Flame Resistance Test*. This work brought attention to the American fire service in general that modern building construction and furnishings were producing heat-release rates at a rate greater than those of legacy construction. It also noted that under high temperature conditions/high heat-release rates, the SCBA facepiece lenses could degrade or melt. At the time of the Safety Alert, NFPA [2012] suggested that fire departments should:

- Remove any SCBA facepiece that was found to have cracks, crazing, bubbling, deformation, discoloring, gaps, or holes
- Review training material and ensure that firefighters understand the limitations of the SCBA and how to respond to issues when encountering high temperature environments
- When selecting strategies and tactics the IC, company officers, and firefighters should take into consideration the factors of delayed recognition of high temperature environments due to protection of the firefighters PPE
- On-scene personnel should maintain situational awareness to changing fire conditions when engaged in interior firefighting operations and should feel compelled to self-evacuate should the conditions begin to rapidly change
- Fire department and emergency services that utilize SCBA should begin planning to upgrade SCBA equipment to the new 2013 edition of NFPA 1981.

In March 2013, the updated NFPA 1981 standard was published to reduce future occurrences of these failures. SCBAs manufactured after August 2013 would need to meet the new 2013 standard that brought about many upgrades to the SCBA to include:

- Specific testing for the SCBA facepiece lenses to include both a flame and radiant heat test
- New voice communication intelligibility requirements
- Changes to the End of Service Time Indicator.

It should be noted that it is unknown whether the hostile fire event in this incident would have exceeded the thresholds of these tests.

Fire departments should consider upgrading or replacing their current SCBA to meet the 2013 or more recent edition of the NFPA 1981 standard. Testing by organizations such as the Fire Safety Research Institute has shown that SCBA models manufactured with more radiant heat and flame-resistant

materials that are compliant with at least the 2013 edition of NFPA 1981 have improved thermal performance when exposed to radiant heating.

Recommendation #3: Train firefighters in fire dynamics, recognition of flow paths, and tactics to reduce the potential of working in the exhaust portion of a flow path.

Discussion: In this incident, E29 approached the scene from the south traveling north to take a position on side Alpha. Upon arrival on side Alpha, E29 confirmed a fire in the rear (side Charlie) of the structure, assumed IC, and stretched a 1 ¾-inch attack line to side Alpha to prepare for an interior fire attack. Fire conditions at this time were well involved on side Charlie and spreading both vertically and horizontally on the exterior of the building on side Charlie. The exterior fire had also communicated into the fire structure itself and was traveling from side Charlie to side Alpha along the first and second floor. The interior finishings of the first floor included a non-combustible drop ceiling, combustible wood panel wall coverings, and normal combustible furnishings throughout the first floor.

During the interior fire attack, the front door on side Alpha was unlocked and was opened as the point of entry for the lieutenant and probationary firefighter from E29. The front door remained open during the incident. The living room window on side Alpha was intact upon the arrival of E29 and during the initial interior fire attack. It is unknown how the window on side Alpha was broken, although it was already broken during the Mayday operations when the captain from T12 was removing the security bars to gain access.

Photo 10. Living room facing side Alpha.
(*Courtesy of NIOSH.*)

Research has been conducted by NIST, UL FSRI, and the International Society of Fire Service Instructors (ISFSI) on modern fire dynamics involving heat release rates, new building construction

techniques, and the composition of modern home furnishings. In years past, these home furnishings were largely composed of natural products such as wood and cotton. Today, many of these home furnishings are now manufactured using petroleum-based synthetic materials that generate high heat release rates as well as toxic and flammable smoke. Consequently, common, everyday structure fires can create an oxygen depleted environment with fuel rich smoke that can sustain combustion given the appropriate mixture of air and heat.

A flow path is defined by NFPA as "the movement of heat and smoke from the higher pressure within the fire area towards the lower pressure areas accessible via doors, window openings, and roof structures" [NFPA 1410 2020]. Flow paths consist of an inlet and an exhaust with the direction of travel being determined by pressure. Heat and smoke in a high-pressure area will travel to an area of lower pressure. It is possible to have multiple flow paths within a structure dependent upon the size of the building, openings, closures such as fire doors, and overall structure design. Personnel working in the flow path (between the seat of the fire and the exhaust) are operating in a significantly risky environment. Coordinated ventilation tactics should be utilized to redirect the flow path from interior operations.

