STRATEGIES FOR SUCCESSFULLY IMPLEMENTING AN 800MHz RADIO SYSTEM IN THE PRINCE WILLIAM COUNTY DEPARTMENT OF FIRE AND RESCUE

ADVANCE LEADERSHIP ISSUES IN EMERGENCY MEDICAL SERVICES

BY: Scott S. Davis
Battalion Chief
Department of Fire and Rescue
Prince William County, Virginia

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

July 2002

ABSTRACT

The Prince William County, Virginia, Board of County Supervisors signed a $21 million contract in December 1999 to replace the existing obsolete and unreliable public safety radio system. A new state-of-the-art 800 MHz radio system is currently being built and is planned to be fully operational by April 2003.

The problem is that an implementation plan has not been developed to transition the fire department into the new radio system. The purpose of this research is to develop a successful implementation plan for a new $21 million state-of-the-art 800 MHz trunked, digital radio system.

The research methodology used included a review of relevant literature obtained from the learning resource center at the National Fire Academy, Prince William County Public Library and an Internet search. Personal interviews were conducted to solicit input from other departments that had already implemented similar radio systems. The Action Research Method was utilized to answer the following questions:

1. How have other departments implemented new 800 MHz radio systems?
2. What features should be incorporated into the technological upgrade of the Prince William County Department of Fire and Rescue radio system?
3. What are the major issues associated with transitioning to an 800 MHz radio system?
4. How will the changes to an 800 MHz radio system impact fire & rescue operations?

The research revealed the historical background regarding 800 MHz radio systems and how they have been implemented. It also identified many of the latest

technological advances that would enhance a radio system. Personal interviews were conducted to solicit feedback from both users and those responsible for managing 800 MHz radio systems to determine how they implemented their systems.

The research determined that the failure or success of implementing a new radio system was determined mostly by proper planning, training and the involvement of the users.

The recommendations are to have an organizational commitment to the successful implementation of the 800 MHz radio project. It is recommended that the Chief establish an implementation team made up of radio users. These stakeholders will consist of representatives from fire, EMS, fire marshals, dispatchers, training division and staff. A comprehensive training program will be developed by training staff, radio technicians and users and will be provided to all users prior to the implementation of the radio system. A list of recommended strategies for successful implementation (Appendix A) has been created and will be provided to the implementation team to assist them.

TABLE OF CONTENTS

ABSTRACT ……. 2

TABLE OF CONTENTS ……. 4

INTRODUCTION ……... 5

BACKGROUND AND SIGNIFICANCE ……... 7

LITERATURE REVIEW …… 11

PROCEDURES …… 24

Assumptions and Limitations …… 26

Definition of Terms …… 27

RESULTS ……. 28

DISCUSSION …….. 34

RECOMMENDATIONS …….. 37

REFERENCES …….. 39

APPENDIX A: Strategies For Successfully Implementing An 800 MHz Radio System …….. 41

APPENDIX B: Regional Map…… 43

APPENDIX C: Prince William County, Virginia, Department of Fire & Rescue Communications Division Incident Growth…… 45

APPENDIX D: Interview Questions…… 47

APPENDIX E: Interview Questions Responses …… 49

INTRODUCTION

The Prince William County (Virginia) Government made a strategic decision five years ago to replace its conventional public safety communications system. In conjunction with the City of Manassas (Virginia) and the City of Manassas Park (Virginia), Prince William County applied for and was licensed 22 channels in the 800 Megahertz (MHz) frequency range by the Federal Communications Commission.(FCC) The City of Manassas and City of Manassas Park are located within the borders of Prince William County. The City of Manassas Fire Department, the City of Manassas Park Fire Department and the Prince William County Department of Fire and Rescue ("The Department") respond into each other's jurisdiction on a routine basis under the provisions of an automatic mutual response agreement.

The Prince William County Government management staff recommended that that existing 154 MHz radio system be replaced with the newly licensed channels to a trunked, digital radio system. This system would provide state of the art communications technology for all Public Safety agencies within the confines of Prince William County. This research will focus on public safety communications as it relates to the provision of fire and rescue services. The Prince William County Board of Supervisors signed a $21 million contract in December 1999 to replace the existing obsolete and unreliable public safety radio system. A new state-of-the-art 800 MHz radio system is currently being built and is planned to be fully operational by April 2003.

The problem is that an implementation plan has not been developed to transition the Department of Fire and Rescue into the new radio system. Included in this project are many technological advances. These advances will result in changes that will impact

every person within the Department of Fire and Rescue. The new equipment, information systems, and resulting operational changes will have a profound effect on the way we currently do business. With these changes will come inevitable stresses on the organization and the individuals impacted. A successful transition will not happen by chance. A successful transition to the new radio system will require a successful implementation plan.

