FIREGROUND RADIO COMMUNICATIONS AND FIREFIGHTER SAFETY EXECUTIVE PLANNING[1]

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An applied research project submitted to the National Fire Academy as part of the Executive Fire Officer Program

March, 1996

ABSTRACT

Concerns over radio channel overloading prompted the Providence Fire Department to obtain additional radio channels to supplement the existing single channel. ... The purpose of this research was to develop a plan to implement the additional channels. The evaluative research method was used. The research questions were:

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2. Are there documented cases of firefighters being killed or injured where the fact that radio channels were too busy with other traffic was found to be a contributing factor?

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The literature review found nationally accepted recommendations for fire communication systems and identified cases of communications-related firefighter casualties. Two surveys were conducted: one of fire officers in Providence to document the extent of overloading problems, and the other of various fire departments to obtain information regarding overloading problems and multichannel operations. The results showed that the single-channel system in Providence was dangerously overloaded. Documented cases of firefighter casualties associated with radio channel overloading [was] identified in other departments. ... Recommendations included implementing a multichannel radio system in Providence; ...; development of a portable radio specifically for firefighters; ...; and additional research into the firefighter safety aspects of radio communications.

[1] http://www.usfa.fema.gov/fire-service/nfa/courses/oncampus/abstracts/tr_96cv.shtm

INTRODUCTION

Between 1989 and 1995, the Providence Fire Department responded to over 36,000 incidents annually. All radio communications within the Department took place over a single radio channel. This included the dispatching of alarms, the relay of pertinent response related information from dispatchers to responding apparatus, incident scene communications between companies and dispatchers, unit to unit communications on the scene, and routine radio traffic[2].

In response to concerns that the single radio channel was being overwhelmed, the Department obtained four additional radio channels for use as fireground tactical channels. These channels were obtained with the intention of alleviating radio congestion and improving operational efficiency[3].

[2] J.R. Richardson, personal communication, October 30, 1995

[3] Ibid.

BACKGROUND AND SIGNIFICANCE

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Radio Communications

Communications have always played a critical role in the efficient management of fireground operations[4]. From the traditional fire chief's "trumpet," to modern high-tech radio systems, the communication of instructions and the flow of information up and down the chain of command has been essential to effective fireground operations[5]. Prior to the use of radios in the fire service, many chief officers believed that the only place they could effectively control fireground operations was inside the building with personnel attacking the fire, or at least within shouting distance of them[6]. Under such a system, freelancing on the fireground was not only tolerated, it was institutionally encouraged and rewarded. Because of the difficulty in communicating and the fact that the chief could not be everywhere at once, freelancing was accepted as a necessary evil[7]. Electronic radio communications first entered the fire service in the 1940s by way of apparatus-based two-way mobile radios[8]. While the addition of radios in apparatus greatly improved the ability of operating forces to communicate with the dispatch center, fireground operations remained virtually unchanged, and were still based in large measure upon face-to-face communications, hand signals, and a lot of guess work[9]. In the 1960s and 1970s, technological advances made portable radios feasible for use in the fire service[10]. Portable radios offered to dramatically increase the flow of information from the company level to the command level. This, in turn, lessened the need for the chief to be just behind the nozzleman. The chief could remain outside the fire building, and rely upon company officers to relay pertinent information. Fireground operational activities could be coordinated effectively from a remote location to an extent never before possible.

The widespread use of portable radios increased the number of radios on the typical fire scene, and led to a dramatic increase in the amount of radio communications taking place. The increased use of radio airwaves led to the need for additional radio

[4] E.J. Spahn, Fire Service Radio Communications (New York: Fire Engineering, 1989)

[5] New Jersey Bureau of Fire Safety, Firefighter fatalities--Hackensack Ford, 320 River Street, Hackensack, New Jersey (Trenton, NJ: Author, 1988)

[6] A.F. Bertoncini, personal communication, January 12, 1996

[7] Ibid.

