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FIREFIGHTER SAFETY AND RADIO COMMUNICATION

BY CURT VARONE

A very subtle change has occurred in the fire service over the past 30 or so years. I say subtle, because it has occurred without a lot of fanfare and without most of us realizing how it has revolutionized how we do our job in the street. It is a change that has occurred in stages amidst a variety of advances in technology and operational procedures that have helped to obscure just how significant a change it has been. That change is the use of the portable radio.

One recent story demonstrated for me just how important the portable radio has become. (The names and companies are changed to protect the innocent.) I was at work awhile back when a union rep stopped by my office to talk about a problem. One of Ladder 10's portable radios was damaged and out of service, leaving the members with three portables for a crew of four. No spare portable radios were available at the time.

The union rep was there because Firefighter Jones from Ladder 10 felt his safety was being unduly compromised because he did not have a portable radio personally assigned to him. My first reaction was to shake my head in disbelief, chalking up another gripe to creative whining. After I shook my head for a minute, it dawned on me that Firefighter Jones was not one to complain about trivial matters. I also realized that he had never worked a day in the fire department without having a portable radio assigned to him. Fire-fighter Jones considered his portable radio to be as much a necessary piece of safety equipment as was his PPE, SCBA, and PASS device. This wasn't an unfounded complaint by someone with too much time on his hands—it was a legitimate safety concern. When I sat back and thought about it, I realized just how far the portable radio has come in a relatively short time.

HISTORICAL PERSPECTIVE

When I started in the fire service in 1972, portable radios were few and far between. The fire chief had a portable radio, but it was years before the company officers at my station were issued a portable radio. I distinctly recall company officers who refused to take portable radios with them on runs, believing them to be a nuisance and not wanting to be responsible if the radios were lost or damaged. So how did we reach the point where individual firefighters feel unsafe without a personally assigned portable radio?

Organized fire departments in the United States stretch back nearly 300 years, and career fire departments have existed for 150 years. In light of this long history, the use of portable radios over the past 30 years is a relatively new phenomenon in the fire service. While portable radios have been available since the late 1960s and early 1970s, many fire departments did not equip every unit with a portable radio until well into the 1980s. Assigning portable radios to every on-duty firefighter is an even more recent phenomenon that most fire departments have yet to embrace.

Effective radio communications play a pivotal role in managing and ensuring safety on the fireground. Missed messages have contributed to firefighter fatalities. (Photos by Michael Porowski.)

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Coincidentally or not, the birth of the portable radio in the late 1960s and 1970s was followed shortly by new concepts like "incident command" and "accountability," that began to catch on in the mainstream of the fire service in the 1980s. For many of us today, it would be hard to imagine using the incident command system at structure fires without portable radios. How would an incident commander possibly coordinate all of the personnel and activities going on at a fire scene to the extent that the incident command system (ICS) requires without portable radios? How would the IC know when a benchmark such as "primary search complete" had been accomplished? How would roll calls (or PARs) be conducted?

Looking back 30 years to the pre-portable radio days, we didn't have incident command, accountability, two in/two out, or even mandatory mask rules. Truth be told, a great deal of freelancing was routinely tolerated at fires. While, no doubt, it was an organized form of freelancing, it was freelancing nonetheless. The reason we freelanced was simple: You either freelanced, or you waited for the "chief in charge" to give you an order face-to-face. Waiting for the chief to give you an order, or even spending time looking around the fire scene for the chief, was considered a sign of a weak, indecisive officer. The hallmark of a good officer or crew was that they knew what needed to be done and immediately set about doing it without being ordered to. It wasn't always pretty, and it wasn't always efficient, but it was all we had.

THE SAFETY CONNECTION

Although the use of the portable radio has clearly improved our operational efficiency at fires, it also has had a major impact on firefighter safety. Proving the initial link between firefighter safety and radio

communications was not an easy proposition, and only recently has the link been fully recognized.[1] Part of the problem has been that poor fireground radio communications don't directly kill or injure firefighters. Floors and roofs collapsing kill and injure firefighters. Firefighters' becoming lost and disoriented and running out of air kills and injures firefighters. Firefighters' being cut off by a rapidly developing fire kills and injures firefighters. At best, radio communication problems could be viewed as contributing factors in firefighter deaths and injuries.

Those who investigated and tracked firefighter deaths and injuries in the 1970s and 1980s rarely considered all of the possible contributing factors. Their perception of what caused firefighter casualties, influenced by years of operating in the pre-portable radio era, focused on the more obvious causes of deaths and injuries: roofs collapsing, firefighters getting trapped or lost, and unexpected flashovers. Despite this obstacle, documented cases of fireground radio communication failures that contributed to firefighter fatalities from the 1970s and 1980s do exist; it is worth looking at these cases, as well as more recent cases, to help us determine what we need to do to help improve our fireground radio communications.

CASE STUDIES

The earliest documented case of a radio communications failure contributing to a firefighter fatality was in Syracuse, New York, in 1978. Four firefighters died in a three-story, wood-frame apartment building when fire erupted out of a void space, trapping them on the third floor.

Approximately 16 minutes into the fire, a weak radio transmission "Help me" was recorded on the "Master Fire Control Tape" at the Syracuse Fire Department dispatch office. Approximately one minute later, a second transmission was recorded: "Help, help, help, static." Fire personnel on the scene and in the dispatch office apparently did not hear these transmissions.

However, an observer at the scene with a scanner heard a radio transmission "Help, help, help, third-floor attic" and immediately reported this to a fire officer on-scene. It was not clear what action was taken; but a second alarm was not called for another 16 minutes (33 minutes into the fire), and the first of the fatalities was not discovered until about four minutes after the second alarm was called (37 minutes into the fire).[2]

The July 1, 1988, fire at Hackensack Ford in Hackensack, New Jersey, claimed the lives of five firefighters when a bowstring truss roof collapsed. According to the National Fire Protection Association investigative report, approximately one minute before the roof collapsed, the incident commander had radioed companies operating on the interior to "back your lines out." No companies acknowledged this message, nor did the dispatch center acknowledge or repeat it. When the collapse occurred, three firefighters in the building were pinned by falling debris. Two other firefighters were able to escape into an adjacent tool room.[3]

Approximately three minutes after the roof collapsed, the two trapped firefighters who escaped into the tool room radioed for help. These calls went unanswered by the incident commander and the fire alarm dispatcher for an extended period of time. However, as was seen in Syracuse, civilians with scanners who were monitoring the incident heard the calls clearly, and the calls were recorded on the dispatch office's tape recorder. Some listeners even called the dispatch center on the telephone to inform the dispatcher of the trapped firefighters' radio reports. By the time the incident commander became aware of the calls for help, it was too late to mount an effective rescue effort.

