

Setbacks and Communication on the Fire Ground

A Study of Firefighter Fatality Reports

Introduction

The National Institute for Occupational Safety and Health (NIOSH) conducts investigations of firefighter fatalities in order to form recommendations for future firefighter practices. These investigations involve detailed accounts of the operations that preceded the fatality. Thirteen of these narrative accounts were analyzed in order to uncover insights into 1) common setbacks or difficulties in firefighting, and 2) the communication practices of firefighters during emergency situations.

NIOSH conducts investigations for both trauma-related and medical-related on-duty firefighter deaths. For the purposes of this analysis, only trauma-related fatalities were included, in order to identify how specific setbacks and operations relate to dangerous working conditions.

Error Analysis

Thirteen incidents from the NIOSH database were analyzed for setbacks experienced by the firefighters involved. Any event that led to dangerous working conditions or that inhibited successful operations was deemed an “error.” These errors were summarized and categorized in order to examine some of the most prevalent causes of adverse situations on the fire ground.

Each narrative is assigned a report number in the NIOSH database, and will hereafter be referred to as follows:

- F2014-02 → Incident A
- F2013-17 → Incident B
- F2013-13 → Incident C
- F2013-07 → Incident D
- F2013-04 → Incident E
- F2012-28 → Incident F
- F2012-13 → Incident G
- F2012-04 → Incident H
- F2011-31 → Incident I
- F2011-30 → Incident J
- F2011-20 → Incident K
- F2011-18 → Incident L
- F2011-15 → Incident M

The letters following each category listed below correspond to the incidents in which that particular error type was observed.

Lack of Visibility (A, D, E, I, K, M): Instances where visibility was severely impaired.

- “Truck 17 informed Command they could not make the roof due to the smoke conditions.” (A)
- “Companies operating on the 2nd and 3rd floors of the apartment building reported conditions to be very hot, smoky, and limited visibility.” (D)
- “At 1820 hours, the crew of Ladder 27 went to the roof of the fire building in the same manner as Rescue 1 (**Diagram 4**) and encountered heavy smoke and very limited visibility. The captain of L27 was walking on the roof from Side Charlie towards Side Alpha of the fire building, which was obscured with smoke, when he fell off the roof.” (D)
- “They had to crawl inside the bingo hall, which was dark with zero visibility and extremely hot.” (E)
- “The SCBA that the fire fighter was using was not equipped with a heads up display (HUD) and the conditions inside the structure would have made it difficult for him to read his remote air gauge.” (I)
- “The smoke was intense and the driver took a couple of steps to the side to get out of the smoke” (K)
- “thick dark smoke was pushed out the front door, further decreasing visibility at the front of the structure and forcing the fire fighters to move back from the doorway” (M)

Extreme Heat (A, D, E, J, L, M): Instances where firefighter activities were hindered or delayed because of extreme heat conditions.

Heat Conditions

- “He tried to look through the window and call out to the Engine 3 crew, but the extreme heat forced him off the ladder” (A)
- “The safety officer and a fire fighter from Engine 17 then attempted to enter the man-door on Side Delta, but the extreme heat kept driving them out of the apartment” (A)
- “The safety officer had crawled in about 5 feet toward the C/D corner before being driven back” (A)
- “E2 tried to get to the side B window to retrieve the hoseline from E6 on the ladder but could not get to it due to fire and heat.” (L)
- “The lieutenant was able to retrieve one box but could not re-enter the store due to the high heat and smoke conditions.” (M)

Fire Conditions

- “L27 “Roof” went across the horizontal ground ladder, reached the captain, and tried numerous times to pull the captain off the roof and onto the ground ladder. While the fire fighter was trying to remove the captain, the color of the smoke changed from light gray to black. Fire erupted from a window of the storage building and the fire fighter was forced to crawl back across the ladder and leave the captain on the roof.” (D)
- “The driver from L27 tried several times to cross the ladder, but was driven back by the fire which was now coming through the roof.” (D)
- “The RIT continued to drag Victim #1 until FF1 had no choice but to drop Victim #1 in an attempt to shield himself from the fire.” (E)
- “E2 tried to get to the side B window to retrieve the hoseline from E6 on the ladder but could not get to it due to fire and heat.” (L)
- “The R-1 Lieutenant decided to go the basement to locate the breaker box and shut off the electrical power. The stairway to the cellar was located at the rear and the Lieutenant could not access the stairway due to the amount of fire burning at the rear on the first floor.” (J)

Lack of Space/Mobility Issues (C, D, I): Instances where firefighters had difficulty navigating the structure due to lack of space.