[8] Spahn, 1989

[9] Bertoncini, January 12, 1996

[10] Spahn, 1989

frequencies[11]. In Providence, the first portable radios appeared in 1969, and were assigned to chief officers[12]. In 1974, portable radios were issued to rescue companies, followed shortly thereafter by engine and ladder companies in 1975.

The issuance of portable radios in Providence resulted in an explosive increase in the volume of radio traffic[13]. At the same time, there was a dramatic increase in the fire department's overall reliance upon radio communications[14].

By 1980, communication problems prompted the Providence Fire Department and the Providence Department of Communications to change the primary radio channel from a simplex to a duplex system[15]. The principal reason for this change was to improve the reception of radio traffic from portable radios in certain areas of the City. Hand-held portable radios were considerably less powerful than the mobile radios installed in apparatus, and thus their signal did not carry as far as the mobile radios. The duplex system facilitated the use of two receiver sites instead of just one, thereby significantly improving the ability of BOC and other units to receive messages from portable radios. In 1994, concerns over communications from portable radios prompted the Department of Communications to increase the number of receiver sites in the City from two to six[16]. The additional receiver sites were intended to ensure that dispatchers at BOC would be able to hear a portable radio transmission made from any part of the City. The widespread use of portable radios by the fire service has improved the operational efficiency of fire departments while at the same time improving the safety and accountability of firefighters[17]. However, not so surprisingly, along with the increased reliance upon radio communications has come an increased number of situations where a breakdown in fireground communications has been implicated in firefighter deaths and injuries. This paper was prepared to satisfy the applied research requirements associated with the Executive Planning course at the National Fire Academy (NFA). ...

[11] J.R. Richardson, personal communication, November 28, 1995

[12] Ibid.

[13] Ibid.

[14] Bertoncini, January 12, 1996

[15] Richardson, November 28, 1995

[16] Ibid.

[17] Bertoncini, January 12, 1996

LITERATURE REVIEW

National Standards and Recommendations

The literature review identified several National Fire Protection Association (NFPA) standards that addressed radio communications in the fire service. NFPA Standard Number 1500, 1992 Edition, entitled "Standard on Fire Department Occupational Safety and Health Program," stated in Chapter 6-1.6 that "The fire department shall establish and ensure the maintenance of a fire dispatch and incident communication system that meets the requirements of Section 3-6 of NFPA 1561, ... Fire departments must provide a "reliable communications system" that complies with NFPA 1221[18]. All field units available for dispatch to emergencies must be radio equipped and capable of constant communications with dispatchers[19]. All chief officers and company officers must be provided with a portable radio while assigned to emergency duty[20].

Chapter 16-5.3 of NFPA 1201 stated that "Sufficient radio frequencies shall be provided to accommodate the operational needs of the fire department...based upon the amount of radio traffic that is anticipated...."[21]. NFPA 1221, "Standard for the Maintenance and Use of Public Fire Service Communication Systems," 1994 Edition, further identified the components of a safe, efficient and reliable communications system. Chapter 3-6.3 stated that "A separate frequency shall be provided for fire ground communications for jurisdictions or multiple jurisdictions on the same channel receiving 2500 or more alarms per year or where multiple jurisdictions share a common radio frequency"[22]. Chapter 3-4.1.5 stated that "Radio dispatch channels shall be separate from radio channels used for routine or fireground communications"[23]. ...

Firefighter Casualties Related to Communications

A literature review was also conducted to attempt to identify documented cases where firefighters have been killed or injured under circumstances where a radio communications failure was found to be a contributing factor. The earliest documented case where radio communications was implicated in a firefighter casualty was

[18] National Fire Protection Association, (1994). NFPA 1201: Standard for Developing Fire Protection Services for the Public (Quincy, MA: Author, 1994 ed) p. 16.

[19] NFPA 1201, 1994, p.17

[20] Ibid.

[21] Ibid.

[22] National Fire Protection Association, NFPA 1221: Standard for the Maintenance and Use of Public Fire Service Communication Systems (Quincy, MA: Author, 1991) p. 20.