David Demers issued a report on the Hackensack fire, concluding that a "major contributing factor" resulting in the firefighter deaths was the "lack of effective fireground communications both on the fireground and

between fireground commanders and fire headquarters ...."[4] Demers analyzed the sequence of communications made by the trapped firefighters, which extended over a 15-minute, 50-second period.

Among the issues that Demers cited was that Hackensack's single radio channel was inadequate to perform all the functions expected of it, including dispatching apparatus, fireground operations, recall of off-duty personnel, and emergency medical calls. He identified numerous times when the dispatcher "overrode" the radio transmissions of fireground units, including urgent requests for help by the trapped firefighters. ([4,15]).

The New Jersey Bureau of Fire Safety also investigated the Hackensack fire and, like the other investigators, cited major communications problems as a contributing factor in the firefighter deaths.[5] The Bureau audited the radio communications tape and discovered that approximately 50 percent of all radio communications made at the Hackensack Ford fire were never acknowledged. The Bureau recommended that all fire departments in New Jersey establish a minimum of two separate radio channels so that the dispatching function take place on a channel other than the one being used for fireground communications.

On September 9, 1989, fire claimed the life of a Seattle fire lieutenant at the Blackstock Lumber Company.[6] The lieutenant and a firefighter advanced a handline into an exposure building, when conditions rapidly deteriorated. After trying unsuccessfully to find their way out, the officer began calling for help on his portable radio. As the officer got low on air, he passed the radio to the firefighter, who also transmitted repeated requests for help. Neither the incident commander, other personnel on the scene, nor dispatch personnel heard any of these requests for help. However, people in the area who were monitoring the incident with scanners heard the transmissions.

The firefighter was able to make his way close to an exit, where he collapsed; he was eventually rescued. At the time the firefighter was rescued, he was incoherent, and no one realized that the lieutenant was still in the building. The lieutenant ultimately died of smoke inhalation.

A fire in 1991 in Brackenridge, Pennsylvania, claimed the lives of four firefighters when a floor collapsed. Communications problems were again implicated. Several communities shared a common primary radio channel, which became overloaded with incident-related communications, dispatch tones, and other routine traffic. Because of the heavy radio traffic, members of one of the mutual-aid units decided to switch to a tactical channel, essentially cutting themselves off from communications with the IC and others operating at the scene. These members, who were operating a handline inside the fire building, were unaware of reports coming from other units at the scene that could have warned them that a dangerous situation was developing and that they should exit the building.

Gordon Routley, who investigated the Brackenridge fire for the United States Fire Administration, concluded that, as a general safety rule, "It is extremely important [for an incident commander] to maintain communications with all units on the fireground, particularly units assigned to interior positions .... All tactical communications must be monitored by designated individuals in the command structure."[7] Routley also cited the dual function police-fire dispatchers as inadequate to effectively manage a major incident.

In 1993, two firefighters in Pittston, Pennsylvania, died while operating a handline inside a commercial building when the floor collapsed. The fact that the interior crew did not have a portable radio with which to communicate with the IC was cited as a contributing factor in the deaths.[8]

The Memphis Fire Department witnessed two fires at which communications problems played a role in firefighter fatalities. A church fire on December 26, 1992, in which a wood-truss roof collapsed, killed two

firefighters. Crews at the scene were operating on a fireground channel that was not being monitored by dispatch personnel.[9]

On arrival, a battalion commander attempted to contact first-in units by radio but was unable to do so after repeated attempts. The commander, believing his portable radio to be malfunctioning, physically went to check on the progress of companies. The collapse occurred shortly thereafter. When the collapse occurred, the commander again attempted to contact other units on the scene to advise them of the situation and again received no response.

Among the recommendations of an internal investigation team were better training of company officers and acting company officers in incident command, an increased emphasis on fireground communications, the recording of fireground communications by the dispatch office, and the dispatch of additional command personnel to working fires in commercial occupancies or large structures. (9)

The USFA investigated the Memphis church fire, concluding that communications problems contributed to the firefighter deaths because of the fact that the battalion commander was unable to direct operations on the fireground channel.[10] The report cited as problem areas the facts that the fireground radio channels were not repeated and that the communications center did not monitor fireground radio channels. The failure of some company officers and acting officers to monitor the radio or hear the radio over ambient noise also contributed to the communications difficulties.

On April 11, 1994, two firefighters died in a fire at the Regis Tower in Memphis. The fire occurred on the ninth floor of an 11-story, fire-resistive, high-rise building. The first firefighters to arrive on the fire floor were quickly in peril for a number of reasons, including a decision to take the elevator to the fire floor, a hysterical and violent male victim, and a flashover in the room of origin.[11]

Companies on the scene were operating on an unrepeated fireground channel. At one point, a firefighter (who later died) made a series of four urgent radio transmissions in an attempt to communicate with his company officer. These transmissions apparently were inadvertently made on the dispatch channel, not the fireground channel.

The IC was monitoring the fireground channel using his portable radio while at the same time attempting to monitor the main dispatch channel using the mobile radio in his vehicle that was serving as the command post. At the time these urgent transmissions were made, the IC had stepped away from his vehicle, and thus he did not hear them. A dispatcher monitoring the dispatch frequency heard the transmissions, but he did not inform the IC that a member may have been in distress.

