AN EVALUATION OF THE HOUSTON FIRE DEPARTMENT'S FIREGROUND COMMUNICATION PILOT PROGRAM

STRATEGIC MANAGEMENT OF CHANGE

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ABSTRACT

The full protective clothing and self-contained breathing apparatus (SCBA) worn by Houston Fire Department firefighters for thermal and respiratory protection in hazardous environments reduces the firefighter's ability to communicate. This project addressed the problem that the Houston Fire Department needs a safe and effective means of communicating when firefighters use full protective clothing and SCBA. The purpose of this research project was to evaluate the equipment and techniques used in the Fireground Communication Pilot Program of the Houston Fire Department (HFD).

Historical and evaluative research methods were used to determine (1) how have communication problems effected firefighters, (2) what is the HFD Fireground Communication Pilot Program, (3) does the equipment and methods used in the Fireground Communication Pilot Program provide effective communications, and (4) are there any elements of the Fireground Communication Pilot Program that can be altered or modified to improve the program.

This research project was conducted with a literature review of published materials, interviews of HFD personnel, and a survey which provided information for an evaluation of the Fireground Communication Pilot Program. The evaluation used the Phase IV: Evaluation section of the Change Management Model taught in the *Strategic Management of Change* Course at the National Fire Academy.

The study determined that communication problems have effected firefighters with ineffective equipment, reduced operational efficiency, and contributed to firefighter deaths and injuries. The HFD Fireground Communication Pilot Program was a field test

of communication equipment with the objective of improving fireground communication with firefighters wearing full protective clothing and SCBA. The evaluation of the pilot program found the equipment improved fireground communications, but did not meet the goals of the future state of fireground communications.

The report recommends the continuance of the pilot program while improving the methods and equipment.

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INTRODUCTION

As a large metropolitan fire department the Houston Fire Department (HFD) daily responds to fires and other hazardous situations requiring fire fighters to wear full protective clothing and self contained breathing apparatus (SCBA). As the personal protective equipment encapsulates the fire fighter to protect against dangerous environments it severely limits the fire fighter's ability to communicate by voice or radio. The lack of communications affects the safety and efficiency of the fire fighters. The Houston Fire Department needs a safe and effective means of communicating when fire fighters use full protective clothing and SCBA.

The purpose of this research project was to evaluate the equipment and techniques used in the Fireground Communication Pilot Program of the Houston Fire Department. Historical and evaluative research methods were used to answer the following questions:

1. How have communication problems effected fire fighters?
2. What is the HFD Fireground Communication Pilot Program?
3. Does the equipment and methods used in the Fireground Communication Pilot Program provide effective communications?
4. Are there any elements of the Fireground Communication Pilot Program that can be altered or modified to improve the program?

BACKGROUND AND SIGNIFICANCE

The Houston Fire Department (Houston, Texas) is the third largest fire department in the United States, (*Houston Fire Department [HFD] Home Page*, 1999). The HFD consists of 85 active fire stations, 81 engine companies, 34 aerial ladder companies, 59 ambulances, 3 haz mat units, 2 heavy rescue units, aircraft fire crash rescue units for two major airports, and 3,195 firefighters. As with any large organization the HFD has communication problems. One communication problem the HFD shares with other fire departments large and small is the difficulty in safely and effectively communicating on the fireground with firefighters wearing full protective equipment and self-contained breathing apparatus (SCBA), (Thiel, 1999). This problem threatens firefighter and civilian lives and reduces operational efficiency.

Communicating with firefighters on the fireground has historically been a problem. In the 1800's Houston firefighters used the speaking trumpet or bugle to amplify the fire officer's voice to direct operations on the fireground (McDonald, Mellott, 1988). This form of communication was very limited, but the technology to resolve the problem was not available. During that time the problems with communication were accepted as one of the hazards of the firefighting profession.

Today the bugle is used as a symbol and worn on a firefighter's uniform to identify that firefighter as a fire officer. Safety attitudes have also changed and greater emphasis has been placed on removing the hazards of the fire profession. Modern firefighters use portable radios to quickly exchange information on the fireground, to improve safety and efficiency.

However when HFD firefighters wear their full protective equipment and

SCBA their ability to communicate normally is impaired, and the present radio equipment is not effective, (A. R. Gunderson, personal communication, July 7, 1999). On the fireground firefighters communicate with their crewmembers by shouting in the other's ear or by touch. Firefighters with hand held radios have the ability to contact the incident commander or dispatcher if the radio is held in contact with the facepiece. The sound quality with this technique is often difficult to understand. Since firefighters must use their hands to work, the radio is often carried in the turnout coat pocket where it can not be heard. This situation leaves firefighters without a reliable means to call for help or report conditions in their area. Fireground communication problems have been contributing factors in many firefighter fatalities, (Thiel, 1999).

Without reliable communications the incident commander who is responsible for everyone at the incident has a limited ability to insure safety and control operations. The National Fire Protection Association (NFPA) has noted the importance of radio communications in firefighting, "Radios are an integral part of a fire department's communication system and are essential for efficient operations" (*National Fire Protection Association [NFPA] 1201 Standard for Developing Fire Protection Services for the Public*, 1994, p.74).

The goal of the HFD Fireground Communications Pilot Program (FCPP) was to improve fireground communications with firefighters wearing full protective equipment and SCBA in hazardous environments, (*HFD Pilot Program for Fireground Communications*, 1998). This research project evaluated the HFD pilot program using a standard change evaluation method from the National Fire Academy.

This report is presented to satisfy the applied research project requirements associated with the National Fire Academy's Executive Fire Officer Program. The report used the "Phase IV: Evaluation" section of the "Change Management Model" taught in the *Strategic Management of Change* course.

LITERATURE REVIEW

Published literature, the Internet, HFD written communications, and personal interviews were conducted to answer the research questions in this literature review.

Research Question 1: How have communication problems effected firefighters?

The communication problems have effected firefighters with ineffective portable communication equipment, operational efficiency issues, and firefighter safety problems.

Ineffective Equipment

The frustration firefighters have experienced with ineffective equipment and /or systems has led to comments like retired Division Chief George Meister's, "It's hard to believe in an era when computers can talk to other computers that people can't talk to other people" (Meister, 1998, p. 56).

The importance of how the current portable radios have been ineffective for firefighters was stated in the United States Fire Administration (USFA) Technical Report *Improving Firefighter Communications*,

> The chief communication problem reported by firefighters and company officers is the difficulty with communicating from inside a fire when using full personal protective equipment, including SCBA. The majority of portable radios currently used by fire departments are ill suited for the task (Thiel, 1999, p.3).

The limitations of existing portable radios include the failure to be waterproof, inaccessibility (under turn-out coats or in pockets), non-ergonomic controls (knobs and switches can not be operated wearing firefighting gloves), (Varone, 1996), the inability to transmit inside buildings or ships (Thiel, 1999), and the reduced performance relative to smoke, rain, and fog (Meister, 1998).

The portable radio equipment used by firefighters today is equipment that has been adapted from other markets (Thiel, 1999). In the Houston area the number of law enforcement portable radio customers is larger than the fire service portable radio customers and radio companies have concentrated on the larger market (K.S. Savage, personal communication, July 20, 1999). "Radio manufacturers have concluded that it is not financially worth the cost of researching, developing, and manufacturing a portable radio specifically for the fire service" (Varone, 1996, p.105).

The National Fire Protection Association (NFPA) has published standards on fire department radio communications. *NFPA 1201 Standard for Developing Fire Protection Services for the Public* section 16-5.1 states "Radio transmitter / receivers shall be provided at headquarters and in emergency vehicles. Every chief officer and company officer shall be provided with a portable transmitter / receiver while assigned to emergency duty" (1994, p.30). *NFPA 1221 Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems* section 3-6.10 specifies "Mobile radios and associated equipment shall be manufactured for the environment in which it will be used" (1994, p.36). Also in *NFPA 1221* section 3-7.1.5 "Multiple frequency fire-radio transceivers shall be capable of changing channels while wearing gloves" (1994, p.36). While the NFPA has set these radio standards the USFA report on firefighter

communications has noted "No NFPA standard currently addresses the certification of portable radio equipment intended for use during interior firefighting operations" (Thiel, 1999, p.13).

Chief J. Curtis Varone of the Providence Fire Department, Providence, Rhode Island said, "Additional research is needed to develop a portable radio specifically for the fire service" (Varone, 1996, p.105). Firefighters should not have to compromise their personal safety to operate portable radios (Chubb, 1992).

Currently several types of devices are available to improve firefighter communication such as facepiece integrated microphones, intercom systems, throat mikes, and "bone conduction" microphones (worn in the ear or on the head). These products have received varying reviews from firefighters, and are too expensive for many fire departments (Thiel, 1999).

The goal of the HFD Fireground Communication Pilot Program was to field test equipment for improving fireground radio and oral communications. Some of the equipment tested was designed specifically for the fire service, but the lapel microphones tested were not designed for firefighting.

Operational Efficiency

> Radios are an integral part of a fire department's communications system and are essential for efficient operations. Radios keep firefighting units in communication with one another and with the communication center to coordinate fireground activities, provide progress reports, request assistance, or return units that are not needed (*NFPA 1201*, 1994, p.74).

To secure the fire department operational efficiency that radio communication can provide the NFPA standard requires:

> A secure communications center shall be provided and staffed to receive requests for emergency assistance from the public, to dispatch that assistance, to coordinate communications with units providing emergency services, and to provide overall coordination and control of fire department operation communications (*NFPA 1201*, 1994, p.28).

Communication problems can reduce the efficiency of firefighting operations. "Firefighters engaged in fighting a fire are acutely aware of the importance of effective communication for tactical and strategic decision-making, and coordination among different units" (Thiel, 1999, p.7). Fire conditions do not wait for information or instructions to be relayed. Incident commanders that can not visualize the whole incident and all the firefighters involved must rely on others from different vantagepoints for information to quickly stabilize the scene (Routely, 1995a).

In his report *Fireground Radio Communications and Firefighter Safety* Chief J. Curtis Varone said,

> Effective communication has always been an important component of successful fireground operations. However, the modern fire service has come to depend heavily upon radio communications, so much so that efficient operations as well as firefighter safety now depend to a great extent on how well our radio communications systems function (Varone, 1996, p.96).