[23] NFPA 1221, 1994, p. 19

in Syracuse, New York, in 1978[24]. 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[25]. There was no indication that anyone on the fireground or in the dispatch office heard the message. Approximately one minute later, a second transmission was recorded: "Help, help, help, static"[26]. This transmission was apparently not heard by any fire personnel on the scene or in the dispatch office. However, an observer with a scanner reported to a fire officer on the scene that he heard a radio transmission, "Help, help, help, third floor attic"[27]. It was not clear what action was taken in response to the information provided by the observer, 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 4 minutes after the second alarm was called (37 minutes into the fire). Among the most well-documented cases of a communications failure contributing to firefighter fatalities, was the July 1, 1988, fire at Hackensack Ford in Hackensack, New Jersey. In 1988, Klem wrote the NFPA investigative report on the Hackensack fire, detailing the circumstances that led to the deaths of five firefighters when a bow-string truss roof collapsed at a fire in an auto dealership. Approximately one minute before the roof collapsed, the IC ordered over the radio for companies operating on the interior to "back your lines out"[28]. This message was not acknowledged by any of the companies operating on the interior of the building, nor was it acknowledged and/or repeated by the dispatch center. 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. Approximately three minutes after the roof collapsed, radio calls for help were made by the two trapped firefighters who escaped into the tool room. These calls initially went unanswered by either the IC or the fire alarm dispatcher. However, the calls were heard clearly by civilians with scanners who were monitoring the incident and 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. By the time the IC became aware of the calls for help, an effective rescue effort could not be mounted to save the

[24] D.P. Demers, Fire in Syracuse: Four Fire Fighters Die (Quincy, MA: National Fire Protection Association 1978).

[25] Ibid., p. 24

[26] Ibid.

[27] Ibid., p. 25

[28] T.J. Klem, Five Fire Fighter Fatalities: Hackensack, New Jersey--July 1, 1988 (Quincy, MA: National Fire Protection Association, 1988) p. 43

trapped members.

In 1988, Demers wrote about 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..."[29]. Demers analyzed the sequence of communications made by the trapped firefighters, which extended over a 15 minute and 50 second period.

Among the points Demers made 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. Demers cited numerous times when the dispatcher "over-rode" the radio transmissions of fireground units, including urgent requests for help by the trapped firefighters[30].

The New Jersey Bureau of Fire Safety (1989), also investigated the Hackensack fire, and like the other investigators cited major communications problems as a contributing factor in the firefighter deaths. 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 the State of New Jersey establish a minimum of two separate radio channels so as to permit the dispatching function to take place on a channel other than the one being used for fireground communications. The Memphis Fire Department witnessed two recent fires where communications problems played a role in firefighter fatalities. Smith[31], wrote about an internal investigation by the Memphis Fire Department into a church fire that occurred on December 26, 1992, in which a wood-truss roof collapsed killing two firefighters. Crews at the scene were operating on a fireground channel that was not being monitored by dispatch personnel.

Upon 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 the investigation team were better training of company officers and acting company officers in incident command, an increased emphasis on fireground

[29] D.P. Demers, Five Fire Fighter Fatalities: Hackensack, New Jersey: July 1, 1988. (Lunenberg, MA: Demers Associates ,1988) p. 1

[30] Ibid., p. 15.

[31] C.E. Smith, Analysis of Two Firefighter Deaths--City of Memphis. (Executive Fire Officer Research Paper) (Emmitsburg, MD: National Fire Academy, 1993)

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.

Routley[32] investigated the Memphis church fire for the United States Fire Administration (USFA). Routley also found that communications problems contributed to the firefighter deaths, concluding that the Battalion Commander was unable to direct operations on the fireground channel. Routley cited the fact that fireground radio channels in Memphis are neither repeated nor monitored by the communications center, as one problem area. Apparently, the failure of some company officers and acting officers to monitor the radio and/or hear the radio over ambient noise, also contributed to the communications difficulties.