On February 5, 1992, two firefighters were killed and four seriously injured after fire erupted from a concealed space at the Indianapolis (IN) Athletic Club. A number of communications-related factors were cited as having an impact on the outcome of the fire. The first was the fact that Indianapolis had implemented a new 800-MHz trunked radio system two weeks before the fire. Lack of familiarity with the system by all members contributed to the communications-related problems observed during the fire.[12]

Second, a fire captain was seriously burned when he removed his glove to activate the emergency distress alarm on his portable radio. The button for the emergency distress alarm was virtually impossible to activate with a gloved hand. The captain also attempted to verbally request assistance using his portable radio but was unsuccessful.

Third, the incident commander's request for a second alarm was delayed while another alarm was dispatched. Then, after the second-alarm request was received, there was a seven-minute delay in processing it. This delay was attributed to a lack of familiarity with the new computer-aided dispatch system and new procedures.

The importance of effective fireground radio communications is not limited to operations at structure fires. On June 25, 1990, a wildland fire in Tonto, Arizona, claimed the lives of six firefighters. Fire crews from different agencies operated on their own frequencies and could not communicate with each other. In some cases, fire crews could not even communicate with their supervisors. The lack of coordination and the fact that there was not a single frequency that all crews could communicate on contributed to 11 firefighters' being trapped in a canyon, six of whom died.[13]

It is difficult to maintain efficient fireground communications on the fireground. Background noise, distractions, and the IC's being engaged in face-to-face communications are among the factors that may cause messages to be missed.

Gordon Routley investigated the October 19, 1991, East Bay Hills fire in Oakland, California, that consumed more than 3,000 structures and killed 25 people. An Oakland Fire Department battalion chief was one of 25 deaths that resulted from this wildland-urban interface fire. Routley found that the communications system being used by the Oakland Fire Department was completely inadequate and overloaded. Oakland used a single radio channel for both dispatch and emergency operations. Although a backup channel was available to handle other radio traffic during an emergency, all six alarms at the East Bay Hills fire were operating on the main channel. The result was that units were routinely transmitting over each other, blocking effective communications.[14]

Another communications problem Routley cited at the East Bay Hills fire occurred when command officers switched momentarily to the backup channel for better communications. The result was that while command officers were communicating on the backup channel, they missed critical operational information being transmitted on the main channel. Routley concluded:

Without effective communications, it became an undirected and uncoordinated situation, with companies doing whatever they could to provide for their own safety and evacuate residents in the path of the fire. It was during this period that the Battalion Chief was lost .... The radio tape indicates that he may have tried unsuccessfully to communicate as late as 1222 hours, approximately 30 minutes after his last successful communication [with the Operations Chief]. (14,76).

In 1995, another wildland fire took the lives of two firefighters in Kuna, Idaho. The investigation team cited the lack of adequate communications as a significant factor in the deaths. The dead firefighters had been operating in the path of a rapidly moving fire. Their radio was not equipped to communicate with the IC, and the IC, as well as other officers on the scene, were unable to warn them of the approaching peril.[15]

Three firefighters died at a house fire on Bricelyn Street in Pittsburgh, Pennsylvania, on February 14, 1995. During a critical period in the fire, four firefighters ran out of air and became disoriented in the building. One firefighter was located and removed by other personnel. Although only semiconscious, the rescued firefighter reported that other members were still inside. Over the next few minutes, confusion developed as to how many firefighters were actually missing and how many had been accounted for. The confusion, fueled in part by an unlucky coincidence, was also the result of radio communication problems, leading to the erroneous conclusion that all members were accounted for, when in fact the three firefighters were still lost in the

building.[16]

Pittsburgh's fire department and emergency medical services were separate municipal departments that routinely responded to fires together. Each department operated on entirely separate radio channels. Direct radio communications between emergency medical personnel at the scene and the fire department IC were not possible. This arrangement contributed to the confusion as emergency medical personnel relayed messages through their dispatcher, to the fire dispatcher, and ultimately to the IC that all personnel were accounted for.

On March 18, 1996, two Chesapeake, Virginia, firefighters died when a trussed roof collapsed at a fire in an auto parts store. An officer and a firefighter from the first-in engine advanced a handline into the structure. When conditions worsened, the officer attempted to radio the IC from inside the store, but because of heavy radio traffic, the IC could not understand the transmission. Shortly thereafter, the building became heavily involved, and the roof collapsed. The heavy radio traffic was attributed to the fact that the main dispatch channel was being used for fireground communications.[17] Too many units were competing for air time on the single channel.[18,19]

On February 17, 1997, two Lexington, Kentucky, firefighters were advancing a handline in the front door of a single-family residence when they fell through the floor and were trapped in the basement. Neither firefighter had a portable radio, and no one on-scene realized they were missing for approximately seven minutes. Their PASS devices, as well as their verbal calls for help, were unheard because a positive-pressure fan and other equipment were operating in the immediate area. One firefighter died; the other was seriously injured.[20]

On August 19, 1997, one firefighter was killed and three were seriously injured in a restaurant fire in South Whitley, Indiana. A crew without a portable radio entered the structure with a handline. As they were battling the blaze, conditions worsened, and a decision was made to exit. Intense heat apparently startled one member of the crew during the exit, and he became disoriented in his haste to exit. Unable to find his way out, the victim collapsed. The National Institute of Occupational Safety and Health (NIOSH) investigation of the incident cited the fact that the crew did not have a portable radio, concluding that if the crew members had been equipped with a radio, they could have alerted the IC that they were in trouble and needed immediate assistance.[21]

Two Houston, Texas, firefighters were killed at a fire in a McDonald's restaurant on February 14, 2000. The victims advanced a handline into the structure and were searching for the fire when a portion of the roof collapsed. At about the same time, the IC ordered an evacuation. The victims became separated from their company officer, who safely exited the building. The officer realized his crew had not exited and reported this to the IC. A search was immediately initiated, but the victims were not where they were expected to be. It is theorized that the victims became disoriented. Their bodies were found entangled in wires, with evidence that at least one of them had attempted to become free from the entanglement. The NIOSH report on the Houston fire recommended that all personnel, not just the company officer, be equipped with portable radios so that if personnel get separated from their officer, they can maintain contact with the IC.[22]