Fire Chief Alan Brunacini of the Phoenix Fire Department in his book *Fire Command* defined what an incident commander must do to effectively control an incident:

> If the fireground commander can initially place his firefighters, move them, and change what they are doing, he has the most important level of control. If he is not able to change the location and function of his resources, the operation is out of control (Brunacini, 1985, p. 67).

Without effective radio communication with firefighters out of normal voice communications an incident commander has limited control. "In a very practical sense, the fireground commander's ability to control the communication process regulates his ability to command the operation" (Brunacini, 1985, p. 59).

Firefighter Safety Problems

The effectiveness of radio communications on the fireground affects firefighter safety. The USFA, local fire departments, and other involved agencies have investigated firefighter fatalities and documented the relationship between communication problems and firefighter safety. The USFA's report on firefighter communications states "Communications problems are continually cited as contributing factors in fires and emergency incidents where firefighters are killed and injured." (Thiel, 1999, p. 4). This report also noted that " the number of 'near miss' incidents where fireground communications was ineffective may be higher than generally realized" (Thiel, 1999, p.4). District Chiefs in the Houston Fire Department have experienced many incidents in which communication problems on the fireground threatened the firefighters safety which were not documented (A.R. Gunderson, personal communication, July 7, 1999).

The following incidents are documented tragedies investigated by the USFA and/or the effected fire department in which communication problems contributed to the firefighter fatalities.

On December 26, 1992, two firefighters from Memphis, Tennessee where killed when the lightweight wood truss roof of a church collapsed seven minutes after the arrival of the first fire units (Routley, 1993). The firefighters were attacking the fire in the sanctuary of the church building when the roof collapsed trapping them in the burning debris (Routley, 1993).

This incident demonstrated the importance of effective fireground communications to incident management and personnel accountability. "The incident commander was unable to communicate with company officers on the tactical radio channel" (Routley, 1993, p.21). Progress reports of the fire spread, and that a hole in the roof could not be cut because of dangerous roof conditions (the fire was venting itself through the roof) were not reported (Routley, 1993). The firefighters trapped in the collapse were from two different companies and their company officers did not know where the firefighters were located or what actions they were involved in (Routley, 1993).

> If the danger of imminent collapse had been recognized, the warning would have been delayed because the incident commander could not communicate with company officers and the company officers did not know where their crew members were or what their crew members were doing (Routley, 1993, p.21).

One of the recommendations from the Board of Inquiry over this incident noted that "increased emphasis on fireground communication between the company officers, the incident commander, and the safety officer must be stressed" (Routley, 1993, p. 24).

Another communication problem at this incident was the trapped firefighters did not have a portable radio with which they possibly could have called for help (Routley, 1993).

On February 5, 1992, two firefighters were killed and four injured in a fire at the Indianapolis Athletic Club in Indianapolis, Indiana (Chubb, 1992). The structure was an old high rise building housing a hotel and other businesses (Chubb, 1992). As the firefighters were attacking the fire on the third floor with a house line (the fire department hose line would not connect to the standpipe) fire erupted from a concealed space forcing the firefighters to seek any exit (Chubb, 1992). The surviving firefighters were rescued with aerial ladders and down stairways (Chubb, 1992).

Among the communication problems noted at this incident were difficulties with a new radio system and equipment (Chubb, 1992). When the fire became visible from outside the building the incident commander requested an additional alarm, but it was not received by the communications center possibly due to a fire at another location being dispatched (Chubb, 1992).

This fire also produced severe firefighter injuries due to the inability to operate the controls of portable radios while wearing firefighting gloves (Chubb, 1992).

> During his desperate attempt to rescue Gelnius and himself Captain Spalding activated the emergency button on his portable radio and made several unsuccessful attempts to verbally request assistance. To operate his radio

> controls, he had been forced to remove his glove, severely burning his hand in the process (Chubb, 1992, p.16).

The severe burns to Captain Spalding's hand kept him off-duty for three months, and required rehabilitative therapy (Chubb, 1992).

In Seattle, Washington, on January 5, 1995, four firefighters died in floor collapse fighting a warehouse fire (Routley, 1995a). The firefighters fell from the first floor into the basement when a "pony" wall collapsed from fire exposure (Routley, 1995a).

The incident commander did not receive situation reports from fire crews in the interior (Routley, 1995a). The first floor firefighters did not notify the incident commander that only a small amount of fire was found, and the fire in the basement was located but not reported (Routley, 1995a). "The significance of the information was not recognized and it was not reported to the incident commander" (Routley, 1995a, p.30).

In addition to the lack of communication from interior firefighters two other communication problems were reported. The Seattle Fire Department's new radio system required the incident commander to monitor two channels providing the opportunity to miss an important message on the other channel (Routley, 1995a). When two of the trapped firefighters activated the emergency signal on their portable radios, one signal was identified as coming from a firefighter who was not at the fire (Routley, 1995a).

Three firefighters from the Pittsburgh Fire Bureau died in a house fire at 8316 Bricelyn Street on February 14, 1995 (Routley, 1995b). The three firefighters were from the same engine crew that advanced the first hose line into the structure to extinguish a fire in the basement (Routley, 1995b). When the firefighters were unable to escape an

interior room their air supply ran out exposing them to the toxic smoke (Routley, 1995b). The status of this engine crew was confused when three other firefighters were rescued from the same room (Routley, 1995b).

The Bricelyn Street fire "illustrates the need for effective incident management, communications, and personal accountability systems, even at seemingly routine incidents" (Routley,1995b). The acting battalion chief arrived after all of the first alarm units were operating and the chief did not receive any progress reports (Routley, 1995b).

Confusion over which firefighters were injured or rescued occurred because the Emergency Medical Service (EMS) units at the fire did not operate on the same radio channel (Routely, 1995b).

Two of the deceased firefighters had portable radios, both were found in their turnout coat pockets (Routley, 1995b). One of the radios, the captains, was found to have a dead battery and a blown fuse, but the other radio worked when it was tested later (Routley, 1995b). "There was no indication that the victims called for assistance" (Routley, 1995b, p.25).

On March 9, 1995, in San Francisco, California, one firefighter was killed and 11 others injured fighting a residential fire. Three firefighters from Engine 26 were trapped in a garage when the overhead door closed behind them (Howell, 1995). The trapped firefighters went unnoticed for several minutes as the fire spread into their area (Howell, 1995). When the rescuers opened the garage door they found all three members of Engine 26 at the door, but the lieutenant died and the other two firefighters were injured, one critically (Howell, 1995).

As the other units responding to this fire tried to transmit progress reports to the incident commander, the incident commander did not receive them. Heavy radio traffic may have prevented the incident commander from receiving the information (Howell, 1995).

The Lieutenant of Engine 26 had a portable radio in his pocket that worked when it was tested later. There is not any evidence the Lieutenant transmitted a call for help, and the San Francisco Fire Department's investigation did not determine an explanation (Howell, 1995).

In Houston, Texas, on December 4, 1996, a volunteer firefighter riding with the career firefighters was killed searching for a trapped woman. Just after entry into the house a flashover separated the crew and the missing volunteer went unnoticed. The fire attack and search for the woman continued in other areas of the house. A Senior Captain searching the west side of the house on his second air cylinder discovered the firefighter (Matejka, Branum, Connealy, Holleman, Casey, 1997).

The HFD investigation noted "had the search been conducted in pairs with communication capabilities, a second firefighter could have possibly removed the fallen firefighter earlier in the incident" (Matejka, et al. 1997, p.8). A Safety and Health Bulletin was sent throughout the department on February 13, 1997, instructing members that upon "entry into a hazard zone a crew must have a working radio" (*HFD Safety & Health Bulletin No.3*, 1997).

The radio transcripts of the incident indicated this incident had to share the radio channel with two other incidents and the dispatcher sending medical units to unrelated calls (Matejka, et al. 1997).

In Washington D.C. at 400 Kennedy Street on October 24, 1997 a firefighter was killed when he fell through a collapsed floor and drowned in the basement from water pumped into the structure from hose streams. The firefighter was lost as his crew (E-14) and E-22 were evacuating the structure (*Washington D.C. Fire & EMS Department [DC-FEMSD] Executive Summary of the Kennedy Street Incident*, 1997).

The Reconstruction Committee of the incident found evidence the firefighter tried to call for help after he fell into the basement, but the calls were not received. Problems with the firefighter's radio had been reported before the incident (*DC-FEMSD Executive Summary of the Kennedy Street Incident*, 1997).

Additional communication problems the committee discovered were "Companies did not provide status reports while in the structure" (*DC-FEMSD Executive Summary of the Kennedy Street Incident*, 1997, p.8), and "the incident commander had to switch back and forth between two channels and missed important information" (*DC-FEMSD Executive Summary of the Kennedy Street Incident*, 1997, p.7)

These fatal incidents occurring in different areas of the country and over several years have many communication problems in common. The fires in Memphis, Seattle, Pittsburgh, San Francisco, and Washington D.C. all had a lack of progress reports or interior conditions being reported to the incident commander. Incident commanders in the Pittsburgh, Seattle, and Washington D.C. incidents were required to monitor two channels, the Pittsburgh incident had the Fire and EMS units operating on separate frequencies. The problems of firefighters not having a portable radio, firefighters having a malfunctioning radio, and firefighters not using the radio in their pocket occurred in more than one location.

The HFD Fireground Communication Pilot Program sought to resolve the issues of not transmitting progress and/or interior situation reports to the incident commander, and not calling for help with a radio in the turnout coat pocket. The program tested equipment designed to permit clear radio transmissions with a firefighter wearing full protective clothing and SCBA with relatively hands-free activation of the radio. Which would permit firefighters to more easily transmit messages of progress or requests for help to outside the hazardous area.

The communication problems involving the monitoring of two separate radio channels, malfunctioning radios, and crowded radio channels could not be addressed with the pilot program's equipment.

Research Question 2: What is the HFD Fireground Communication Pilot Program?