The purpose of this applied research is to develop a successful implementation plan for a new $21 million state-of -the-art 800 MHz trunked, digital radio system. Research was conducted using trade magazines, technical reports, and textbooks to determine historical background information regarding radio communication systems. Personal interviews were conducted to solicit input from other departments that have already implemented similar radio systems. I hope to build on their experiences and successes and avoid pitfalls and mistakes others have encountered. An action research methodology was used to answer the following questions:

1. How have other departments implemented new 800 MHz radio systems?
2. What features should be incorporated into the technological upgrade of the Prince William County Department of Fire and Rescue radio system?
3. What are the major issues associated with transitioning to an 800 MHz radio system?
4. How will the changes to an 800 MHz radio system impact fire and rescue operations?

BACKGROUND AND SIGNIFICANCE

Effective radio communications are vital for the successful mitigation of most fire and rescue incidents. The safety of emergency personnel may be jeopardized if radio signals are scratchy, unintelligible, or simply absent. Radio communications problems have been found to be the most common operational obstacle in a majority of fire department operations. Such problems affect the fire department's ability to start, coordinate and complete effective operations (Brunacini, 1985). Communications systems allow firefighters and command officers to better protect the public during emergency operations and to more efficiently provide routine services.

The current 154 MHz radio communications system is a VHF high band simplex radio system that was installed in 1964. The original single channel system has grown to three countywide base mobile channels with the addition of two mobile channels. There are three main (dispatch) base stations operated remotely via microwave from the communications center. The base stations were installed in 1987. In addition to these channels, there are two fire mutual aid channels. There currently exist more than 700 mobile and portable fire department radios in use system wide.

The current 154 MHz radio system does not provide effective communications for the Department. The three available radio channels are not enough to handle the peak load periods. Emergency messages have not been able to be made in a timely fashion due to multiple emergency incidents on such a limited number of available channels. Due to the size of the county, coverage is quite poor in some areas and often messages from emergency scenes have to be relayed by other users, increasing radio traffic further. Radio transmissions have frequently been "lost" at times which can have serious safety

implications on the personnel at the scene of emergencies. As a result of obsolescence and the incompatibility of new technology with the existing system, no substantive upgrade, short of a complete equipment replacement, initiative was technically possible.

The County Board of Supervisors signed a $21 million contract in December 1999 to replace the existing obsolete and unreliable public safety radio system. A new state-of -the-art 800 MHz radio system is currently being built and is planned to be fully operational by April 2003.

The problem is that an implementation plan has not been developed to transition into the new radio system. The new radio system will have a profound effect on how we currently do business. A successful transition to the new radio system will require a well thought out and coordinated implementation plan. A failure to properly implement the new radio system could waste a $21 million investment and hinder the Department of Fire and Rescue from accomplishing its basic mission of ensuring the delivery of quality, efficient, and effective fire protection, emergency management services and timely responses to the community of Prince William County.

Prince William County is located in Northern Virginia approximately 35 miles southwest of Washington, D.C. It is bounded on the north by Fairfax and Loudoun Counties, on the east by the Potomac River (Maryland), on the south by Stafford County and Quantico Marine Corp Base and on the west by Fauquier County (Appendix B).

Prince William County encompasses a total area of 348 square miles. Prince William County includes within its boundaries the independent cities of Manassas and Manassas Park. Prince William County also includes four incorporated towns of

Dumfries, Haymarket, Quantico and Occoquan. The combined area of Prince William County and the independent cities and towns is 360 square miles (Appendix B).

According to Census 2000, the population of Prince William County was 280,813 persons as of April 1, 2000. Between 1990 and 2000 the populations of the County grew by 30.2%. Even though this represents relatively rapid growth, it is not as fast as in some previous decades (Prince William County Office of Information Technology, 2002).

According to Census 2000, Prince William County is the third most populous jurisdiction in Virginia. More than 65,000 people have been added to the County's population in the past decade, once again ranking it third in Virginia (behind Fairfax County and Loudoun County) for most population added during the 1990's (Prince William County Office of Information Technology, 2002).

The current estimated population of Prince William County is 306,229 persons (as of March 15, 2002). The County population has grown by 42% since 1990 when the population was 215,686 persons. The average annual increase since 1990 is approximately 7,570 persons and the average annual growth rate is 2.93%. The County is projected to grow over 400,000 persons by 2020 (Prince William County Office of Information Technology, 2002).

In comparison to the population growth, the Department of Fire and Rescue incident call volume in 2001 was 27,267 total incidents. The department had 13,196 incidents in 1980 and 17,297 incidents in 1990 (Appendix C). The average annual incident volume growth rate from 1980 through 2001 has been 4.07%.