In Fraser, Michigan, one firefighter was killed and another firefighter seriously injured in a fire on March 3, 2000. The firefighters were attempting to rescue a woman from an apartment building when they were cut off by heavy fire. The crew members did not have a portable radio to report their situation to other personnel on the scene. By the time other personnel realized they were trapped, it was too late.[23]

On November 25, 2000, a Pensacola, Florida, firefighter got separated from his officer while exiting a house fire as the fire was rapidly intensifying. The officer had a portable radio, but the victim did not. The victim apparently became disoriented and sought refuge in the rear of the house. When the officer exited and realized the firefighter had not, a prompt search and rescue effort was begun. The victim was not found for about 40 minutes; he was found on the side of the house opposite from where searchers believed he would be. The cause of death was asphyxiation caused by smoke and carbon monoxide inhalation. As we saw in the Houston fire, NIOSH recommended that fire departments consider providing all firefighters with portable radios so that if members get separated from their officer they can still communicate.[24]

On May 9, 2001, a firefighter from Passaic, New Jersey, was conducting a primary search of the upper floors of a three-story apartment building with his partner. After searching the second floor, they advanced to the third floor, where they encountered heavy smoke and high heat. Both members backed down to the second floor. While his partner went to retrieve lights from their apparatus, the victim returned alone to the third floor and became trapped. He initially radioed for help from Engine 2, which was operating a handline on the second floor. The IC, who began talking over the radio to an incoming ladder company about apparatus placement and assignments, apparently did not hear the victim's message. The IC's communications with the ladder company predominated the airwaves for the next 70 seconds, after which the victim again tried to call for help. This time, the victim called his company officer (Truck 2) to tell him he was trapped on the third floor and running low on air. The officer of Engine 3 heard his third call for help and reported the Mayday. The subsequent rescue effort failed to reach the trapped member in time.[25]

On March 1, 2002, a firefighter from Jefferson City, Tennessee, died after becoming separated from his crew. Firefighters were making an interior attack on a house fire when the fire began intensifying. The IC ordered firefighters to evacuate the building. However, the IC's messages were garbled and breaking up. When crews ran out of air, they tried to exit the building, but it was too late. One firefighter was trapped and died; another collapsed as he was exiting and suffered severe burns.[26]

Collectively, the cases discussed above leave no doubt as to the connection between fireground radio communications and firefighter safety. By no means do the above examples represent all of the documented cases of problems with fireground radio communications. On the contrary, there are now literally hundreds of documented cases in which communications failures have affected firefighter safety.

Some of the better-known cases of fireground radio problems have been omitted from this article, including the World Trade Center Bombing in 1993 and the World Trade Center attack on 9-11-01. Communications problems must be viewed in the context of being an everyday problem for every fire department. They do not just occur at the larger, more spectacular incidents; they happen at the "bread and butter" fires as well. Our focus on improving fireground radio communications must take this reality into account.

Note: My information and conclusions are based on written reports about these incidents. The sources used are included at the end of this article. My focus here has been to discuss these incidents from the perspective of radio communications. No doubt, each of these incidents could be discussed, critiqued, and analyzed from many other perspectives, such as staffing, tactics, training, and rapid intervention. My focus is necessarily narrow. I apologize to those who may have been involved in these incidents or who have a more detailed knowledge of the specifics of these cases and feel that issues more important than radio communications are being ig-nored in this article.

TIPS FOR MORE EFFECTIVE FIREGROUND

COMMUNICATIONS

Following are some ways that fire departments can enhance communications—and therefore firefighter safety—on the fireground.

- *All crews entering a fire building should be equipped with a portable radio.*

Providing a portable radio to each crew member entering a building may seem like a pretty basic requirement in this day and age. However, there are many fire departments— particularly volunteer, combination, and small career departments—that rely heavily on recalled personnel to handle working fires that do not meet this requirement. As was seen in the Pittston, Pennsylvania fire in 1993, firefighters who enter a building without portable radios are out of touch with what else is occurring on the fireground. They cannot hear radio reports that may warn them that other crews have encountered dangerous conditions, that occupants for whom they are searching have been accounted for, or that indicate that fire conditions have changed. Most importantly, they cannot receive orders from the IC, including an order to withdraw.

In addition, crews without radios cannot give progress reports to the IC, provide warnings of dangerous conditions they encounter to other crews, and inform the IC if they are in trouble. This was evident in the 1997 Lexington, Kentucky, house fire, where two firefighters fell through the first floor into the basement and were unable to inform the IC of their situation. One firefighter died; the other was seriously injured. The lack of a portable radio was also an issue in the South Whitley, Indiana, fire in 1997, and the Fraser, Michigan, fire in 2000. Coincidentally, in the Lexington and South Whitley fires, the victims' PASS devices were activated but could not be heard because of the noise levels in the area from positive-pressure fans and other equipment.

The portable radio has become so fundamental to our operations that many departments have taken the approach of issuing a portable radio to all on-duty members, not just to company officers. As we saw in the Pensacola, Florida, and Houston, Texas, fires (both in 2000), there are strong arguments for making portable radios a mandatory part of the personal protective equipment for all firefighters. In Pensacola, a firefighter became separated from his officer as they withdrew from a rapidly extending fire. Search efforts were initially concentrated in the area where the victim was believed to have been. Forty minutes later, the victim's body was found on the side of the building opposite from where search efforts had initially been focused. The Houston fire involved a similar set of circumstances: Firefighters without radios got separated from their company officer as conditions deteriorated. If the victims in these cases had a portable radio and had been able to inform the IC of their locations, search efforts could have been more focused.

Looking realistically at the situation, firefighters have in the past, and will in the future, get separated from their company officers. Preaching accountability and company integrity can only get us so far. In such cases, the portable radio may be one of the most important pieces of safety equipment we can issue to our personnel.

Another advantage of assigning portable radios to each crew member is that all members will be able to hear fireground radio traffic and keep apprised of changes on the fireground. These additional radios will minimize the risk that a message critical to the safety of the crew will be missed entirely. Giving each member a radio provides a level of redundancy within the crew in case the company officer's radio malfunctions or the message is missed.