After a 1997 survey of the District Chiefs in the department declared that radio communications problems were the District Chief's most serious problem the HFD formed a Communication Committee to resolve the issues (A.R. Gunderson, personal communication, July 7, 1999). This committee searched for equipment that would permit firefighters to communicate with fellow crewmembers in the hazard area and be able to contact the incident commander and/or the dispatcher outside the hazard area (M. Casey, personal communication, July 20, 1999).

In July, 1998, the HFD Communication Committee tested a "bone" microphone earplug, several models of a small radio that attached to the facepiece, lapel microphones, and a voice amplifier in live-fire tests at the HFD Fire Training Academy (M. Casey, personal communication, July 20, 1999). The committee found the Scott Voice Amplifier used with a Motorola Lapel Microphone performed more effectively than the

other devices . Fire Chief Lester Tyra ordered a pilot program to test the equipment on a larger scale (K.S. Savage, personal communication, July 20, 1999).

The HFD Fireground Communication Pilot Program tested several pieces of equipment,

- Scott Voice Amplifiers
- Lapel Microphones from Motorola (also called a remote microphone)
- Charging handles from the HFD Maintenance Shop
- Spare portable radio batteries
- A/C portable radio battery chargers
- Firefighter's turnout coats with an epaulet for attaching a lapel microphone (*HFD Pilot Program for Fireground Communications*, 1998)

The Scott Voice Amplifiers were connected to each firefighter's facepiece of the pilot program's assigned companies. The voice amplifiers would permit crewmembers to communicate orally while wearing their SCBA facepieces by amplifying the firefighter's voices. The equipment would also amplify the voice for transmitting a radio message (*HFD Pilot Program for Fireground Communications*, 1998).

The lapel microphones were issued to the officers of the program's fire companies. The officers would clip the lapel microphone onto the epaulet added to their turnout coat. This would permit the officers to hear radio messages better than when the portable radio was carried in the coat pocket. To transmit messages the officer would push the push to talk (PTT) switch on the lapel microphone anchored on his/her shoulder, and speak with the amplified voice (*HFD Pilot Program for Fireground Communications*, 1998).

The charging handles tested in the pilot program were metal rods that connect to a portable radio battery and hold the battery in the proper position in a mobile battery charger for the battery to be properly recharged (*HFD Pilot Program for Fireground Communications*, 1998). The charging handles were needed because the portable radios with a lapel microphone attached would not fit into the mobile radio chargers HFD units were equipped with (S. Speed, personal communication, July 7, 1999). The charging handles were assigned only to Stations 7, 31, and 68 (*HFD Fireground Communication Pilot Program*, 1998).

The spare portable radio batteries were issued to all the portable radios assigned to pilot program units to permit the lapel microphones to remain attached to the portable radios, and to test whether rotating the portable radio batteries would improve performance (*HFD Fireground Communication Pilot Program*, 1998).

The a/c portable radio battery chargers were assigned to Stations 46 and 51 to test for improved performance from an alternate battery charging method (*HFD Fireground Communication Pilot Program*, 1998).

The Fireground Communication Pilot Program (FCPP) participants consisted of five engine companies and five aerial ladder companies (assigned to Stations 7, 31, 46, 51, & 68). These companies were selected for the large number of fire incidents they respond to, and their geographical location in different areas of the city (K.S. Savage, personal communication, July 20, 1999).

The FCPP began in October of 1998, when all of the equipment had been issued. The participants were instructed to complete equipment comment forms monthly or whenever an issue arose (*HFD Fireground Communication Pilot Program*, 1998).

Research Question 4: Are there any elements of the Fireground Communications Pilot Program that can be altered or modified to improve the program?

Published literature contained information on technical and non-technical methods to improve the Fireground Communication Pilot Program.

The non-technical techniques to improve fireground communication involves the human performance factors (Thiel, 1999). Radio discipline, standard procedures, and cultural problems are areas that can be improved (Thiel, 1999). Prioritizing radio messages and effectively listening to messages from other units are two elements of radio discipline that have positively effected communications (Thiel, 1999). Standard procedures that specify using standard messages, accurate situation reports, and the incident command management system have improved communications (Thiel, 1999). Another human performance factor that can be improved is to eliminate the embarrassment firefighters feel about calling for help (Thiel, 1999).

Technical methods to improve the Fireground Communication Pilot Program include new radio equipment designed for firefighters.

Lion Apparel has a product called the Helmet-Com. The Helmet-Com has a bone conduction microphone and speaker designed to fit into the firefighter's helmet and connect to the portable radio (*Hands-On Fire Fighters Need Hands-Off Communications*, 1999). The equipment is designed to work with a firefighter wearing a SCBA (*Hands-On Fire Fighters Need Hands-Off Communications*, 1999).

Scott, whose voice amplifier the Fireground Communication Pilot Program is already testing, has a new product called the Envoy Radiocom. This product connects to

the firefighter's SCBA facepiece and a portable radio. The Envoy Radiocom is designed to be a voice amplifier or when the PTT switch is pushed transmit through the portable radio (*When Every Word Counts Scott's Envoy Radiocom*, 1999). This device is designed to provide the same functions as the pilot program's voice amplifier and lapel microphone working together (*HFD Pilot Program for Fireground Communications*, 1998).

Safety Tech Industries is releasing a new communications system called the MaskCom. The system includes a radio transceiver that connects to the firefighter's SCBA facepiece and transmits to mobile repeater on the fire apparatus. The MaskCom is designed to transmit locally by voice activation, and to the repeater system when the PTT switch is activated. The repeater system includes the ability to maintain personnel accountability, and other fire fighter features (*Fully Automatic Electronic Accountability. Built to Save Lives*, 1999).

PROCEDURES

Definition of Terms

HFD Full Protective Clothing. A NFPA approved helmet, turnout coat with liner, turnout pants with liner, boots, gloves, firefighting hood, and self-contained breathing apparatus (SCBA), (*HFD Protective Clothing II-2*, 1990, p.1).

HFD – SCBA. A self-contained breathing apparatus, the type used by the HFD is the Scott 4.5 model. The Scott 4.5-model air-pack is an open circuit breathing apparatus designed to provide respiratory protection in hazardous atmospheres (Scott Health and Safety, 1996).

Portable Radio. *NFPA 1221* states "a fire portable radio must have the size and construction making it capable of one-handed operation" (*NFPA 1221*, 1994, p.40). Also known as a "hand held radio", or a "walkie-talkie".

Mobile Radio. A radio installed in vehicles (fire engine, command vehicle). Required for fire apparatus in *NFPA 1221* section 3-6.1 (*NFPA 1221*, 1994).

Scott Voice Amplifier. A device manufactured by Scott that attaches to the Scott SCBA facepiece that "amplifies the user's voice over a wider range and distance" (Scott Health and Safety, 1998, p.8).

Lapel Microphone. An HFD term for a small speaker and microphone that is connected to a portable radio by a small cord permitting the user to talk and listen without removing the radio from the belt or turnout coat pocket. The actual product name is the Remote Microphone Speaker (Motorola, 1999).

Research Methodology

The purpose of this research project was to evaluate the HFD Fireground Communication Pilot Program following the Change Management Model Phase IV: Evaluation from the *Strategic Management of Change* Course taught at the National Fire Academy. Historical and evaluative research was used to answer the research questions and document the results and recommendations. The research questions were answered with information from a literature review, interviews, comment forms, and an evaluation survey of the HFD pilot program participants.

Literature from the National Fire Academy's Learning Resource Center, the HFD Fire Training Academy's Library, the internet (for example: the USFA Web Site), and HFD inter-department communications (included in Appendix D and Appendix E) were used during the literature review.

Interviews with HFD personnel were conducted to provide information from the department that has not been published. HFD District Chief Alan Gunderson, District 10 "C" Shift, a member of the District Chief's Technical Advisory Committee's Steering Committee (DC-TAC), was interviewed on July 7, 1999. Chief Gunderson provided information on the DC-TAC's evaluation of HFD problems. HFD Communications Committee members District Chief Mike Casey, District 8 "C" and District Chief Scott Savage, District 46 "A", were interviewed on July 20, 1999 concerning the HFD communications situation and the Communication Committee's activities. HFD Communications Supervisor Steve Speed was interviewed on July 7, 1999 to provide information on the department's radio equipment.

Historical research was conducted during the literature review to answer research question # 1 How have communication problems affected firefighters?, and research question # 2 What is the HFD Fireground Communication Pilot Program?. The material was analyzed in order to predict future HFD fireground communication needs.

Evaluative research was used to answer research question # 3 Does the equipment and methods used in the Fireground Communications Pilot Program provide effective communications?, and research question # 4 Are there any elements of the Fireground Communications Pilot Program that can be altered or modified to improve the program?

This report followed the Change Management Model Phase IV: Evaluation, Task 4.1 to evaluate the HFD Fireground Communications Pilot Program. The Phase IV Task 4.1 Evaluation Steps are:

A. Evaluate the change against the initial change goals

B. Evaluate the change against the described future state

C. Evaluate how well established the change becomes

D. Evaluate how rapidly the change was accomplished

E. Evaluate the costs to individuals and the organization

F. Identify unanticipated actions and or occurrences the change generates

G. Assess the initial resistance to change (*Strategic Management of Change [SMOC] Exercises*, 1996, p. SM C-13)

Fireground Communication Pilot Program Evaluation Form

To evaluate the pilot program following the Phase IV Task 4.1 Evaluation Steps, and provide information to answer research question # 4 the Fireground Communication Pilot Program Evaluation Form (see Appendix B) was written. The evaluation form was sent via HFD mail with an introductory memo (see Appendix A) to each station and shift of the program's participants. In addition to sending the forms in the HFD mail, the forms were handed out on personal visits and faxed to participating firefighters.

The HFD Air-Pack Shop Supervisor, and the Radio Shop Supervisor were sent copies of the evaluation form also, to provide information concerning purchasing, installing, and repair of the program's equipment. The program participants were allowed 30 days to return the completed forms.

The ten fire companies participating in the program were assigned to five fire stations with an engine company and a ladder company sharing the same station. Each engine and ladder company was staffed with four fighters. 40 firefighters on each of the four shifts of the HFD participated in the pilot program. 174 pilot program participants were surveyed (160 firefighters + 12 District Chiefs + 2 support supervisors). 121 evaluation forms were completed to provide a sampling representation of the HFD members who participated in the pilot program.