The International Fire Service Training Association (IFSTA) notes in the 7th Edition of the Essentials of Firefighting that, "when firefighters advance a hoseline or ventilate windows to make entry into a building, they establish new flow paths between the fire compartment (in this case the location) and exterior vents of the building" [IFSTA 2018].

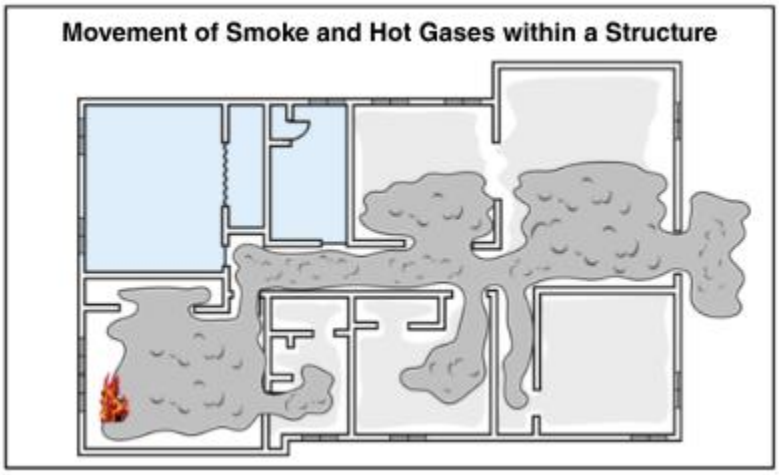

Figure 3. Movement of Smoke. (*Courtesy of IFSTA.*)

When identifying the flow path within a structure, personnel should be mindful to wind conditions. Wind can create pressure changes within a structure or building which could spread both smoke and fire into non impacted parts of the structure or building. Interior firefighting personnel should be mindful to these changes in conditions that place the interior firefighting personnel in the exhaust

portion of the flow path. Sudden changes in temperature and smoke are factors that should alert interior personnel of imminent changes to conditions.

Understanding that modern fuel loads inside of residential structures creates flammable gasses that will sustain combustion interior fire attacks should utilize TI devices (recommendation #4). Water should be applied to the fire as quickly as possible utilizing the reach of an effective fire stream that is delivering an appropriate volume of water to overcome the heat release rate. In some cases, it may be appropriate to introduce water from the exterior of a structure through a window/door with an attack line or begin the fire attack from the exterior with a coordinated blitz attack flowing 300 gallons per minute or greater before committing personnel to the interior. Fire departments should be cooling interior spaces from the safest and closest location possible, especially in vent limited spaces.

Recommendation #4: Ensure proper training for firefighters on the use and limitations of TI devices as they relate to interpreting fire dynamics.

Discussion: In this incident, the fire department provided a standalone TI device for each company officer on every fire apparatus that included a color screen and temperature measurement. In June 2023, four months prior to the incident, the department also issued a TI device for each SCBA within the department. The department had distributed training material and information as it relates to the assigned TIs. Although the standalone TI device is larger in size when compared to the TI attached to the SCBA, the standalone TI device incorporates a larger screen with more user functions in relation to the images being displayed.

These smaller and more compact TI devices attached to each SCBA are not only cost efficient but also allow for a compact, portable option for carrying a TI device into an immediately dangerous to life and health (IDLH) atmosphere. On the day of incident, E29 lieutenant did not use the standalone TI that was assigned specifically for company officers for observing changing fire conditions; however, he was wearing the TI assigned to the SCBA. E29 probationary was also in possession of the SCBA TI during the interior fire attack. It is unclear as to whether either the E29 lieutenant or E29 probationary utilized the TI attached to their SCBAs during the event. Since this incident, the fire department has enabled recording features to the standalone TI's that are assigned specifically to company officers.

TI devices are a valuable tool especially for scene size-up, fire attack, search and rescue, and overhaul. Fire departments should ensure that training is conducted in the use, functionality of the specific TI, and the various options associated with a specific TI. Firefighters should be able to demonstrate the knowledge, skill, and ability for the use and interpretation of the images seen while utilizing a TI. Caution should be exercised when utilizing a TI as they are an electronic device and could malfunction or lead to a false sense of security in relation to situational awareness. Training and education should help the user understand and interpret the conditions being encountered in relation to the unfolding fire dynamics.