As with all things, there is a downside to providing radios to all members. First, the additional radios

on-scene will create a much greater likelihood of feedback, particularly when operating inside structures. This may cause additional communication problems.[27] Second, the inadvertent keying of microphones will increase dramatically when all personnel are issued radios, which in turn will interrupt messages on a more frequent basis.

Finally, the risk of radio channel overload is increased as more radios are present on the scene. Some members issued a portable radio will feel empowered, if not compelled, to use the radio as a convenience, increasing the competition for air time. This compounds the serious problem of radio channel overload we already have at fires. The solution is really a matter of radio discipline, discussed below.

- *All fireground radio communications should be on the same channel.*

Having crews at the same incident operating on different channels creates the risk that some crews will miss vital information that could warn them of a dangerous condition or an impending disaster or that might dictate a change their tactics. It also creates the risk that if a crew gets into trouble, the IC and others who may be in a position to aid them or who might also be imperiled will not learn of the situation until it is too late.

The fact that crews were operating on different channels was cited as a factor in the deaths of four firefighters in Brackenridge, Pennsylvania; six firefighters in Tonto, Arizona; and two firefighters in Kuna, Idaho. In all three cases, crews did not hear vital size-up information and progress reports that would have warned them of their impending doom. Multichannel operations were also cited in the Bricelyn Street fire in Pittsburgh, where confusion between fire personnel on one channel and EMS personnel on another contributed to the mistaken conclusion that all firefighters were accounted for, when in fact three were still missing.

I have heard some "experts" advocate the regular use of multiple channels at structure fires to alleviate overloaded channels. I have even heard an "expert" recommend that the roof team and each engine company be assigned to their own channel. The risk of having companies operating on multiple channels at a structure fire far outweighs the benefits of being able to get "air time" on a "free" channel that only a portion of the personnel on-scene are monitoring.

Placing crews on multiple channels at the same structure fire incident also creates major problems for the IC. As the case studies show, ICs have a difficult time effectively monitoring one channel without missing messages. Expecting an IC to monitor multiple channels creates an unreasonable risk of missed messages, unless a separate individual is assigned at the command post to monitor each additional channel being used. If enough personnel are available to manage the additional channels, then the use of such channels may be feasible. However, because of concerns that crews may miss critical information, the use of other channels beyond the fireground channel should be limited to exterior operations such as relay pumping operations, tanker shuttles, and communications between the command post and staging or the command post and dispatch.

Allowing communications for exterior operations to take place on a separate channel is tolerable, because generally it would not involve the communication of tactical information that crews operating in and around the building may need to rely on for their safety. However, if a separate channel is used to manage exterior communications, the IC and personnel monitoring communications on the other channel must be prepared to relay any critical messages that come over on the other channel to crews on the main fireground channel. An example of such a critical message would be a warning of an imminent interruption in the water supply or the observation of a dangerous condition.

No doubt, at major emergencies such as large wildland-urban interface fires, high-rise fires, and conflagrations of significant proportion, separate channels would be necessary for various aspects of the incident. Nevertheless, whenever multiple chan-nels are used, ICs must ensure that extra precautions are taken to address the concern that crews who are in harm's way may miss critical information being exchanged on other channels. The precautions to be taken must include an expanded command post with trained on-scene radio operators assigned to each fireground channel in use.

* *Fireground channels must be separate from dispatch channels.*

Separate channels should be maintained for dispatching apparatus and for fireground operations. This will allow for the prompt transmission of alarms on the dispatch channel while not tying up airtime on the fireground channel. It will also allow the IC to communicate with the dispatch office or additional responding companies without taking up valuable airtime on the fireground channel. However, as discussed above and below, for the IC to communicate on a channel other than the fireground channel, someone at the command post must be monitoring the fireground channel.

There have been several cases in which firefighter deaths were associated with radio channel overload problems because dispatch and fireground operations were on the same channel. Probably the most well-known case was the Hackensack Ford fire in 1988. Two firefighters trapped inside a small room were calling for help for more than 15 minutes. Their initial requests for help were overridden by dispatching tones and other dispatch-related communications. Investigators cited the use of the same channel for dispatch and fireground communications at the 1991 East Bay Hills fire in Oakland, California; the 1991 Brackenridge, Pennsylvania, fire; and the 1996 Chesapeake, Virginia, fire.

- *The IC needs help in monitoring the fireground channel.*

If there is one consistent factor that the case studies show, it is that we simply cannot depend on the IC alone to monitor fireground radio communications. Whether we look at Syracuse, Hackensack, Blackstock Lumber Company, Regis Tower, or Chesapeake, the reality is that incident commanders will miss messages. It is therefore incumbent on us to ensure that our fireground radio communication systems are designed to take this reality into account.

The reasons an IC may miss messages are too numerous to mention, including being engaged in face-to-face communications, talking on a cell phone, reviewing or preparing incident documentation, ambient noise conditions, radios accidentally being turned down, radio failure, simultaneous transmissions on separate channels, or simply being distracted with other tasks.

The challenge for us is to figure out a way to "engineer in" a backup to the IC as a "safety net" so that no critical messages are missed. Having a trained dispatcher monitoring the fireground radio channel for missed messages is the best solution. The dispatcher is in a secure environment, isolated from fireground distractions and noise. The dispatcher should have access to playback technology that will allow him to listen to hard-to-understand messages a second or third time, if need be, to get it right. The dispatcher should also have access to "identifier" information that will allow him to ascertain which portable radios are making which transmissions.

Another option for engineering in a backup to the IC is assigning a chief's aide at the command post. Having an aide at the command post to monitor the fireground radio channel provides another layer of protection against missed messages while allowing the IC the opportunity to conduct face-to-face communications, talk on a cell phone, or communicate on a command or dispatch channel. Using support personnel, such as the

safety officer and rapid intervention crews, to monitor fireground channels are also good options. However, these options should be in addition to, not in place of, a trained dispatcher and a command aide.

Some fire departments dispatch additional chief officers, communication officers, staffed command post vehicles, or communication vehicles to help better effectuate fireground radio communications. Any or all of these solutions help address the critical safety factor of providing a backup to the IC. They in essence provide a trained dispatcher at the scene of the emergency to help the IC manage fireground radio communications.