Question #1 of the Fireground Communication Evaluation Form was written to provide data to answer the Phase IV Task 4.1 Evaluation Step (A) "Evaluate the change against the initial change goals" (*SMOC Exercises*, 1996, p. SM C-13). The stated objective of the pilot program was "…to improve fireground communications with fire fighters wearing full protective clothing and SCBA in hazardous environments. Firefighters need to communicate effectively with fellow crewmembers and outside the hazard zone with the incident commander or dispatcher" (*HFD Fireground Communication Pilot Program*, 1998). The survey form asked participants to answer yes or no to the following questions:

- Did the Scott Voice Amplifiers provide safe and effective communication between company members when wearing full protective clothing and SCBA?
- Did the lapel microphone provide safe and effective communications between company officers, or members wearing lapel microphones, and the incident commander or dispatcher?
- Did using the lapel microphones with the voice amplifiers provide safe and effective communications with crewmembers and the incident commander or the dispatcher?
- Did the spare hand held radio battery improve hand held radio performance?
- Did the charging handles properly charge the hand held radio batteries?
- Did the a/c bank chargers properly charge the hand held radio batteries? (*HFD Fireground Communication Pilot Program Evaluation Form*, 1999, p.1).

Question #2 addressed the Phase IV Task 4.1 Evaluation Step (B) "Evaluate the change against the described future state" (*SMOC Exercises*, 1996, p. SM C-13) by

asking the firefighters if the voice amplifiers and lapel microphones met the goals of the future state of fireground communications.

Question #3 completed Phase IV Task 4.1 Evaluation Step (C) “Evaluate how well established the change becomes” (*SMOC Exercises*, 1996, p. SM C-13) by asking the participants how often do you use each piece of pilot program equipment. The respondents could select an answer from “never”, “occasionally”, “often”, “daily”, and “every incident”.

Question #4 answered Phase IV Task 4.1 Evaluation Step (D) “Evaluate how rapidly the change was accomplished” (*SMOC Exercises*, 1996, p. SM C-13) by asking the firefighters to record the time required to use the fireground communication equipment routinely.

Question #5 responded to Phase IV Task 4.1 Evaluation Step (E) “Evaluate the costs to individuals and the organization”(*SMOC Exercises*, 1996, p. SM C-13) by asking the firefighters to list the costs of the Fireground Communication Pilot Program to themselves or their group.

Question #6 addressed Phase IV Task 4.1 (F) “Identify unanticipated actions and or occurrences the change generates”(*SMOC Exercises*, 1996, p. SM C-13) by asking the firefighters to list any unanticipated actions or occurrences with the Fireground Communication Pilot Program equipment.

To resolve Phase IV Task 4.1 Evaluation Step (G) “Assess the initial resistance to change” (*SMOC Exercises*, 1996, p. SM C-13) question #7 asked firefighters to list problems with the equipment and the pilot program, and question #8 asked the participants to list reasons for not using the communication equipment.

Question #9 of the evaluation form was written to provide information to answer research question # 4 “Are there any elements of the Fireground Communication Pilot Program that can be altered or modified to improve the program?”. The question asked the firefighters to list ideas for improving the equipment or the pilot program.

Assumptions and Limitations

The results of the survey assume the program participants answered truthfully in the personal opinions requested. The survey was limited to two pages to encourage completion of the form. The only information included with the evaluation form was a memo introducing the form (see Appendix A).

The total number of answers to each question varies because not all respondents answered every question. The survey results did not receive a statistical analysis to determine a margin of error.

Fireground Communication Pilot Program Comment Form

The Fireground Communication Pilot Program Comment Form was the first evaluation form issued with the pilot program. The purpose of the comment form was to receive documented feedback. The form was asked to be completed whenever necessary, and at least once a month (*HFD Fireground Communication Pilot Program*, 1998). A sample comment form is included in Appendix C.

The comment form asked for name, date, station assignment, rank, and unit number. A checklist was included to mark which equipment the respondent used. The respondent was asked to list the benefits of the equipment, the problems with the equipment, and any ideas for improvement.

The statements written on the comment form were applied to the Phase IV Task 4.1 Evaluation Steps that the statement was relevant to.

Assumptions and Limitations

The results of the comment form assume the participants answered truthfully in the personal opinions requested. The only information included with the comment form was the memo announcing the pilot program (see Appendix E).

The comment form did not provide a sampling representation of the HFD pilot program participants.

The form was not based on an evaluation model such as the Change Management Model Phase IV Task 4.1, however many of the comments addressed at least one of the evaluation steps. The information from the comment forms was included in this report to supplement the answers from the Fireground Communication Pilot Program Evaluation Form.

RESULTS

The research questions were answered with information from the literature review and the survey of HFD Fireground Communication Pilot Program participants.

Research Question Answers

Research Question 1: How have communication problems effected firefighters?

The literature review was used to answer this research question. The published material indicated that firefighters have been effected with ineffective communication equipment, operational efficiency issues, and firefighter safety problems.

Ineffective Equipment

When firefighters wear full protective clothing and SCBA (which includes a firefighting hood that fits over the firefighter's ears, a facepiece which covers the eyes, mouth, and nose, and the bulky gloves that reduce dexterity) their portable

communication equipment is ineffective (Thiel, 1999). Firefighters and company officers have considered the difficulties of communicating in protective equipment to be a serious problem (Thiel, 1999).

The existing portable radios used by firefighters have several limitations. The radios do not overcome the effects of the SCBA facepiece on normal speech (Thiel, 1999). The portable radios are not waterproof, they are carried in inaccessible locations such as under the turnout coat or in a pocket, and are difficult to operate wearing firefighting gloves (Varone, 1996). Additionally the radios have difficulty transmitting inside buildings, or ships (Thiel, 1999), and have reduced performance in smoke, rain, and fog conditions (Meister, 1998).

The portable radio equipment used for firefighters today has been adapted from radio designs for other uses (Thiel,1999) such as law enforcement (K.S. Savage, personal communication, July 20, 1999). Radio manufacturers have determined the fire service market has not been worth the cost of researching and developing a special portable radio for their use (Varone, 1996).

Current national standards such as *NFPA 1201 Standard for Developing Fire Protection Services to the Public,* and *NFPA 1221 Standard for Installation, Maintenance, and Use of Public Fire Service Communication Systems* list requirements for fire service portable radios (1994). However at the present time the national standards do not set certification specifications for portable radios designed for interior firefighting (Thiel, 1999).

At the present time the devices on the market to improve firefighter communications such as facepiece integrated microphones, intercom systems, throat

mikes, and bone conduction microphones have received only mixed successes (Thiel, 1999).

Efficient Operations

"… Firefighters engaged in fighting a fire are acutely aware of the importance of effective communication for tactical and strategic decision making, and coordination among different units…" (Thiel, 1999, p.7). An incident commander cannot coordinate fire companies in different areas of a structure without radio communication equipment. For this reason the NFPA standards list radios as "essential for efficient operations" (*NFPA 1201*, 1994, p.74).

Efficient firefighting operations require effective control to prevent the waste of time and resources. Fire Chief Alan Brunacini defined effective control as the ability to "initially place firefighters, move them, and change what they are doing" (Brunacini, 1985, p.67). When an incident commander can not maneuver the firefighters or change operations the situation is not under control (Brunacini, 1985).

Firefighter Safety

Fireground communication problems have been repeatedly listed as "contributing factors" in firefighter fatalities (Thiel, 1999, p. 4). Technical reports from the USFA and local fire departments document the relationship between communication problems and firefighter safety.

The lack of progress or situation reports being transmitted to the incident commander has contributed to firefighter deaths across the country. At the roof collapse of the church in Memphis, Tennessee, which killed two firefighters, fire progression from one end of the structure to the other and the dangerous roof conditions were not reported

to the incident commander (Routley, 1993). In the Seattle, Washington, warehouse fire where four firefighters perished, lack of progress reports from the first floor and basement prevented the incident commander from anticipating the floor collapse (Routley, 1995a). At the housefire in Pittsburgh, Pennsylvania, the lack of progress reports from different areas of the structure, and confusion regarding rescued firefighters led to the loss of three firefighters who were unable to escape from an interior room (Routley, 1995b). In the San Francisco, California, housefire which killed one of the three firefighters trapped in the garage, the incident commander did not receive progress reports of the rapid fire spread into the structure (Howell, 1995). The Reconstruction Committee of the Kennedy Street fire in Washington, D.C. that killed one firefighter in a floor collapse reported that the incident commander did not receive status reports from the interior (*DC FEMSD Executive Summary of the Kennedy Street Incident*, 1997).

The Pittsburgh, Seattle, and Washington D.C. incidents required the incident commander to monitor two channels simultaneously (Routley, 1995a, 1995b) (*DC FEMSD Executive Summary of the Kennedy Street Incident*, 1997). The monitoring of two channels allowed important information to be missed (*DC FEMSD Executive Summary of the Kennedy Street Incident*, 1997).

The inability of firefighters to call for help has been noted in firefighter fatalities and injuries. In the Memphis, Tennessee and Houston, Texas incidents the fatally injured firefighters did not have a radio with which to call for help (Routley, 1993) (Matejka, et al. 1997). One of the firefighters in Pittsburgh, and the firefighter from Washington D.C. had malfunctioning radios (Routley, 1995b) (*DC FEMSD Executive Summary of the Kennedy Street Incident*, 1997). In the Indianapolis, Indiana fire a firefighter severely

burned his hand because he could not operate the emergency signal with his gloved hand (Chubb, 1992).

Firefighters that were fatally injured in Pittsburgh, Pennsylvania and San Francisco, California were found with working radios in their turnout coats, but no calls for help were heard (Routley, 1995b) (Howell, 1995).

Conclusion for Research Question #1

Communication problems have effected firefighters with ineffective equipment, reduced operational efficiency, and contributed to firefighter deaths and injuries. Firefighters require portable radio equipment that is designed for interior firefighting to resolve their communication problems while wearing full protective clothing and SCBA. When radios provide incident commanders with reliable communication to start operations, adjust operations, and stop operations the efficiency of fire operations will improve. Providing every firefighter with effective fireground communications equipment will improve firefighter safety by permitting progress and/or situation reports to be transmitted to the incident commander, and providing a method to call for assistance.