In 1995, Chubb and Caldwell wrote about the April 11, 1994, fire at the Regis Tower in Memphis, at which two firefighters died. The fire occurred on the ninth floor of an eleven story fire-resistive highrise 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, an hysterical and violent male victim, and the occurrence of a flashover in the room of origin.

Companies on the scene were operating on an unrepeated fireground channel. At one point a firefighter (who was later to die) made a series of four urgent radio transmissions attempting to communicate with his company officer. These transmissions were apparently made inadvertently 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 was away from his vehicle, and thus he did not hear them. The transmissions were heard by a dispatcher monitoring the dispatch frequency, but no further action was taken by the dispatcher to inform the IC that a member may have been in distress.

In 1990, Isner wrote about his investigation of a fire at the Blackstock Lumber facility in Seattle, Washington, on September 9, 1989. The fire claimed the life of a Seattle fire lieutenant. The lieutenant had advanced a handline into an exposure building with another firefighter 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. None of these requests for help were heard by the IC, other personnel on the scene, or by dispatch personnel. However, the transmissions were heard by people in the area who were monitoring the incident with scanners. The firefighter was able to make his way close to an exit where he

[32] J.G. Routley, Wood Truss Roof Collapse Claims Two Fire Fighters (Emmitsburg, MD: United States Fire Administration, 1992)

collapsed and 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 "inhalation of products of combustion"[33]. The firefighter subsequently reported that when he was calling for help over the radio he could hear the dispatchers providing "move-up" information to companies that were relocating, so he knew that the radio was working. Isner concluded that the radio was not on the normal fireground channel, since no one at the scene heard the requests for help. He also concluded the radio was not transmitting through the repeater, without which the portable radio could not have been heard by the dispatch center. In 1993, Routley wrote about a USFA investigation into the deaths of two firefighters in Pittston, Pennsylvania. The firefighters were operating a handline inside a commercial building when the floor collapsed. Routley cited the fact that the interior crew did not have a portable radio with which to communicate with the IC as a contributing factor in the deaths.

Routley[34] investigated the East Bay Hills fire in Oakland, California. 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. Oakland used a single radio channel for both dispatch and emergency operations. Although a backup channel was available to handle all 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. Another communications problem that 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][35].

[33] M. Isner, "Fire fighter dies in warehouse fire," Fire Command, 57 (8), (1990, August) p. 33

[34] J.G. Routley, East Bay Hills Fire, Oakland - Berkeley, California (Emmitsburg, MD: United States Fire Administration, 1991a).

[35] Ibid., p. 76).

Routley[36] also investigated a fire in Brackenridge, Pennsylvania, in which four firefighters were killed when a floor collapsed. Communications problems were again implicated. Several companies shared a common primary radio channel, which became overloaded with incident-related communications, dispatch tones and other routine traffic. Because of the heavy traffic, 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. This unit, which was operating a handline inside the fire building, was unaware of reports coming from other units at the scene that could have warned them that a dangerous situation was developing. Routley 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.[37] Routley also cited the dual-function police/fire dispatchers as inadequate to effectively manage a major incident.

Chubb[38] investigated a fire that occurred at the Indianapolis Athletic Club in Indianapolis, Indiana, on February 5, 1992. Two firefighters were killed and four seriously injured after fire erupted from a concealed space. Chubb cited a number of communications-related factors 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. Second, a fire captain was seriously burned when he removed his glove to activate the emergency-distress alarm on his portable radio. Chubb concluded that the button for the emergency distress alarm was virtually impossible to activate with a gloved hand, particularly given the fact that radios must be concealed in pockets of under protective clothing to protect them from the hazards of firefighting. The captain also attempted to verbally request assistance using his portable radio, but these attempts were unsuccessful. Third, the IC'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. Chubb attributed this delay to lack of familiarity with the new computer-aided dispatch system and/or new procedures.[39]

In 1995, the Bureau of Land Management investigated a wildland fire that 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.

In 1991, Rosato wrote about the June 25, 1990, wildland fire in Tonto, Arizona, where a communications breakdown was cited as a major factor in the deaths 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, 6 of whom died.