- *Dispatchers must be properly trained.*

Like any other aspect of our profession, all of our people need to be properly trained before being assigned to a critical task. In the world of fireground operations today, effective radio communications are absolutely critical, and the dispatcher is one of the most critical components in our radio communications systems. Proper training of a dispatcher involves more than teaching which buttons to push and how to figure out what companies to send where. Dispatchers need a thorough understanding of incident command, fireground tactics, firefighting vernacular, and what their role is during emergency operations such as a Mayday, roll calls, or building evacuations. Dispatchers must also understand the critical role they play in handling missed messages.

The job of dispatching should not be assigned to the "junior" firefighter or to a police dispatcher who does not have adequate fireground radio communications training. Investigators have cited untrained or poorly trained dispatchers in several of the fatality incidents we have reviewed, including Hackensack, Brackenridge, and the Regis Tower fire in Memphis. In the Hackensack and Regis Tower fires, dispatchers had information that a firefighter was in distress yet failed to act on that information.

Dispatching is not a job that should be left to just one person who may be called away from monitoring the fireground radio to field telephone calls or dispatch runs. Dispatchers who monitor a fireground radio channel must be able to put 100 percent of their concentration into listening for missed messages and providing support to companies on-scene. Ideally, one dispatcher should be assigned to each fireground channel in use.

- *Fireground radio channel discipline is essential.*

It should come as no surprise to anyone who has listened to fires over a scanner that radio channel overload is an epidemic problem that threatens the safety of all personnel. It's a problem on the East Coast; it's a problem on the West Coast; and it's a problem everywhere in between. Furthermore, it seems the more critical the situation in a fire, the more overloaded the radio channel gets.

Part of the problem is an overreliance on radio communications. We have come to recognize the efficiency and speed with which radios allow us to communicate, to the point that we use the radio in situations where we don't need to. This overreliance typically starts at smaller incidents, where there is little competition for airtime. Even at one-alarm incidents, the quantity of radio traffic among the five or six units on-scene is not usually enough to clog the airwaves. Because the unnecessary use of the radio at smaller incidents causes us no harm, it raises no red flags.

However, during the early minutes of a rapidly expanding incident or during an emergency situation such as a Mayday or building evacuation at a "routine" fire gone bad, it is often impossible to get airtime for even a dire emergency transmission. In the hindsight of a critique or in a classroom lesson on fire tactics, we would all say that we know that we need to limit our radio transmissions during a Mayday or building evacuation. But reality shows us time and time again that we don't do it.

The reason we don't exercise that level of discipline at the larger incidents is that we have become accustomed to overusing the radio out of convenience at the smaller, more frequent incidents. When that less-frequent but larger incident occurs, we use the radio exactly as we are accustomed to doing at smaller incidents.

The following are some radio transmissions that occurred within the first five minutes of a recent rapidly extending six-alarm mill fire. At the time these transmissions were made, the IC was trying to ascertain from Fire Alarm the identities of his second- and third-alarm companies so that they could be deployed to cover exposures. He was prevented from communicating with Fire Alarm by these transmissions, which occurred in rapid succession. The names have been changed to protect the innocent.

"Engine 20 to Engine 21: Do you have a hydrant up there?"

"Engine 21C to Engine 21: I need the other wrench."

"Ladder 10 to Ladder 10B: Back up about 10 feet."

Unidentified company: "Take a left when you get to the street."

"Engine 22 to Engine 22B: Is the hydrant ready yet?"

"22B to 22C: Are you ready for water?"

"Squad 1 to Engine 20: Are you on Main Street?"

"Car 30 on scene."

"22B to 22C: Are you ready for water?"

Unidentified company: "Take a left—I said left."

"22C: Spin that hydrant up."

"Engine 23 to Fire Alarm: Did anyone strike a second alarm on this yet?"

"Ladder 11: I need feeders."

Radio channel overloading was specifically cited as a factor at several of the fatality case studies cited above, and more than likely it was a factor at many others. The first and most dramatic case of radio channel overloading was the Hackensack fire. There, the frantic calls of trapped firefighters were "stepped on" by the dispatcher and numerous other units on-scene. Similar occurrences were cited in the East Bay Hills fire; the Chesapeake, Virginia, fire; and the Brackenridge fire. In the Brackenridge fire, radio channel overload caused the crew of four firefighters who died to switch from the main channel, being used by other units, to a different channel.

The solution to radio channel overloading at the vast majority of incidents is to establish and enforce radio discipline. This discipline must become engrained in the minds of all officers and firefighters. It must be

enforced at smaller incidents so that bad habits are not allowed to be practiced and incorporated into our routine.

What Is Radio Discipline?

Discipline can be defined in many ways, but the pertinent definition for us is "the ability to behave in a controlled and calm way even in a difficult or stressful situation." Radio discipline involves the following procedures that will ensure efficient and orderly radio communications:

- Fireground radio communications should be used only between persons who cannot feasibly communicate in any other way. The preferred method of communicating is face to face. Using the radio to communicate must not be one's first instinct. In general, only chief officers, company officers, or crew leaders should be using the radio—not all personnel within a company or crew who have a radio. All communications within a company or crew should be done face to face, except under extraordinary and emergency conditions. Once sector officers are assigned, only the sector officers should be communicating over the radio with Command, again, absent ex-treme circumstances. Radio traffic within the sector must be kept to an absolute minimum or be avoided altogether, and radio traffic within a company assigned to a sector must be nonexistent.
- Know which messages are so urgent that they must be made immediately and which can wait. We are all guilty at one time or another of believing that what we have to say is the most important thing anyone on the fire scene has to say. Experience is a good teacher in this regard, but good training and critiquing can help develop a better sense of when to talk and when not to.
- Know which messages can be delivered by radio and which are so complicated and lengthy they need to be made face to face. The more lengthy and complicated a message, the less likely it will be understood over the radio. If it crosses your mind that a message may be too lengthy or complicated as you are preparing to say it, it probably is. Face to face is a much preferable method of communicating and should be used whenever possible. Lengthy messages tie up val-uable airtime and also increase the frustration of others waiting to use the airwaves. This sense of frustration causes some people to cut in on the radio whenever they can, much like driving in bumper-to-bumper traffic causes some frustrated drivers to cut in and out of traffic.
- Make sure that the messages being transmitted are clear and concise. Choose words and phrases that will be easily understood, and don't be unnecessarily wordy. Lengthy messages and confusing messages invariably need to be repeated, further tying up airtime. People who like to hear themselves talk are the enemy in this regard and need to be given a short leash by their superiors.
- Make sure the radio channel is free before transmitting. This goes beyond making sure that no one is presently talking on the channel before transmitting. It means making sure you are not interrupting an ongoing conversation that has merely paused. Example: "Command to Engine 20"—pause—"Engine 20 answering, go ahead Command"—pause—during this pause, another company cuts in "Ladder 11 to Command" before Command can transmit his message to Engine 20. All personnel must exercise discipline to make sure that the channel is free before transmitting.
- Make sure the message has a clear recipient. Messages that have no clear recipient are the fire service equivalent of a "jump ball." Many times I hear messages directed to no one in particular, such as, "I need a line to the third floor" or "I need some ladder men up here." Even worse, I have heard messages such as, "Command to any company on the third floor," which not only shows poor radio practice because the message does not have a clear recipient but indicates that the IC does not know which of his companies are on the third floor. Unless the message is directed to a clear recipient, you are inviting a free-for-all, or you run the risk that no one will feel obliged to respond to your request.

- Communications must follow the incident command system structure established for the incident. In other words, the incident command system for a given incident should be treated like your department's chain of command. It should not be violated, absent extraordinary circumstances. While this is not strictly a radio communicatio

The IC—and to a lesser extent, the dispatcher who is monitoring the channel—is responsible for enforcing radio discipline on a fireground channel. Both must work to prioritize messages as the activity level increases. However, as should be evident, there is only so much an IC and a dispatcher can do at the time of an emergency. The fire department needs to ensure that adequate radio procedures are in place and that all members receive appropriate levels of training.

A properly configured and engineered radio system is essential for firefighter safety. For a fireground radio system to function efficiently, it must be properly configured and engineered. As many fire departments have found, this is a lot easier said than done.

There are a variety of radio systems out there, ranging from the simplest (a simplex, single-channel system) all the way up to the most complex (a computer-controlled 800 MHz digital trunked system). Which type of radio system is best is a question that can only be left up to each jurisdiction. There are so many variables, not the least of which is the funding necessary to make sure that the system can be properly configured and installed and then tweaked and modified as needed.

A Word About Digital Trucked Systems

The 800 MHz digital trunked radio system has been touted by some as the ultimate solution to all radio communications problems in the fire service. As many fire departments have found out, there are inherent problems with digital trunked radio systems, the discussion of which goes beyond the scope of this article. Suffice it to say that any fire department considering a digital trunked system needs to do its homework to ensure the system will work as advertised. Many in the fire service believe that while such systems are theoretically capable of performing, they are prone to failure at the most critical times.

Simplex or Duplex Systems?

Any fireground radio system must be able to enable portable radios to communicate effectively and clearly under all conditions. In a small geographic area, a simplex system may be adequate. A simplex system uses a single radio frequency to transmit and receive. Unless the coverage area is exceptionally small, a duplex system will be required. In duplex systems, radios transmit on one frequency and receive on another. "Receivers" strategically placed around the community pick up transmitted messages. The receivers send the message to a "repeater," which rebroadcasts the message at higher power on the "receive" frequency.

The benefit of a duplex system is that relatively weakly powered portable radios (usually a maximum of five watts of power) can broadcast with the strength of the repeater (often 100 watts or more), provided the signal from the portable can reach a receiver. One drawback is that if a portable radio cannot transmit a strong enough signal to reach a receiver, the transmission will not be heard even by the radio that is next to the radio that is transmitting. Another drawback is that each duplex channel requires two frequencies to be allocated. In many geographic locations, additional frequencies are not

available in the frequency bands being used.

For a duplex fireground radio system to be properly configured, an adequate number of receiver/repeaters stations must be strategically located throughout the area to provide reliable reception. Engineering such a system requires a great deal of research and planning. All dead spots must be identified, and suitable receivers must be installed. Extra consideration must be given to eliminating dead spots in high-rise buildings and underground structures.

All radio systems should also provide for radio system failure. For example, in the case of a duplex system, the radios should be able to be easily switched to a simplex or direct mode. This will allow crews on the fire scene to be able to communicate directly with each other despite the fact that the transmissions are not being repeated.

Another communications-related issue that has been found to impact firefighter safety is radio channel "bleedover." Radio frequencies used for fireground channels must be sufficiently far apart from other radio frequencies being used in the area, so they do not interfere with each other. Bleedover has been implicated in radio communications breakdown in several cases of firefighter fatalities, including the 2002 Jefferson City, Tennessee, incident. Bleedover distorts and garbles messages. It can lead to the breakdown of the command system because the IC cannot communicate effectively with personnel, and personnel cannot communicate with Command. The National Fire Protection Association recommends at least a 15 kHz separation in the VHF band to avoid such interference.

- All fireground radio communications should be recorded.
- All fireground radio communications should be recorded at the dispatch center. The use of these recordings can be invaluable for training purposes, as well as for investigations. Audiotapes of fireground communications should regularly be incorporated into incident critiques. A great deal can be learned from listening to the radio tapes from fires, and it provides the opportunity to address specific communications issues, such as lack of discipline.
- Fire departments must provide radio communication procedures and training to all members of the department.

All fire departments need to provide their personnel with procedures and training on fireground radio communications. Effectively communicating over the radio is not something people intuitively know how to do. In fact, from what I have seen, even experience does not seem to help some individuals improve their radio communication techniques.