Research Question 2: What is the HFD Fireground Communication Pilot Program?

HFD memorandums and interviews with HFD personnel were used to answer this research question.

After a HFD survey indicated that the department's radio communications problems were very serious, the department formed a committee to resolve the problems (A.R. Gunderson, personal communication, July 7, 1999). The HFD committee located and tested equipment that would permit firefighters to communicate with fellow

crewmembers in the hazard area and be able to contact the incident commander and/or the dispatcher outside the hazard area (M. Casey, personal communication, July 20, 1999). Of the equipment tested in July, 1998, the committee determined that the Scott Voice Amplifier used with a Motorola Lapel Microphone performed the most effectively. Fire Chief Lester Tyra ordered a pilot program to test the equipment on a larger scale (K.S. Savage, personal communication, July 20, 1999).

> The objective of the Fireground Communication Pilot Program was to improve HFD fireground communication with firefighters wearing full protective clothing and SCBA in hazardous environments. Firefighters need to communicate effectively with fellow crewmembers and outside the hazard zone with the incident commander or dispatcher (*HFD Fireground Communication Pilot Program*, 1998).

The pilot program issued Scott Voice Amplifiers, Motorola Lapel Microphones (also called Remote Microphones), spare portable radio batteries, charging handles, a/c portable radio battery chargers, and firefighting turnout coats with an epaulet for attaching lapel microphones to five engine and five aerial ladder companies (Stations 7, 31, 46, 51, & 68). The voice amplifiers were assigned to each firefighter to permit oral communication and the lapel microphones were issued to the officers to allow radio communication with the portable radio carried in the turnout coat pocket. The spare portable radio batteries, the charging handles, and the a/c portable radio battery chargers were issued to test battery charging methods (*HFD Fireground Communication Pilot Program*, 1998).

The Fireground Communication Pilot Program started in October, 1998 after all the equipment was issued. The participants were asked to complete comment forms monthly or whenever an issue arose (*HFD Fireground Communication Pilot Program*, 1998).

Conclusion for Research Question #2

The HFD Fireground Communication Pilot Program was a field test of communication equipment (Scott Voice Amplifiers, Motorola Lapel Microphones, spare portable radio batteries, charging handles, and a/c portable radio battery chargers) with the objective of improving fireground communication capability of firefighters wearing full protective clothing and SCBA.

Research Question 3: Does the equipment and methods of the Fireground Communication Pilot Program provide effective communications?

This project used the Change Management Model, Phase IV: Evaluation, from the *Strategic Management of Change* Course taught at the National Fire Academy to answer this research question. To provide information to satisfy the Phase IV: Evaluation section the Fireground Communication Pilot Program Evaluation Form was written. The participants of the pilot program completed the evaluation form's questions.

The Phase IV: Evaluation section of the Change Management Model consists of seven steps Task 4.1A.-G. (*SMOC Exercises*, 1996).

Task 4.1A

The first evaluation step is Task 4.1A. "Evaluate the change against the initial change goals" (*SMOC Exercises*, 1996, p. SM C-13).

The objective of the Fireground Communication Pilot Program was

to improve HFD fireground communication with firefighters wearing full protective clothing and SCBA in hazardous environments. Firefighters need to communicate effectively with fellow crewmembers and outside the hazard zone with the incident commander or dispatcher (*HFD Fireground Communication Pilot Program*, 1998).

Question #1 of the Fireground Communication Pilot Program Evaluation Form asked participants to answer yes or no to the following questions,

- Did the Scott Voice Amplifiers provide safe and effective communication between company members when wearing full protective clothing?

  103 Firefighters answered “yes”, and 13 firefighters answered “no” and two were uncertain.

- Did the lapel microphone provide safe and effective communications between company officers, or members wearing lapel microphones, and the incident commander or dispatcher?

  85 Firefighters answered “yes”, and 21 firefighters answered “no” and seven were uncertain.

- Did using the lapel microphones with the voice amplifiers provide safe and effective communications with crewmembers and the incident commander or dispatcher?

  74 Firefighters answered “yes”, and 34 firefighters answered “no” and seven were uncertain.

- Did the spare hand held radio battery improve hand held radio performance?

  105 Firefighters answered “yes”, and 8 firefighters answered “no”.

- Did the charging handles properly charge the hand held radio batteries?

  76 Firefighters answered “yes”, and 17 firefighters answered “no”.

- Did the a/c bank chargers properly charge the hand held radio batteries?

  92 Firefighters answered “yes”, and 4 firefighters answered “no”.

Conclusion for Task 4.1A

The majority of the firefighters indicated the Scott Voice Amplifiers provided safe and effective communication between company members when wearing full protective clothing. The majority of the firefighters also indicated that the lapel microphones provided safe and effective radio communications. A majority of the firefighters voted that using the lapel microphone with the voice amplifier provided safe and effective communication with crewmembers and the incident commander, however a significant number of firefighters voted the equipment was not safe and effective. The firefighters voted by large majorities that the spare radio batteries, the charging handles, and the a/c bank chargers met the program’s objective.

The pilot program’s participants believed the Fireground Communication Pilot Program met the objective of improving HFD fireground communications.

Task 4.1B

The second evaluation step was Task 4.1B. “Evaluate the change against the described future state” (*SMOC Exercises*, 1996, p. SM C-13). Question #2 defined “the future state of fireground communication as the ability of firefighters to communicate easily with crewmembers and the incident commander or dispatcher” (*HFD Fireground Communication Pilot Program Evaluation Form*, 1999, p.1). The question then asked the firefighters if the voice amplifiers and lapel microphones met the goals of the future

state of fireground communications. 36 Firefighters voted "yes" the equipment met the future goals, while 63 firefighters voted "no", 25 firefighters were undecided.

Conclusion for Task 4.1B

While the majority of the participants felt the program achieved it's objective the firefighters did not believe the equipment met the future state of fireground communications.

Task 4.1C

The third evaluation step was Task 4.1C. "Evaluate how well established the change becomes" (*SMOC Exercises*, 1996, p. SM C-13). Question #3 completed Task 4.1C. by asking the participants how often do you use each piece of pilot program equipment. The participants could choose from "never", "occasionally", "often", "daily", and "every incident". The amount of use the pilot program equipment received was used to evaluate how well established the change in communication equipment became. The participant's selections are below in Table 1. Use of FCPP Equipment.

	Never	**Occasionally**	**Often**	**Daily**	**Every Incident**
Voice Amplifier	16	37	20	22	18
Lapel Microphone	18	35	9	11	40
Spare Battery	3	30	15	55	7
Charging Handle	31	25	13	45	2
A/C Battery Charger	21	19	13	57	30

Table 1. Use of FCPP Equipment

The pilot program equipment was available to be used by the program participants with the following exceptions. The firefighters assigned to the pilot program were not required to use the voice amplifier and/or the lapel microphone. Spare portable radio batteries were issued to each engine and aerial ladder company. The charging handles

were assigned to three stations (three engines, and three aerial ladder companies) while the a/c portable radio battery chargers were assigned to two stations (two engine companies, and two aerial ladder companies). The firefighters were instructed to rotate the spare batteries daily.

The Scott Voice Amplifier was used by 97 of the 113 participants who completed the survey. Only 40 participants out of the 113 participants indicated using the voice amplifier "daily" or at "every incident". With less than half of the participants using the voice amplifiers regularly the change to the use of the voice amplifier is not well established. The problems with the voice amplifiers that prevented greater acceptance from the firefighters are discussed in Task 4.1F and Task 4.1G.

The lapel microphone was used "daily" or at "every incident" by 51 participants indicating that the lapel microphone's use was accepted by more firefighters than the voice amplifier. However the change to the new equipment has not been overwhelmingly accepted. The problems with the lapel microphones that prevented greater acceptance from the firefighters are discussed in Task 4.1F and Task 4.1G.

The evaluation form shows the spare battery, charging handle, and a/c battery charger were used the most "daily" as the firefighters were instructed. The spare battery had the lowest votes of participants "never" using the equipment with only three. The higher number of "never" using the equipment votes with the charging handle and the a/c battery charger was related to the equipment not being assigned to all the stations. The survey indicates the pilot program change that received the most acceptance by the firefighters was the spare portable radio batteries, charging handles, and a/c portable radio battery chargers.

Conclusion for Task 4.1C

The Table 1 survey information indicates the use of the Scott Voice Amplifier and the Motorola Lapel Microphone was not a well established change. The regular use of the spare portable radio batteries, charging handles, and a/c portable radio battery chargers was established by the pilot program participants.

Task 4.1D

The fourth evaluation step was Task 4.1D "Evaluate how rapidly the change was accomplished" (*SMOC Exercises*, 1996, p. SM C-13). Question #4 answered the evaluation step by asking the firefighters to record the time required to use the fireground communication equipment routinely. Table 2 shows the program participants' responses to question #4.

	1 Hr.	1 Day	1-6 Days	1 Week
Voice Amplifier	72	4	1	
Lapel Microphone	70	2		3
Spare Battery	69	3		1
Charging Handle	66	4		1
A/C Battery Charger	67	2		

Table 2. Time Required for FCPP Equipment To Be Used With Routine

The large majority of the firefighters indicated they quickly used the equipment routinely.

Conclusion for Task 4.1D

The large majority of the firefighters voted they used the equipment routinely quickly, but the responses from question #3 show that not all the equipment is used regularly. The responses to this question indicate that the firefighters quickly learned

how to use the equipment routinely. However the previous information shows that many of the participants are not regularly using the equipment.

Task 4.1E

The fifth evaluation step was Task 4.1E "Evaluate the costs to individuals and the organization" (*SMOC Exercises*, 1996, p. SM C-13). Question #5 answered the Task 4.1E by asking the pilot program participants to list the costs to themselves or their group. Table 3. FCPP Costs shows the participants answers divided into actual purchasing expenses and labor expenses.