Clutter

- “He encountered vehicles, piles of firewood, and numerous other large items that limited access around the residence” (C)
- “The E56 nozzleman noticed the 1st floor hallway access was severely limited, due to accumulation of furniture, art supplies, etc., along the walls and on the floor, so they took the stairs to the second floor landing where they encountered heavy heat and zero visibility.” (C)
- “At this time, the E56 attack crew, hindered by clutter within the structure, tried to advance down the 2nd floor hallway and heard a PASS alarm” (C)
- “A fire fighter from E11 went down the stairs but could only make it halfway due to all the boxes and stored merchandise in the way” (D)

Structure Layout

- “Due to the small size of the apartment, the amount of furniture in the apartment, the narrow stairwell, and the size of the victim, the rescue effort took several minutes” (I)
- “Both companies had trouble moving through the aisles which were barely shoulder width.” (D)

Personal Protective Equipment (PPE) Issues (A, C, E, F, I, J)

PPE Degradation/Malfunction

- “It was observed later that the safety officer’s gear had turned reddish orange from extreme heat exposure, thus comprising the integrity of the turnout gear.” (A)
- “After a few minutes, they had to exit the structure because the T1 operator had a seal issue with his facepiece.” (E)
- “thermal degradation did occur to the SCBA facepiece of the fire fighter of Engine 3, which affected fire-fighting and rescue operations. This required the fire fighter from Engine 3 to leave the building to retrieve another facepiece before his assignment was completed.” (I)

Loss of PPE

- “The fire fighter was face down with no helmet, hood, facepiece, or gloves” (C)
- “The E123 pipeman was on air and his facepiece became dislodged while assisting the victim.” (F)
- “One of the R-1 Team 3 fire fighters had his helmet knocked off during the collapse.” (J)

Communication Failure (B, C, E, F, I): Any lack of coordination or communication between firefighters.

Lack of Info b/w Responders (B, I): A failure to communicate important information.

- “For most of the initial response, he was alone in the parking lot without supervision or communication as to where units were located, or knowledge of their operating instructions” (B)
- “Setting up the Command Post on Side C caused confusion since the command post and the Incident Commander typically set up the stationary command post on Side A” (B)
- “BC7 reported to the Command Post to check in, but did not find an Incident Commander and realized that the Command Board had not been set up yet.” (B)
- “The lieutenant from Engine 5 got to the 2nd floor and realized there were two apartments instead of just one. Due to smoke conditions and confusion, he tried to enter the apartment (Apartment 4) across the hall from the fire apartment (Apartment 3).” (I)
- “The lieutenant lost contact with the victim at this point.” (I)
- “The victim had gone into the fire apartment without contacting the lieutenant or the Incident Commander.” (I)
- “When the victim was found by the officer from Engine 7 and removed from the structure, the victim was not wearing his facepiece and the SCBA cylinder was out of air. The fire fighter did not declare a “Mayday”.” (I)

Lack of Radio Response (C, E, F): Instances where attempts to communicate by radio were unsuccessful.

- “The E56 crew called out to the SU418 crew with no response. The nozzleman tried contacting the SU418 crew via radio with no response” (C)
- “The E2 officer attempted to radio the IC without a response.” (E)
- “the IC radioed the victim that there was heavy fire in the covered porch and attic area and that E49 was going to put water on the fire, around the Sector 3 attic window, but there was no acknowledgement from the victim.” (F)

Radio Traffic (F, K)

- “the SQ5 Lieutenant tried to transmit a Mayday over heavy radio traffic” (F)
- “There was some confusion over assignments at this point due to the number of fire fighters inside the hallway and bedroom area, and the large volume of radio traffic.” (K)

Radio Issues (E, F): Any issues relating to difficulty of communicating with handheld radios.

- “the SQ5 Lieutenant tried to transmit a Mayday over heavy radio traffic” (F)
- “The dispatch supervisor advised NIOSH investigators that Victim #1’s radio mic was keyed up and opened for the duration of the fire. The fire department believed that the radio continued to activate due to thermal damage from the fire. This would interrupt communications on the fireground.” (E)
- “The FF/PM had no radio and he couldn’t locate the victim’s radio so he yelled Mayday as he tried to get the victim and other crew member untangled.” (F)

Failure to Locate PASS (E, I): Firefighter difficulty in locating lost or downed firefighters by their PASS alarm.