Members need to know how the radio system operates, how to physically operate the hardware, and what procedures they are expected to follow. Training should include the steps we expect personnel to follow during emergency traffic conditions, Mayday situations, building evacuations, roll calls/PARs, urgent or priority messages, and times of radio system failure. In addition to the specifics of the procedures, training should acquaint personnel with incidents like Hackensack, East Bay Hills, Regis Tower, Passaic, and others so that everyone understands not only the procedures but also the consequences that may occur if the procedures are not followed.

Maydays and firefighter survival.

Several important issues relating to Maydays and fireground radio communications need to be addressed through training and procedures. First, we need to change our organizational culture so that

our personnel are willing to report a Mayday before they are beyond the point where we can come to their aid. Experience has shown that all too often, lost and disoriented firefighters wait until they are low on air to call for help. This shortens the window of opportunity for the rapid intervention crew to reach the trapped members. Awareness training and drills can be used to help overcome the reluctance to call a Mayday. In addition, there is a movement spearheaded by Dr. Burt Clark of the National Fire Academy to establish objective criteria for when to call a Mayday, analogous to the criteria fighter pilots use to decide whether or not to eject from an aircraft. Dr. Clark's approach holds great promise for overcoming our institutional reluctance to call a Mayday.

Second, and perhaps related, we need to ensure that personnel understand the proper procedures to follow if they get into trouble. At both the Regis Tower and Passaic incidents, members in grave distress attempted to call company officers, not the IC, over the radio for help. In neither case did the member clearly report a Mayday, nor did he declare an emergency.

The failure of personnel equipped with radios to clearly report a Mayday was cited in a number of the case studies we examined, including the 1995 Bricelyn Street fire in Pittsburgh; the 1996 Chesapeake, Virginia, fire; and the 2002 Jefferson City, Tennessee, fire. Personnel need to be trained to report a Mayday in unequivocal terms—and to report it to the IC. Any fire department that has not already adopted a procedure for declaring an emergency needs to find a way to implement such as policy as soon as possible. The term "Mayday" has come into common use, but any clearly defined terminology will do, provided all personnel understand its meaning.

Third, we also need to ensure that personnel who hear a Mayday declared by someone else know how to respond. As we have seen from the case studies, there is significant risk that an IC may miss a Mayday. However, the possibility that well-meaning personnel will completely jam the radio channel once a Mayday has been called is also of grave concern. Once the IC acknowledges the May-day, all personnel on-scene must exercise discipline and stay off the radio channel until the Mayday situation has been cleared.

Fire departments need a backup communications plan.

Fire departments need procedures and training on a backup plan to deal with communications failures. Plans need to address everything from the failure of one member to be able to reach the IC up to managing complete radio system failure. These plans will differ greatly from department to department and may require relatively drastic measures.

For duplex radio system failures, it may be possible to use simplex communications on a separate radio channel or on the nonrepeated side of the duplex channel. This requires planning on the part of system engineers to ensure that the radios will be able to operate in this fashion in an emergency. If used, extra precautions will have to be taken at the scene for simplex channels that cannot be monitored by a dispatcher to ensure that the IC will not miss messages. This may necessitate assigning trained personnel at the command post to monitor the fireground channel.

In the case of a complete radio system failure, backup plans may necessitate the use of runners to deliver messages between the IC and various sector officers. Modern safety regulations, such as the two-in/two-out rule, dictate that personnel cannot enter a hazardous area alone, so runners will have to be assigned in pairs. Accounta-bility rules require that we continuously track the runners' whereabouts. Also complicating our plans are OSHA regulations that prohibit entry into immediately dangerous to

life and health atmospheres without some means of visual, voice, or signal line communication [29 CFR 1910.134 (g) (3) (ii)]. Considerable thought needs to go into developing such a backup plan for complete radio system failure.

There also needs to be a specific procedure for a firefighter who is in distress and cannot reach the IC on the fireground channel. The procedure may include instructing a member in distress to switch to the dispatch channel to contact a dispatcher. Such a procedure is not something that should be developed by a firefighter "on the fly" during an emergency. Personnel (firefighters and dispatchers) need procedures and training on what to do in such a case, and the radios and the radio system need to be engineered with such a backup procedure in mind.

The discussion of having personnel switch channels to declare an emergency also raises the question of whether there should be a separate "emergency channel" to which members in distress and unable to reach the IC could switch to contact a dispatcher. Novel ideas such as these warrant serious consideration and an analysis of the pitfalls and difficulties that multichannel operations entail.

The user of the radio must be able to hear.

One final subject suggested by the case studies involves operations in areas of high ambient noise levels. For radios to serve their function, the user must be able to hear. In the Lexington, Kentucky, and South Whitley, Indiana, fires, ambient noise in the immediate area was so loud that the victims' PASS devices could not be heard. At several other recent fatality incidents, positive-pressure ventilation (PPV) was in use and the noise from the fans complicated communications.

Incident commanders can be overwhelmed and may need someone at the command post to effectively manage radio communications.

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Obviously, if ambient noise levels are so loud that a victim's PASS device cannot be heard, it is unlikely that the victim would have been able to hear his radio or the audible warning sounds that usually accompany building evacuations. It is further unlikely that members will be able to transmit understandable messages from such a loud noise environment.

When operating in areas of high-noise levels in which saws, PPV fans, and other noise-producing equipment are in use, company officers need to realize they will not be able to hear radio reports or evacuation signals. In such cases, company officers must position themselves or a member with a radio outside of the high-noise area with the specific responsibility of warning crews if necessary. Technology may hold some hope in this regard with PASS devices the IC can activate remotely and that have a visual or vibration alert feature to warn members to exit the structure.

NO QUICK FIXES

Fireground radio communications is an evolving area that no doubt will continue to develop in the future, as technology advances and our experience grows. It is heartbreaking that so many of our advances have to be written in the blood of deceased firefighters, but it would be even worse if we failed to learn from these tragedies.

There are people out there who offer quick, easy, and expensive solutions to our communications problems. There are no solutions that have been proven to work satisfactorily under all conditions. The above recommendations should be reviewed and understood, keeping in mind the wisdom of Frank Holt: "Just as no two emergency communications are the same, there's no foolproof plan for success in managing your emergency communications system. Only a fool would suggest that such a plan were possible."

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