	Firefighters	Air Pack Shop	Radio Shop	Metal Shop
Materials				$265
Equipment		$8,000		
Labor-hr.	160	20 hours	20 hours	8 hours
$ per hr.	$45	$60	$60	$45
Total Labor	$7,200	$1,200	$1,200	$360
Total Cost	$7,200	$9,620	$1,200	$630

Table 3. FCPP Costs

The labor costs of the pilot program for the firefighters refer to the amount of time used to train the firefighters on the equipment. This training was accomplished during the firefighter's normal work schedule. The pilot program did not cost the HFD any additional labor expense for the firefighter's time.

The equipment purchased by the Air Pack Shop included the Scott Voice Amplifiers and clips to attach the voice amplifiers to the SCBA facepieces. The SCBA technicians required 20 hours to deliver and install the voice amplifiers.

The Motorola Lapel Microphones, the spare portable radio batteries, and the a/c portable radio battery chargers were taken from existing inventory for the pilot program and did not have to be purchased. The Radio Shop's labor costs were for issuing the batteries and installing the charging handles.

The Metal Shop purchased raw materials and built 25 charging handles for the pilot program.

Conclusion for Task 4.1E

The total cost of the Fireground Communication Pilot Program including equipment and labor was $18,650.

Task 4.1F

The sixth evaluation step was Task 4.1F "Identify unanticipated actions and or occurrences the change generates" (*SMOC Exercises*, 1996, p. SM C-13). Question #6 responded to the evaluation step by asking the firefighters to list any unanticipated actions or occurrences with the Fireground Communication Pilot Program equipment.

Most of the unexpected challenges with the equipment and/or the methods in using the equipment occurred with the voice amplifiers and the lapel microphones.

13 pilot program participants listed problems with the clips that attach the voice amplifier to the SCBA facepiece, and properly exchanging the amplifiers at relief time.

The voice amplifiers require a clip (price $9.52) to attach the voice amplifier to the SCBA facepiece. Initially 40 clips were included with the 40 voice amplifiers purchased for the program; one to be placed on the SCBA facepiece of the SCBA the voice amplifier was assigned to. However many of the firefighters participating in the pilot program had been issued a personal SCBA facepiece, and preferred to use their personal facepiece instead of the facepiece assigned to the SCBA. The clips could be moved to another facepiece, but the extra time required took a special effort to accomplish. As the shifts changed each day the clips would have to be moved each time

and the clips were not always moved. When this problem was noted additional clips were purchased and issued.

Even with the firefighters' personal facepieces having the attachment clips the improper exchanging of the voice amplifiers from firefighter to firefighter at shift change continued to be a problem. When the on-coming firefighter did not remove the voice amplifier from the off-going firefighter's facepiece the voice amplifier became unavailable for use when the off-going firefighter secured his/her gear.

In the initial test using the voice amplifier and lapel microphone the test personnel did not experience any feedback from the voice amplifier while transmitting on the radio (Savage,1999). 37 Pilot program participants listed excessive feedback between the lapel microphone and the voice amplifier. The feedback did not occur with every use of the equipment, but was noted when the batteries are weak, or new, and varied with the position of the lapel microphone.

10 Participants wrote that the epaulets that were snapped in the fire officers turnout coats to attach the lapel microphones to, came off of the turnout coats very quickly.

Other unanticipated challenges the participants noted were the difficulty using the lapel microphone PTT switch, and the equipment's ability to resist exposure to heat. One comment noted the resistance of the firefighters to use the new equipment.

12 Participants remarked there were not any unanticipated issues, and 44 did not answer the question.

Conclusion for Task 4.1F

The unanticipated actions that occurred with the Fireground Communication Pilot Program were the need for extra clips to attach the voice amplifiers, the inadequate exchange of equipment at relief time, the excessive feedback between the lapel microphone and the voice amplifier, and the epaulets falling off the turnout coats easily.

Task 4.1G

The next evaluation step was Task 4.1G "Assess the initial resistance to change" (*SMOC Exercises*, 1996, p. SM C-13). To answer Task 4.1G question #7 asked firefighters to list problems with the equipment and question # 8 asked the participants to list the reasons for not using the equipment.

The firefighter's responses were organized into which piece of equipment was effected. Table 4 lists the problems with the voice amplifiers.

Problems With The Voice Amplifiers

Response	Problems
12	Problems with properly sealing the hood with the voice amplifier
3	Voice amplifier clips falling off facepiece
37	Excessive voice amplifier feedback with lapel microphone
2	Dead batteries in the voice amplifiers
4	Poor voice quality with the voice amplifiers

Table 4. Problems With The Voice Amplifiers

Table 5 lists the problems with the lapel microphones.

Problems With The Lapel Microphones

Response	Problems
32	Entanglement with the lapel microphone cord
5	Difficulty with the lapel microphone PTT with fire gloves
9	Unable to work radio controls with fire gloves
37	Lapel microphone clips do not hold
2	Lapel microphone is not resistant to heat

Table 5. Problems With The Lapel Microphones

Table 6 lists the problems with the charging handles.

Problems With The Charging Handles

Response	**Problems**
1	Charging handle ruined battery
1	Charging handle shocked user
9	Charging handle too long
1	Charging handle did not fit battery

Table 6. Problems With The Charging Handles

Table 7 lists the reasons why firefighters did not use the communication equipment that were answered in reply to question #8.

Reasons For Not Using The Communication Equipment

Response	**Reason**
8	No SCBA facepiece clips
10	Relief person locked-up voice amplifier
8	Lapel microphone entanglements
3	The equipment is inconvenient
2	No epaulet to attach lapel microphone
7	Excessive feedback
18	No reason not to use equipment
38	No replies to question

Table 7. Reasons For Not Using The Communication Equipment

The problems listed in Tables 4-7 contributed to the firefighters resistance to the communication equipment change. However the pilot program participants have accepted the equipment enough to determine the equipment's weaknesses and problems. In Table 5, 32 participants list the problems of entanglement with the lapel microphone cord, however in Table 7, only eight list the entanglement hazard as a reason not to use it.

Conclusion for Task 4.1G

Problems with the program equipment contributed to the resistance to the change in communication equipment, however the change was complete enough to determine the equipment's weaknesses.

Research Question 4: Are there any elements of the Fireground Communication Pilot Program that can be altered or modified to improve the program?

Information from the literature review and the Fireground Communication Pilot Program Evaluation Form (question #9) was used to answer this research question. The published literature contained information on improving the non-technical elements of fireground communication, and new technical products for firefighter's use. The HFD pilot program participants listed suggestions for improvement in answer to question #9 of the Fireground Communication Pilot Program.

The non-technical factors that can improve fireground communications include the human elements of radio discipline, standard procedures, and cultural problems. Prioritizing radio messages and effectively listening to messages from others are two elements of radio discipline that can improve fireground communications. The use of standard messages and regular accurate situation reports with the incident command management system are examples of standard procedure techniques to improve communications. A cultural problem that can prevent effective communication is that of firefighters not calling for help to avoid embarrassment (Thiel, 1999).

Three new radio products in the literature which could provide technical improvements to fireground communications. Lion Apparel has a bone conduction

microphone and speaker designed to fit into the firefighter's helmet called the Helmet-Com (*Hands-On Fire Fighters Need Hands-Off Communications*, 1999). A product that amplifies the firefighter's voice and attaches to a portable radio for radio communications from Scott is called the Envoy Radiocom (*When Every Word Counts Scott's Envoy Radiocom*, 1999). A new communications system from Safety Tech Industries called the MaskCom provides wireless communication and personnel accountability (*Fully Automatic Electronic Accountability. Built to Save Lives*, 1999).

To generate ideas that would improve the HFD Fireground Communication Pilot Program question #9 of the evaluation form was used to ask the firefighters suggestions for improving the equipment or the pilot program. Table 8 shows the firefighter's suggestions for improving the communication equipment and pilot program.

	FCPP Improvements
Response	**Suggestions**
24	Find a wireless communication system
12	Issue a portable radio to every firefighter
5	Cover the cords to protect the lapel microphone cord
5	Fix the voice amplifier feedback
4	Tighten the lapel microphone clip springs

Table 8. FCPP Improvement Suggestions

The responses to question #9 indicate that the firefighters would like to use a wireless method to use a radio while wearing full protective clothing and SCBA. Currently the HFD has two portable radios assigned to each four firefighter crew, 12 of the participants answering the question noted every firefighter should have a portable radio. Other improvement suggestions included covering the lapel microphone cord with a fire resistive material to protect the cord, tightening the lapel microphone clip springs, and reducing the voice amplifier feedback.

Conclusion for Research Question #4

Improvements to the HFD Fireground Communication Pilot Program can be made with technical and non-technical methods. The pilot program could benefit from improving the human elements of fireground communication such as radio discipline, standard procedures, and cultural issues (Thiel, 1999). The new radio equipment designed for firefighters may provide technical improvements to the pilot program.

The most suggested idea for improving the pilot program from the participants was the request for wireless equipment. Several participants also requested a portable radio to be assigned to every firefighter.

Summary

Communication problems have effected firefighters with ineffective equipment, reduced operational efficiency, and contributed to firefighter deaths and injuries. Radio communication equipment designed for firefighters wearing full protective clothing and SCBA could increase operational efficiency by providing the incident commander with a higher level of control. The equipment would also improve firefighter safety with the ability to transmit progress reports and call for help.

The HFD Fireground Communication Pilot Program was a field test of communication equipment with the objective of improving fireground communication with firefighters wearing full protective clothing and SCBA.

The evaluation of the pilot program following Phase IV: Evaluation, of the Change Management Model gave the following results. The firefighters participating in the pilot program believed the equipment met the program's objective of improving

fireground communications. The participants did not feel the equipment met the goals of the future state of fireground communication. The most accepted elements of the pilot program were the use of the spare portable radio batteries and the charging equipment. The voice amplifier and the lapel microphone were not as well accepted. The survey results indicated the communication equipment's operation was easily understood, but the equipment's use did not become a routine for all the participants. The total cost of the pilot program was $18,650. The unanticipated actions of not having enough facepiece clips for personal facepieces, the improper exchanging of equipment at relief time and the excessive feedback from the voice amplifiers effected the pilot program. The unanticipated problems and the problems with lapel microphone cord entanglement, and weak lapel microphone clip springs contributed to resistance the communication equipment change.