- “The T1 crew then followed the red hoseline in, following the sound of the PASS device. They stated that it seemed like the sound of the PASS alarm was moving away from them as they advanced.” (E)
- “The T1 acting lieutenant asked the E2 crew if they had heard a PASS alarm; they hadn’t heard a PASS alarm.” (E)
- “He could hear a PASS alarm sounding but wasn’t sure where the sound was coming from in the apartment.” (I)

Structural Integrity (D, J, M): Issues relating to the structural integrity of the fire structure.

- “After several minutes, the roof of the storage building collapsed into the basement of the fire building with the captain” (D)
- “Part of the Side D wall was leaning inward and had to be shored up to stabilize the wall and make the area safe for the rescue crews.” (J)
- “Due to the collapse hazard, the fire fighters operating the hose lines under the awning were directed to move back into the street” (M)
- Note: “A master stream flowing 500 gallons of water per minute could potentially add 21,100 pounds or more than 10½ tons of excess weight in just 5 minutes to a structure not designed to support this additional weight at the same time the structure is being degraded by fire.” (M)

Debris (D, J): Difficulties arising from structure debris.

- “Due to the amount of fabric stored on the first floor, the fabric kept falling on the members of E11.” (D)
- “The crew from E11 was unable to bring the hoseline out due to the fabric that had fallen on the 1¾ inch hoseline” (D)
- “As the E-2 crew descended to the ground level, soffit near the A/D corner began to fall and the crew had to avoid being struck by the falling debris.” (J)
- “R-1 Team 3 had to slow their advance up the stairs because of the falling debris.” (J)

Lack of Structure Awareness (D, E, I, L): Issues relating to firefighters’ lack of knowledge about the fire structure or spread of the fire.

Fire Location

- “T1 first breached an office door on D-side, which contained no smoke or fire. They then closed the door and repeated this procedure for a single door on C-side; light smoke was visible but no fire was observed.” (E)

Structural Layout

- “The lieutenant from Engine 5 got to the 2nd floor and realized there were two apartments instead of just one. Due to smoke conditions and confusion, he tried to enter the apartment (Apartment 4) across the hall from the fire apartment (Apartment 3).” (I)
- “At 1820 hours, the crew of Ladder 27 went to the roof of the fire building in the same manner as Rescue 1 (**Diagram 4**) and encountered heavy smoke and very limited visibility. The captain of L27 was walking on the roof from Side Charlie

towards Side Alpha of the fire building, which was obscured with smoke, when he fell off the roof.” (D)

- “In the pre-plan of the structure, the doorway of the North stairwell opened into the west hallway but the door was moved 90 degrees.” (L)
- “Also, the door adjacent the stairwell door was closed and thought initially to be a wall. This prompted the E2 crew to go clockwise stretching the hoseline.” (L)
- “Another R3 fire fighter (with only a few years’ experience) and an E1 fire fighter noticed the victim headed down the hallway so they followed after the victim. The victim and two fire fighters ended up in a small alcove with a bathroom at the end of it off the hallway to the fire room” (L)

Equipment Issues: Any error relating to a failure or insufficiency of equipment.

Hoseline (F, I, G, J, L)

- “The victim’s hoseline in the hallway (see Diagram 2) had burst but it is believed to have occurred during the thermal incident or post incident.” (F)
- “However, an obstruction, such as the coupling, caught on the steps or a doorway which prevented the hoseline from being advanced any further than the couch in the living room.” (I)
- “They were able to advance into the second floor but only had enough hose to reach to the kitchen” (J)
- “Due to poor water pressure, Pipeline 61 dropped a manifold on Side Alpha and supplied L10.” (G)
- “They observed that one of the hose lines was leaking and radioed the E-12 pump operator to shut down the lines one at a time so that they could determine what line needed to be shut down and fixed.” (J)
- “the R3 crew on the 5th floor grabbed the hoseline, could not get water to flow, and reported it to Command.” (L)
- “The E2 crew picked up their original hoseline and moved it into the hallway but reported they were 30 feet short and needed another section of hose” (L)
- “The R3 crew, at the 5th floor north stairwell door, noticed the E8 captain and another fire fighter were untangling high-rise hoseline in the stairwell.” (L)