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Recommendation #5: Consider level of experience, tacit knowledge, skill familiarity, and the need for close supervision when assigning tasks with higher potential of injury to probationary firefighters.

Discussion: In this incident, E29 probationary had recently graduated from a ten-month non-residency full time fire academy. During the fire academy, students receive Pro Board® certification in Firefighter 1 and Firefighter 2 and complete four weeks of focused, hands-on skills training to demonstrate skills and abilities before graduation. Upon graduation, the firefighter recruit is assigned to ten shifts at their assigned discipline (Engine, Truck, or Squad) before being assigned to ten shifts in the opposite discipline. Probationary firefighters also spend time as an EMT on a transporting EMS ambulance to be orientated as a dual role firefighter/EMT. Probationary firefighters are assigned a recruit task/skill book that is completed during probation and requires a skills check by their battalion chief before being released from probation.

Since being recently graduated, E29 probationary had only 19 shifts before the date of incident. Each of those shifts were split between both riding a fire apparatus and a transporting ambulance. On the day of incident, E29 was being commanded by a lieutenant not normally assigned to this E29 crew. E29 probationary, on this day, was assigned the nozzle/pipe position on the apparatus leaving only the lieutenant and probationary firefighter on the nozzle with a more experienced firefighter assigned the lead off position assisting with water supply. What transpired during the interior fire attack is not fully known, but the 1 ¾- inch attack line was advanced 20 – 25’ inside the small living room area no further than 13’ into the structure. There was no evidence from on-scene personnel or the E29 apparatus operator that the attack line was ever operated inside of the structure during the interior fire attack.

The role of crew members should be clearly outlined in department policies regarding expectations and roles in the professional development, coaching and mentoring of probationary firefighters. Company officers must take into consideration the experience and skill level of probationary firefighters when responding to emergencies. Nicholas Papa, Fire Engineering author notes in his book “Coordinating Ventilation” regarding recruit firefighters that “while we largely do an adequate job of training on the fundamental skill sets needed to physically perform the core duties, we often fail to correlate those tactics to fire behavior and the immediate effect of the tactics on the fireground, especially relating to victim survivability” [Papa 2021].

Mark Keough notes, “when environmental factors overload our senses, or a small but meaningful element of a chaotic scene distracts attention, or a fast-moving situation that has never been seen before is encountered, cognitive processes can get overloaded” [Keough 2023]. In this incident, the probationary firefighter from E29 had only responded to a total of three fires coded as a 111-Building Fire as defined by the National Fire Incident Reporting System. None of his experiences included being on the first due arriving engine company functioning as the nozzle firefighter.

Fire departments should build their response to emergencies based upon reliability and resiliency. Reliability is defined in this context by Keough [2023] as performing consistently. Unfortunately, the probationary firefighter from E29 had no previous first due engine company experience as it relates to

structure fires, and it could be easily assumed that the probationary firefighter was experiencing for the first time, a chaotic and dynamic fire scene. Furthermore, it could be reasonably assumed that the probationary firefighter was experiencing cognitive fixation and overload.

A serious risk to firefighters and on-scene personnel safety can occur when a firefighter is placed into positions or tasked with a skill for which they do not yet have past experiences upon which to build muscle memory. It should be the shared responsibility of fire department leadership to ensure that probationary firefighters are not placed in situations or asked to perform tasks for which they have little experience without close supervision and guidance. To protect probationary firefighters, fire department leadership should ensure that a probationary firefighters' knowledge, skill, and abilities are shared with company officers to encourage the growth and exposure of dynamic situations in more controlled situations.

Fire departments should build their emergency response frameworks to incorporate resiliency. A framework of resiliency would be flexible and be adaptable to unknown situations and responses. Keough describes the four cornerstones to resiliency to include [Keough 2023]:

- Response – Response system must be able to respond to any given situation or request for service
- Monitor – Monitoring the situation as it unfolds
- Anticipate – Anticipating the possible threats that could occur
- Learn – Learning from past experiences of both success and failure.