The HFD Fireground Communication Pilot Program can improve fireground communications with technical and non-technical methods. The HFD participant's most popular suggestion was to request for wireless equipment.

DISCUSSION

Comparison to Findings

A comparison of the literature review with the results of the HFD Fireground Communication Pilot Program Evaluation Form indicates agreement on the opinions the participants had over the current communication equipment available and firefighters need for radio equipment specifically designed for firefighters.

In the USFA Technical Report *Improving Firefighter Communications* Adam Thiel reported,

> A variety of products are currently available that seek to mitigate the problem including speech ports, facepiece-integrated microphones, intercom systems, portable radio interfaces, throat mikes, and "bone" mikes worn in the ear or on the forehead. Most of these systems have received relatively mixed reviews from firefighters in the field… (Thiel, 1999, p.8).

The results of the HFD pilot program evaluation agree with the USFA report and indicate mixed reviews of the communication equipment by the HFD firefighters. The pilot program participant's mixed reviews were noted in their responses to the questions regarding the equipment effectiveness and the firefighter's use of the equipment. When the HFD firefighters were asked if the equipment provided safe and effective communications a wide margin of firefighters (103 – yes, 13 - no) indicated the voice amplifier provided inter-crew communication. A smaller majority of the firefighters (85 – yes, 21 - no) voted the lapel microphone provided safe and effective radio communications. The votes for combining the voice amplifier with the lapel microphone to improve inter-crew and radio communications indicated an even smaller majority (74 – yes, 34 – no). The firefighters responses to how frequently the communication equipment was used demonstrated that while some firefighters were using the equipment regularly (40 – voice amplifier, 51 – lapel microphone) many were only using the equipment inconsistently or not at all (73 - voice amplifier, 66 – lapel microphone).

Chief J. Curtis Varone in his report *Fireground Radio Communications and Firefighter Safety* wrote, "Additional research is needed to develop a portable radio specifically for the fire service" (Varone, 1996, p. 105).

The results of the HFD pilot program show the participants felt that additional research is still required. The participant's answers concerning the future state of fireground communication and suggestions to improve the program match Chief Varone's request for specifically designed radio equipment. In the second question the participants were asked if the pilot program equipment met the needs of the future state of fireground communications and the response was 63 votes "no", and 36 votes "yes". Almost half (24 of 50) of the suggestions to improve the pilot program called for a wireless communications system to meet the fire service's need for equipment that will not entangle in the firefighter's protective gear.

Interpretation of Study Results

The survey results of the HFD Fireground Communication Pilot Program provided for a systematic evaluation of the pilot program using Phase IV: Evaluation, of the Change Management Model. This evaluation of the program noted the positive factors as well as revealing several challenges to resolve.

The results of the study showed the pilot program met the objective of improving HFD fireground communications, however the study indicated the need for a more accurately measurable objective. The pilot program participants also noted that the communication equipment tested did not meet the goals for the future state of fireground communications.

The change in communication equipment was not well established by the program participants. Use of the equipment was quickly learned by the participants, but only the use of the spare portable radio batteries and charging equipment became well established. The unanticipated actions of a lack of facepiece clips for every firefighter's personal facepiece, the feedback noise from the voice amplifiers, and the improper transfer of equipment at relief time prevented the use of the voice amplifiers from becoming more accepted. The problems with the lapel microphone falling off the turnout coat and the lapel microphone cord becoming entangled created resistance to the lapel microphone. The participants felt that a wireless communication system would improve the pilot program.

The results of the Fireground Communication Pilot Program indicate that fireground communication equipment must meet the emergency demands of interior firefighting and satisfy the non-emergency concerns such as transferring easily between the different personnel.

Implications to the Organization

The evaluation of the Fireground Communication Pilot Program following the Phase IV: Evaluation section of the Change Management Model provided useful information to the HFD regarding the change evaluation method as well as the results of the pilot program. For example, as the HFD tests other radio communication equipment the use of a standard evaluation method will provide comparable results.

The results of the pilot program indicate that the HFD can improve fireground communications with the pilot program equipment, but that equipment may not be the long-term solution to communication problems. The evaluation noted that the use of

some elements of the pilot program became well established (the rotation of spare portable radio batteries) and that other elements (the voice amplifiers and lapel microphones) did not. The evaluation of the pilot program costs will enable the HFD to accurately predict the expenses required for expanding the program. The identification of the unanticipated problems of needing personal facepiece clips and voice amplifier feedback will enable the department to address these issues. The knowledge that equipment problems (i.e. lapel microphone cord entanglement and the lapel microphone clips not holding) created the resistance to the communication equipment change enables the department to reduce change resistance by resolving the equipment problems.

The results of the pilot program evaluation provided the HFD with the information necessary to continue, modify, expand, or terminate the future use of the communication equipment. The experience of evaluating an organizational change using a standard evaluation method (i.e. Change Management Model Phase IV: Evaluation) enables the department evaluate other changes with the same technique.

RECOMMENDATIONS

The full protective clothing and SCBA worn by HFD firefighters for thermal and respiratory protection in hazardous environments reduces the firefighter's ability to communicate. Along with normal voice communication the fully encapsulated firefighter has difficulty with the portable radio equipment.

The problem that this research project addressed was the Houston Fire Department needs a safe and effective means of communicating when firefighters wear full protective clothing and SCBA. With ineffective portable radio equipment

operational efficiency and firefighter safety are threatened. The purpose statement of this research project was to evaluate the equipment and techniques used in the HFD Fireground Communication Pilot Program.

The Fireground Communication Pilot Program was evaluated using the Task IV: Evaluation section of the Change Management Model taught in the *Strategic Management of Change* course at the National Fire Academy. Following the evaluation steps the results of the pilot program recommend the following actions. The evaluation results recommend the HFD continue the Fireground Communication Pilot Program. The pilot program participants voted the communication equipment improved fireground communications. The evaluation does not recommend expanding the pilot program as a majority of the participants did not believe the equipment met the goals of the future state of fireground communications. The results of the study noted that the regular use of spare portable radio batteries, the charging handles, and the a/c portable radio battery chargers became well established, but the regular use of the voice amplifiers and the lapel microphones did not. The problems affecting the regular use of the voice amplifiers and the lapel microphones should be addressed. The evaluation found the participants quickly understood the use of the equipment, but were not regularly using all of the program equipment (i.e. voice amplifiers, lapel microphones). The study reported on the cost of the pilot program to each group of the HFD involved. These expenses provide the department with accurate data on the cost of expanding the pilot program. The unanticipated actions noted in the evaluation include the lack of extra facepiece clips for personal SCBA facepieces and the improper exchange of equipment at shift change. The unanticipated actions should be resolved to improve the pilot program. The evaluation

noted the resistance to the communication equipment change was related to equipment problems. Resolving the equipment problems would decrease the resistance to change.

The research project researched the literature and asked the pilot program participants for suggestions to improve the pilot program. The literature review contained information on non-technical methods to improve firefighter communication. The pilot program participants listed several suggestions to improve the program such as finding a wireless communication system and issuing a portable radio to each firefighter. Additional research is recommended to investigate applying these technical and non-technical methods into improving the pilot program.

The results of the studies use of the Phase IV: Evaluation section of the Change Management Model recommend the continued use of the model for altering, re-evaluating, and institutionalizing the changes associated with the HFD Fireground Communication Pilot Program.

This research project studied the Houston Fire Department's efforts to resolve fireground communication problems. However fire departments around the world have the same problems. Communication equipment manufacturers have not been willing to research and build equipment for the Houston Fire Department alone. A united effort by the fire service community is needed to demonstrate the large demand for the special communication equipment firefighters require.

Additional research on fireground or tactical communications is needed. The USFA's Technical Report series notes the effects of poor fireground communications, however most of the published information available concerns dispatching operations.

The major fire publications should research and publish more than the advertisements for the communication equipment becoming available for firefighting.

Future researchers should use the Internet to expand their search for fireground communication information. The web site for USFA Technical Reports is www.usfa.fema.gov/techreps/. The Federal Emergency Management Agency (FEMA) web sites, fellow firefighters, and equipment manufacturers may be able to provide links to the necessary information.

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APPENDIX A

INTRODUCTORY MEMO FOR THE FIREGROUND COMMUNICATION PILOT PROGRAM EVALUATION FORM

CITY OF HOUSTON

INTEROFFICE CORRESPONDENCE

To: All participants of the Fireground Communication Pilot Program

From: District Chief T.A. Stone

Date: 13 May 1999

Subject: Fireground Communication Pilot Program Evaluation Form

In the fall of 1998 the Fireground Communication Pilot Program was initiated. Since that time many fire fighters and support personnel have worked with the Scott Voice Amplifiers, Motorola Lapel Microphones, the spare hand held radio batteries, the A/C bank chargers, and the Charging Handles. To date the equipment has been evaluated using a simple comment form.

During February 1999, I attended a National Fire Academy class on Change Management as part of the Academy's Executive Fire Officer Program. This class requires students to complete an applied research project after each class. The class included a "Change Management Model" with an outline for evaluating changes made by an organization. A formal evaluation of the Fireground Communication Pilot Program will provide the department with a detailed analysis of the program using a nationally recognized technique, and will satisfy my applied research requirements.

Attached to this memo is a Fireground Communication Pilot Program Evaluation Form that will permit formal evaluation of the pilot program using the "Change Management Model". Please complete the form and return it via the interoffice mail or fax before June 30, 1999. Mail the forms to:

District Chief T.A. Stone, District 10D

or fax to:

District Chief T.A. Stone, District 10D (713) 272-3659

Thank you in advance for your cooperation.

Respectfully,

T.A. Stone
District 10D

APPENDIX B

FIREGROUND COMMUNICATION PILOT PROGRAM EVALUATION FORM

FIREGROUND COMMUNICATION PILOT PROGRAM
EVALUATION FORM

1. In the blank in front of each goal place a Y(yes) or N(no), to indicate in your opinion whether the Fireground Communication Pilot Program reached the goal.

___ Did the Scott Voice Amplifiers provide safe and effective communication between company members when wearing full protective clothing and SCBA ?

___ Did the lapel microphones provide safe and effective communications between company officers, or members wearing lapel microphones, and the incident commander or dispatcher?