Ladder (D, H)

- “The captain began climbing the ladder and as he traversed the fly section the operator noticed that the tip was bouncing with each step he took. He also noticed that the ladder was twisting to the left.” (H)
- “All ground ladders on L27 had been removed by other companies.” (D)

Thermal Imager

- “The lieutenant from SQ47 stated he tried to use the thermal imaging camera (TIC) but the image was featureless due to the amount of heat and fire in the basement.” (D)
- “Due to the heat and fire conditions, the image provided by the TIC was featureless.” (I)

Other

- “The rescue crews experienced problems with the power saws running due to the smoke and dust in the area so battery powered saws were put into service.” (J)

Operator Error (L): Instances where firefighters made improper use of equipment.

- “The hoseline was inadvertently charged, causing multiple kinks on the 5th floor between the standpipe connection and the 5th floor doorway” (L)
- “When the victim made his buddy breather connection, he did not control the release of air and all of the partner’s air escaped through the victim’s unclipped regulator”
- “The victim told his partner to activate his PASS. The victim activated his PASS but inadvertently the R3 fire fighter turned his off”
- “The victim and his driver were wearing self-contained breathing apparatus but did not don their air masks during this incident” (K)
- “Being out of air, he removed his mask, and called another Mayday, and dropped his portable radio in haste” (L)

Disorientation (E, L): Instances of firefighters becoming lost or disoriented while inside the fire structure.

- “Victim #1 followed behind him but soon became separated from his probationary fire fighter.” (E)
- “The E1 probationary fire fighter stated he briefly got turned around on the hoseline because there was a loop in it” (E)
- “The victim was following the R3 fire fighter but the E1 fire fighter got separated from them in the hallway due to the heavy smoke” (L)

Access Issues (F, I, M): Any inability to enter (or forcibly enter) part of the fire structure.

- “He first went to the basement door which he was unable to force open.” (F)
- “He could not get the door to the apartment open because it was locked.” (I)

- “Fire fighters used the hose line water stream to try to break the glass in the third window but were unsuccessful so they moved the ladder to the third window and a fire fighter climbed the ladder to knock out the third window.” (M)

Environmental/Situational (J, H, M): Any setback resulting from environmental/situational conditions, rather than any action on the part of the firefighters.

- “As the fire intensified, electrical utility wires running between the structure and a utility pole behind the structure caught fire and dropped from the pole into the back yard and started to arc.” (J)
- “The high winds were blowing the heavy fire erupting from the structure toward the Side D exposure.” (J)
- “Due to the positioning of the aerial apparatus in the street, the turntable operator was unable to hit the fire.” (H)
- “The fire continued to intensify at the rear causing overhead power lines and a utility pole to catch fire. The lieutenant radioed that the utility company was needed to cut the power to the electric lines.” (M)
- “The fire impinged upon overhead power lines causing them to fall to the ground in the alley near the C/D (north east) corner.” (M)
- “A utility pole located in the alley near the center of the building caught fire.” (M)

Communication Analysis

Ten incidents from the NIOSH database were also analyzed for how orders and information were communicated on the fire ground. Below are listed some of the general communication trends observed in the reports. Fatality reports are assigned the same letter designations as in the previous section:

- F2014-02 → Incident A
- F2013-17 → Incident B
- F2013-13 → Incident C
- F2013-07 → Incident D
- F2013-04 → Incident E
- F2012-28 → Incident F
- F2012-13 → Incident G
- F2012-04 → Incident H
- F2011-31 → Incident I
- F2011-30 → Incident J

The letters following each category listed below correspond to the incidents in which that particular error type was observed.