Resiliency in the context of firefighting is a result of building a reliable response framework that adapts for response system variability, response timing variability, and uncertainties. In this incident, an appropriate number of personnel and apparatus were responding but many of the first due companies were out of service due to training and other calls for service. This resulted in a delay of arriving apparatus and consequently, functions such as security bar removal from the windows and ventilation were delayed. This delayed arrival of apparatus was abnormal to the department and stresses the importance of reliability of firefighter performance (consistency) and resiliency (adapting and flexibility).

References

Amy Mensch, G. B. [2011]. Fire Exposure of Firefighter Self-Contained Breathing Apparatus Facepiece Lenses. NIST TN 1724. Gaithersburg, MD: National Institute of Standards and Technology.

Cotter, M. J. [2016]. Outside-In Fires: Effective Response. *Fire Engineering*.

FSRI [2024]. *Residential Attic and Exterior Fires*. Retrieved from https://training.fsri.org/course/75/residential-attic-and-exterior-fires: Accessed: May 22, 2024.

IFSTA [2018]. Fire Dynamics. In O. S. University, *Essentials of Firefighting 7th Edition* (p. 162). Stillwater, OK: International Fire Service Training Association.

Keough, M. [2023]. Cognitive Fixation or Overload. In *Hold the Blame-Hunt to Learn* (p. 77). Serey/Jones.

Madrzykowski, D. [2017]. *Fire Fighter Equipment Operational Environment: Evaluation of Thermal Conditions*. Columbia, MD: UL Firefighter Safety Research Institute. Retrieved December 2024.

National Fire Protection Association [2012]. *NFPA Alert Notice. SCBA facepiece lenses may undergo thermal degradation when exposed to intense heat*. Retrieved from https://docinfofiles.nfpa.org/files/AboutTheCodes/1981/scba_alert_070212.pdf.

NFPA [2021]. *Glossary of Terms*. QUINCY, MA: National Fire Protection Association.

NFPA 1001 [2019]. Standard for Fire Fighter Professional Qualifications. Quincy, MA: National Fire Protection Association.

NFPA 1410 [2020]. Standard for Training for Emergency Scene Operations. Quincy, MA: National Fire Protection Association.

NFPA 1700 [2021]. NFPA 1700 Guide for Structural Fire Fighting Chapter 9. Strategic Considerations. Quincy, MA: National Fire Protection Association.

NFPA 1971 [2018]. *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Quincy, MA: National Fire Protection Association.

NFPA 1981 [2007]. *Standard on Open-Circuit Self Contained Breathing Apparatus (SCBA) for Emergency Services*. Quincy, MA: National Fire Protection Association.

NIOSH [2010]. Career Probationary Fire Fighter and Captain Die as a Result of Rapid Fire Progression in a Wind-Driven Residential Structure Fire - Texas. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2009-11.

Papa, N. [2021]. Coordinating Ventilation. Tulsa, OK: Fire Engineering Books and Videos.

Weather Underground [2024]. *Baltimore/Washington International Thurgood Marshall Airport Station*. Retrieved from www.wunderground.com/history.

Investigator Information

This incident was investigated by Patrick R. Montague (former), Investigator, and Tammy L. Schaeffer, Investigator, both with the Fire Fighter Fatality Investigation and Prevention Program,

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Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. The report was written by Patrick R. Montague (former) and Dr. Wesley R. Attwood, Investigator and Program Advisor, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH. An expert technical review was provided by Dan Madrzykowski from the Fire Safety Research Institute, part of UL Research Institutes. The NFPA Public Fire Protection Division also provided a technical review.

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. Mention of any company or product does not constitute endorsement by NIOSH, Centers for Disease Control and Prevention (CDC). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date. *NIOSH Approved is a certification mark of the U.S. Department of Health and Human Services (HHS) registered in the United States and several international jurisdictions*.

National Institute for Occupational Safety and Health (NIOSH)

Safety & Health Advisory

Reporting Adverse Conditions Involving Self-contained Breathing Apparatus – Thermal Degradation and Failure of Facepiece Lens

NIOSH continues to identify instances where certain facepiece lens materials on self-contained breathing apparatus (SCBA) fail before other components of the firefighter's SCBA and personal protective equipment ensemble.