___ Did the using the lapel microphones with the voice amplifiers provide safe and effective communications with crew members and the incident commander or the dispatcher?

___ Did the spare hand held radio battery improve hand held radio performance?

___ Did the “Charging Handles” properly charge the hand held radio batteries?

___ Did the A/C Bank Chargers properly charge the hand held radio batteries?

2. ___ The envisioned future state of fireground communications includes the ability of fire fighters to communicate easily with crewmembers and the incident commander or dispatchers. In your opinion do the voice amplifiers and lapel microphones meet this future state of fireground communications? Please answer Y (yes) or N (no).

3. Do you use the fireground communication equipment? For each type of equipment circle the correct response.

Scott Voice Amplifier	Never	Occasionally	Often	Daily	Every Incident
Lapel Microphone	Never	Occasionally	Often	Daily	Every Incident
Spare Radio Battery	Never	Occasionally	Often	Daily	Every Incident
Charging Handles	Never	Occasionally	Often	Daily	Every Incident
A/C Bank Charger	Never	Occasionally	Often	Daily	Every Incident

4. Write in the blank the time required to use the fireground communication equipment with routine ease.

_____ Scott Voice Amplifier _____ lapel microphone

_____ Spare hand held radio battery _____ Charging Handles

_____ A/C Bank Charger

5. List the costs of the Fireground Communication Pilot Program to you and/or your group. For example - $100.00 equipment cost or 10 hours of labor for training.

6. List any unanticipated actions or occurances with the Fireground Communication Pilot Program equipment.

7. List problems with the equipment and the pilot program.

8. List reasons for not using the communication equipment.

9. List any ideas for improving the equipment or the pilot program.

APPENDIX C

FIREGROUND COMMUNICATION PILOT PROGRAM COMMENT FORM

FIREGROUND COMMUNICATION PILOT PROGRAM

COMMENT FORM

Please return to District Chief T.A. Stone, District 10D, fax (713) 272-3659

_____
Date

_____ _____
Name Station Shift Debit Day

_____ _____
Unit Number Position

Incident type __ Fire __ EMS __ Rescue __ Haz Mat _____other

Check pilot program equipment used. __ Voice Amplifier __ Lapel Microphone

__ Spare Battery __ Charging Handles __ A/C Bank Charger

Benefits of Equipment

Problems with Equipment

Ideas for Improvement

APPENDIX D

HOUSTON FIRE DEPARTMENT
PILOT PROGRAM FOR FIREGROUND COMMUNICATION
MEMO

CITY OF HOUSTON
INTEROFFICE CORRESPONDENCE

To: Fire Chief Lester W. Tyra

From: District Chief T.A. Stone

Date: August 6, 1998

Subject: Pilot Program for Fireground Communications

This memo is the preliminary plans for a pilot program to improve fireground communications for fire fighters wearing full protective clothing and SCBA.

GOAL

The goal of the project is to improve fireground communications with fire fighters wearing full protective clothing and SCBA in hazardous environments. Fire fighters need to communicate effectively with fellow crewmembers and outside the hazard zone to the incident commander or dispatcher.

PLAN

A pilot program which will equip five Engine and Ladder Companies (E-7,L-7,E-46,L-46,E-31,L-31,E-51,L-51,E-68,L-68) with Scott "Voice Amplifiers" on the Scott 4.5 facepieces. The amplifiers permit clear voice communication with a fire fighter wearing an SCBA with the facepiece in place. This will provide intercrew communication capability. To permit radio communication outside the hazard zone the company officers of the program units will have lapel microphones added to their hand held radios. The lapel microphones will be attached to the fire fighter's coats with a loop of "PBI" material. With the lapel microphone fixed to the coat the fire fighter will be able to hear the radio, and to transmit the fire fighter will only have to push the transmit button and speak.

To support this equipment each unit will receive spare hand held radio batteries, and two different methods of charging the hand held radio batteries would be evaluated. An a/c powered bank charger that can charge up to six batteries will be used by one group during the pilot program. The rest of the pilot group will be issued charging handles to use with the mobile chargers already in place on their vehicles.

Voice Amplifiers

The Scott "Voice Amplifier" part number 804564-01 sells for $176.00. The "Voice Amplifier" requires a mounting bracket to attach to the facepiece, part number 804636-01, which costs $9.52. To equip 10 companies will require the purchase of 40 "Voice Amplifiers" and a minimum of 40 mounting brackets for a total of $7421.00. Several fire fighters in the department have been issued their own facepiece and additional mounting brackets should be purchased to simplify placing the "Voice Amplifiers" on fire fighter's facepieces at relief time.

Lapel Microphones

The lapel microphones, spare batteries, charging handles, and bank charger to be used in this pilot program will be taken from stock at the radio shop. No additional radio equipment will need to be purchased.

14 lapel microphones are available to use for the pilot program. The radio shop has twelve lapel mikes and Engine and Ladder 68 already have units. With every fire company assigned two hand held radios there are not enough lapel mikes for every unit to have two. Some units can be issued two lapel mikes, or District 8, District 46, District 31, and District 10 may be issued the mikes to improve command post communications.

Fire Coats

At least 40 fire coats will have a loop of "PBI" material attatched on the right shoulder for the lapel microphone. These coats come from fire fighters from all four shifts throughout the city. The fire fighters should be able to come to Logistics get the loop attatched and return to service. The quartermaster is working on snaps at the present time.

Conclusion

The Scott "Voice Amplifiers" have been in service for at least two years, and will improve voice communication for fire fighters wearing SCBA. Lapel microphones are useful communication tools, and while not designed for fire fighting will be more effective than a radio in the pocket. This combination of lapel mikes and "Voice Amplifiers" was found during tests at the Fire Training Academy to be as effective as the other devices currently available. This pilot program will cost less than $8,000 to improve fire fighters communication capability. It is difficult to estimate the value of the safety and efficiency this program will increase.

If you have any additional questions please contact District Chief T.A. Stone, Planning and Research.

Respectfully,

T.A.Stone
Planning and Research

Xc: Assistant Chief T.J. Slagle
Assistant Chief W.R. Campbell
Dave Folkers
Fire Fighter Air Pack Supervisor J. Grantham
Engineer/Operator Quartermaster H. Hunter

APPENDIX E

HOUSTON FIRE DEPARTMENT
FIREGROUND COMMUNICATION PILOT PROGRAM
MEMO

HOUSTON FIRE DEPARTMENT

PLANNING AND RESEARCH

FIREGROUND COMMUNICATION PILOT PROGRAM

15 September 1998

OBJECTIVE

The objective of the pilot program is to improve fireground communications with fire fighters wearing full protective clothing and SCBA in hazardous environments. Fire fighters need to communicate effectively with fellow crewmembers and outside the hazard zone with the incident commander or dispatcher.

PROGRAM

The pilot program consists of equipping five Engine and Ladder Companies (E-7, L-7, E-31, L-31, E-46, L-46, E-51, L-51, E-68, L-68) with Scott "Voice Amplifiers" for each Scott 4.5 SCBA. Each officer of the program companies will receive a lapel microphone for the hand held radio, and an epaulet will be attached to his fire coat to secure the microphone.

The voice amplifiers will permit each member of the crew to communicate while wearing an SCBA using their voice. The lapel mikes will allow the officers to hear radio communications and the voice amplifier will improve their ability to transmit information while wearing a facepiece.

Along with the voice amplifiers and lapel mikes each unit will receive a spare battery for each hand held radio. Station 46 and Station 51 were issued an a/c powered bank charger to recharge batteries. The other units were issued "charging handles" to use with their mobile hand held radio chargers. Battery performance of the department's hand held radios has been poor. This program will experiment with battery replacement schedules and test the effectiveness of having spare batteries on apparatus.

If additional lapel mikes become available District 8, 31, 46, and 10 will receive one to test whether the equipment will improve communication for the incident commander.

Engineer/Operators and Fire Fighters

The E/Os and Fire Fighters on these units are asked to use the equipment responsibly. Any comments good or bad are encouraged on the equipment's effectiveness or maintenance. If the enhanced communications ability improves safety or efficiency in fire operations please comment.

Officers

Officers should use the equipment during all operations, i.e. rescue, fire attack, ventilation, to determine the effectiveness of the equipment. The officers will be responsible for supervising the hand held battery recharging. Comment forms will be provided to encourage input. Each shift will be required to submit at least one comment form per month, but everyone is encouraged to fill one out at any time. The further acquisition of equipment depends on the results of this test.

Questions

Questions on the program should be addressed to District Chief T.A. Stone, Planning and Research at (713) 247-8652.

HOUSTON FIRE DEPARTMENT

FIREGROUND COMMUNICATION PILOT PROGRAM

15 September 1998

Page 2

BATTERY REPLACEMENT SCHEDULE

A/C Bank Battery Chargers

Station 46 and 51(who is temporarily backed in to Station 10) were assigned a/c bank battery chargers. Each hand held unit was issued a spare battery. At the beginning of this program use the following rotation schedule;

- Hand held radios without the lapel microphone may continue to use the mobile charger
- One battery will be in service on the hand held radio with the lapel microphone
- One battery will be on the appartatus as a spare battery
- One battery will be in the a/c bank charger recharging
- Under normal conditions batteries will rotate from the charger to the apparatus to the radio
- Rotate the batteries each morning at relief time. When the battery is used heavily change it as needed

When recharging batteries remember that to prevent batteries from developing a memory and not charging fully, use the battery before recharging. Turn the radio off if it is in the charger. The charger will recharge the battery in only one hour.

Mobile Chargers With Charging Handles

Units with charging handles added to their mobile chargers will carry the spare batteries on the apparatus, and use the following rotation schedule;

- One battery will be on each hand held unit, one battery will be in the mobile charger, and one battery will be a spare
- Under normal conditions rotate the batteries from the charger to the apparatus to the radio
- Rotate the batteries every morning at relief time. When the battery is used heavily change it as needed.

This program is an experiment to determine if spare batteries and proper battery rotation will increase performance in the hand held radios. In November another rotation schedule will be implemented. If you have any ideas or comments please contact District Chief T.A. Stone, Planning and Research.