Arriving units will radio fire conditions to other units (A, B, D, E, F, G, I, J)

Radio communication is primarily used:

1) *Between the IC and division/company officers (A, B, D, E, G, I, J)*

- Incident Commander radios orders to company officers/lieutenants/battalion chiefs (A, D, E, G, I, J)
- Company officers/lieutenants/battalion chiefs radioed command with conditions, actions, and needs (A, B, D, E, G, J)

2) *Between officers (usually the Incident Commander) and dispatch, to request another alarm or update on conditions (B, C, D, E, G, I, J)*

- The Incident Commander keeps in radio contact with dispatch/department communication center to update on conditions (D)
- Incident Commander radios dispatch to strike out another alarm (B, C, D, E, G, I, J)
 - Personnel request the Incident Commander to call alarm (E, G)
- Other personal (besides the Incident Commander) personnel requests alarm from dispatch (B, G, J):
 - Arriving units (B, G)
 - Battalion Chiefs (G)
 - District Chief (en route) (J)

3) *By the Incident Commander when calling for an evacuation, Personnel Accountability Report, or switch to defensive operations (A, B, D, G, I, J)*

- An evacuation might also be called using an evacuation tone (E, J)
- Incident Commanders radio for Personnel Accountability Reports (D, G, I)
- Incident Commanders announce switch to defensive operations over radio (B)

4) *To call a "Mayday" or signal an emergency (A, B, D, J)*

- Unit relayed emergency information without calling mayday, but was expected to do so (D)
- Officer did not have radio and couldn't find victim's so yelled "mayday" which was radioed by officer who heard it (F)
- Firefighters can activate emergency buttons on their radios to signal distress (D, E, G)

5) *In a fire structure, when verbal communication fails (C)*

Verbal communication is mainly used:

1) *Between crew members inside the fire structure (A, B, C, E, F, I)*

2) *By the Incident Commander assigning units at the start of an operation (B, C, F, I, J)*

3) *Sometimes, during an operation:*

- When units have finished their assigned tasks and report to their superior officer (B)
- When the incident commander has decisions to make with multiple parties (J)
- When there are difficulties with radio traffic (E)
- When there is confusion over assignments (B)

Visual/face-to-face communication & confirmation sometimes used in emergency situations or in instances of uncertainty:

- Incident command resorts to face-to-face communication when there are difficulties with radio traffic (E) or confusion over assignments (B)
- Safety Officer may be tasked with counting firefighters as they exit a structure (E)
- Officers may walk across the fire ground to view a structure collapse (J)
- Multiple parties may conduct initial walk-arounds of a structure (E)

Radio communication sometimes presents unwanted challenges (A, C, E, F)

- Radio activation with no transmission (A, E)
- Inability of maintaining or initiating radio contact (A)
- Firefighters traveling without radios (C, F)

Lost or down firefighters are usually located:

1) *Aurally (more common) (A, B, I, J)*

- Firefighters locate downed crew members with audible PASS alarms (A, B, I, J)
 - There can be confusion over the location of the PASS (B, I)
 - PASS alarms can also be manually activated (A)
- Firefighter located by his portable radio (I)
- Crew members can also be located by their low air alarms (J)

2) *Occasionally with electronic tools (I, J)*

- Crew member located with a "Pak-Tracker" (guides searchers towards firefighter receivers that have been motionless for 30 seconds) (J)
- Crew member located with a search camera (I)

Firefighters typically notified of emergency situations aurally, but low air might be signaled tactually (E, J)

- Tone used to signal an evacuation (E, J)
- Firefighters notified of low air by audible warning (E, J)
- Vibralert system vibrates and sounds when air is low (E)

Firefighters sometimes find their way in and out of a structure tactually (following a hose line), but occasionally with visual aids (A, E, J)

- Firefighters can help crew members escape by tugging on their hose line (A)
- Firefighters might follow their hose line into or out of a structure (A, J)
- Firefighters might place lights at structure entrances to signal to escaping crew members (E)

Communication on the fire ground typically occurs:

- 1) *Within the chain of command—Incident Commander orders division chiefs, who order their crews and report back to the Incident Commander (A, B, D, E, G, I, J)*
- 2) *Between the Safety Officer and any crew members involved in safety operation (B, E, G, J)*
 - Safety Officer discusses pertinent situational information with Incident Commander (B, E, J)
 - Safety Officer reported a collapse over radio and directly requested a rescue team (G)
 - Safety Officer communicates directly with units searching structure (G)
- 3) *Occasionally between firefighters/officer, not following the chain of command (C, D, J)*
 - Firefighters/officers may contact other units with information about a structural collapse (D, J)
 - Firefighters may communicate to other units with immediate requests like water shutoff (J)
 - Units may requests assistance from Command (C, D)

Firefighters may undertake action after observing the actions or needs of others, without receiving an official assignment (A, E, H, J)