Since 2009, several Fire Fighter Fatality Investigation and Prevention Program reports have identified the severe thermal degradation and failure of SCBA facepiece lenses which led to holes, melting, and other deformities. The SCBAs in these incidents were approved by NIOSH and certified as meeting the National Fire Protection Association (NFPA) 1981 standard on Open-circuit SCBA for Emergency Services, 2007 edition by a third-party certification body. NIOSH is the approval body for respiratory protective devices under the U.S. Code of Federal Regulations (CFR), 42 CFR 84 and applicable Chemical, Biological, Radiological, and Nuclear (CBRN) Statement of Standards. A third-party certification body assesses the additional requirements and associated signaling devices covered by NFPA standards.

WHAT FIRE DEPARTMENTS CAN DO

- Recognize that that SCBA facepiece lenses meeting the 2007 or earlier edition of NFPA 1981 will undergo thermal degradation when exposed to intense heat faster than lenses meeting the 2013 or later editions
- Understand that the tests added to the 2013 edition of NFPA 1981 increase SCBA facepiece lens integrity
- Upgrade or replace current SCBAs to meet the 2013 or more recent edition of the NFPA 1981 standard
- Report any conditions involving an SCBA or SCBA components that lead to failure, near-failure, or a significant degradation of performance according to the relevant edition of NFPA 1852

An SCBA facepiece with severe deformation and failure. Photo by NIOSH.

QUESTIONS & ANSWERS on page 2

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QUESTIONS & ANSWERS

What issues have been identified involving SCBA facepiece lenses?
Since 2009, several NIOSH Fire Fighter Fatality Investigation and Prevention Program reports suggest that:

- Certain SCBA facepiece lens materials may be failing before other components of the firefighter's SCBA and personal protective equipment ensemble.
- SCBA facepiece lenses certified to the 2007 NFPA 1981 standard, or earlier editions, may undergo thermal degradation when exposed to intense heat and energy while operating in the modern flow path. This may include bubbling, crazing, holes, or other severe deformation developing in the lens.

A 2012 NFPA Safety Alert, along with research by the National Institute of Standards and Technology and other entities, helped establish the *Lens Radiant Heat Test* and the *Elevated Temperature Heat and Flame Resistance Test*. NFPA added these tests in 2013 to its testing procedures to reduce future occurrences of these severe failures.

What actions can fire departments take?
Fire departments can upgrade or replace their current SCBA to meet the 2013 or more recent edition of the NFPA 1981 standard. Testing by organizations such as the Fire Safety Research Institute has shown that SCBA models manufactured with more radiant heat and flame-resistant materials that are compliant with at least the 2013 edition of NFPA 1981 have improved thermal performance when exposed to radiant heating.

How can fire departments report adverse conditions involving SCBAs?
When an SCBA or its components fail, nearly fail, or significantly degrade during use, fire departments can follow the procedure in NFPA 1852 for reporting adverse conditions which includes:

- Notifying the SCBA manufacturer and the organization that certified the SCBA to NFPA requirements in writing of the specific condition(s) or cause(s) and the circumstances involved with the specific condition(s) or cause(s).
- Providing a copy of the notification to NIOSH by emailing PPEConcerns@cdc.gov.

Why is it important that fire departments notify NIOSH?
Upon notification, NIOSH works with the SCBA manufacturer to address any identified non-conformances to 42 CFR 84 or the CBRN Statement of Standards and may initiate a Nonconforming Respirator Investigation . These investigations may result in user notices, voluntary stop sales, recalls, retrofits, changes to the SCBA manufacturer's quality control process or design of the approved product, or revocation of the NIOSH approval. These actions ensure respirators offer the level of protection that manufacturers claim. NIOSH publishes PPE Case Reports to share findings from post-market SCBA tests, evaluations, and investigations.

REFERENCES

NIOSH [2009]. Career probationary fire fighter and captain die as a result of rapid fire progression in a wind-driven - Texas. By Merinar T., Tarley J, and Miles S. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2009-11.

NIOSH [2012]. Volunteer fire fighter caught in a rapid fire event during unprotected search, dies after facepiece lens melts – Maryland. By Tarley J., Miles S., and Loflin M. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, F2011-02.

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