Finally, Routley[40] investigated the February 14, 1995 fire in Pittsburgh, Pennsylvania, that claimed the lives of three firefighters. 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 rescued. The confusion led to the erroneous conclusion that all members were accounted for, when in fact the three firefighters were still lost in the building. Routley cited communications problems as a contributing factor in the failure to realize that three members were still

[36] J.G. Routley, Four firefighters Killed, Trapped by Floor Collapse, Brackenridge, Pennsylvania. (Emmitsburg, MD: United States Fire Administration, 1991b)

[37] Ibid., p. 24

[38] M. Chubb, Indianapolis Athletic Club Fire, Indianapolis, Indiana. (Emmitsburg, MD: United States Fire Administration. 1992)

[39] Bureau of Land Management, Point Fire Accident Investigation (Kuna, ID: Author, 1995).

[40] J.G. Routley, Three Firefighters Die in Pittsburgh House Fire, Pittsburgh, Pennsylvania. (Emmitsburg, MD: United States Fire Administration, 1995)

missing. 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 and the fire department if was 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 about who was missing and who had been rescued. Collectively, the writings of Demers, Klem, the New Jersey Bureau of Fire Safety, Smith, Routley, Chubb and Caldwell, Isner, Chubb, the Bureau of Land Management and Rosato, provided a factual foundation for the linkage of firefighter safety to effective fireground communications, as well as evidence of the converse: the failure of fireground communications has contributed to documented cases of firefighter deaths and injuries. These writings also show the level to which the fire service has come to rely upon radio communications.

The Providence Fire Department routinely responds to over 36,000 incidents annually using a single radio channel for both dispatch and fireground communications. Thus, the existing radio system in use by the Providence Fire Department does not comply with NFPA requirements regarding the need for multiple radio channels. The survey of Providence Fire Department officers indicated that 65 percent (65 out of 100) believed the existing single-channel radio system was not meeting their needs. Seventy-eight percent reported that they have had to wait to transmit a critical radio message while the radio was tied up with radio traffic not related to the incident they were at. The term "critical" was defined as when lives were in jeopardy, or potentially in jeopardy. Fifty-seven percent reported that the inability to transmit a critical radio message occurred to them personally more than once or twice a year. A full 94 percent of officers believed the use of additional radio channels will improve communications, with the remaining 6 percent reporting that additional channels will neither improve nor hamper communications.

The Radio Communications Survey indicated that 147 of 158 fire departments surveyed, or 93 percent, use multiple radio channels. In fact, every fire department that responded to the survey that handled more than 12,000 incidents annually used multiple radio channels. Also, all surveyed departments that protect a population larger than 100,000, reported using multiple channels.

The literature review into communications-related deaths and injuries disclosed that in the aftermath of the Hackensack fire, investigators cited the fact that the single radio channel was overwhelmed with traffic as a major contributing factor to the firefighter deaths. A similar conclusion was drawn after the East Bay Hills fire in Oakland, California[41].

2. Are there documented cases of firefighters being killed or injured where the fact that radio channels were too busy with other traffic was found to be a contributing factor?

The Radio Communications Survey found that eight fire departments, or 5 percent, experienced communications-related casualties where the fact that radio channels were too busy with other radio traffic was found to be a contributing factor. In addition, two surveys reported that such problems had occurred in neighboring fire departments.

The literature review disclosed two documented cases where overloading problems occurred, with Hackensack being the most prominent. Demers cited the fact that the single radio channel in Hackensack was overwhelmed with radio traffic as a contributing factor in the deaths of at least two of the five firefighters[42]. Competition for "air time" had a "significant impact on communications with the trapped firefighters[43]." This competition was both incident-related (other fireground communications) and non-incident related (dispatching, recall of off-duty personnel, and emergency medical responses).

The East Bay Hills fire in Oakland, California, was another example where the use of a single radio channel was overwhelmed by the volume of radio traffic[44].

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[41] Demers, 1988

[42] Routley, 1991a

[43] 1988

[44] Demers, 1988, p. 15

[45] Routley, 1991a