Today the PWCDFR is a combination department, which consists of 800 volunteers and 282 career personnel staffing 18 fire and rescue stations. Together they

provide fire protection, emergency medical services, technical rescue, public education and hazardous materials response. There are four new stations identified to be built within the next five years and 105 additional career personnel are projected to be in the five-year staffing plan (Prince William County Office of Executive Management, 2002).

As the population increases, the service demand will increase. Both an increased incident call volume and increased number of Fire Department personnel will increase the amount of radio transmissions. It is mission-critical that the future providers of emergency services have a reliable radio system that will support them in carrying out their mission of providing the highest level of service to the citizens in the most efficient and safest way possible.

This applied research project was performed to contribute to the existing body of knowledge within the fire and rescue profession, to research a major problem currently under review by the author's department, and to fulfill the requirements of the National Fire Academy's Executive Fire Officer Program. The topic of this research relates to the Advanced Leadership Issues in Emergency Medical Services in that contemporary EMS systems and their personnel rely as heavily on their communications systems as they do any other resource available to them. Effective communication networks provide: access to the EMS system, dispatch of EMS and other public safety agencies, coordination among EMS and other public safety agencies, access to medical direction, communications to and between emergency health care facilities, communications between EMS and other health care providers, and outlets for disseminating information to the public (Delbridge & Paris, 1994, p. 245-261).

LITERATURE REVIEW

A literature review was performed to examine relevant historical information regarding 800 MHz radio communications systems and how they were successfully implemented.

The literature review involved a research of fire service trade journals, magazines, textbooks, newsletters, newspapers and an Internet search. Despite the obvious importance of having an effective communications system, only a limited amount of published research could be found dealing specifically with implementation of 800 MHz radio systems.

In the seventeenth edition of *NFPA Fire Protection Handbook*, Evan E. Stauffer, author of "Fire Department Emergency Communications Systems", states that "considerable thought should be given to selecting the proper radio system, and professional personnel should be used to ensure the proper functioning of each system." He further states that "several brands of radio frequencies are available to the fire service. VHF low band, VHF high band, UHF 450 MHz and UHF 800 MHz bands." Trunking systems are described by Mr. Stauffer as systems which use a group of radio frequencies. He states, "The system is controlled by a computer in the communications center or at the base station transmitter site. When a transmitter is keyed, it transmits its unique identity code to the computer. The computer instantaneously selects an available communications frequency and automatically directs the transmitting radio to use that frequency for the transmission" (Stauffer, 1991, p. 4-4, 4-5).

At the Redmond Symposium: Weapons of Mass Destruction and Fireground Communications, the International Association of Firefighters (IAFF) reported,

“Effective and reliable radio systems and fireground communications have always been essential elements of fire fighter safety has become a hot topic in the recent past as fire departments across North America switch to newer technologies, such as 800MHz systems.” The IAFF also stated, “But many firefighters have reported problems with newly-introduced systems including gaps in communication that can pose a serious threat during response to a major incident.” They have learned that these problems usually resulted from the fact that fire fighters, and their unique communication needs, were not a part of the system design process (IAFF, 2001, p.1). Phoenix firefighter, Jim Hill shared his department’s experience with the introduction of an 800MHz radio system providing a good example of how fire fighter involvement can lead to a reliable and properly-built emergency radio system. “Before, we’d only heard horror stories about 800MHz systems,” Hill said, noting reports from other jurisdictions of sudden loss of communication during major incident response raised serious concerns among Phoenix fire fighters. As a result, they fought for - and won - representation on steering committees that were designing the system. “The result will be the launch of a properly funded and reliable radio system in which the fire fighters have confidence, which is extremely important”, he said. Funding for the proper radio infrastructure and adequate user training are key elements to a reliable system, he stressed. “We’re working through the challenges, but we’re confident that in the end we’ll have a better system than we had before” (IAFF, 2001, p. 1-2).

Carrollton, Texas, Fire Chief Bruce Varner echoed Hill’s advice on fire fighter participation in system design. To illustrate his point about the need for user training, Vanrer randomly handed 800 MHz radio units to two fire fighters at opposite ends of the

room and asked them to communicate with each other. After a half hour of trying they had failed. Unfortunately, that's essentially what's happening in some fire departments, he warned. Fire fighters are being handed radios without being trained to use them. (IAFF, 2001, p.2).

"Our communications are mission-critical. Our communications need to work 100 percent of the time," he told workshop participants. "Anything less is unacceptable. The lives of not only our fire fighters, but also the public depend on it" (IAFF, 2001, p.2).

According to Captain Mike Worrell of the Phoenix, Arizona fire department he stated that "in the aftermath of September 11th, many questions have arisen about communications difficulties that were encountered. Reading many of the articles the term communications was not limited to radio technology. Many communications were procedural and operational. Since we (at Phoenix Fire) are in the midst of a large-scale radio system change, the communications problems encountered in New York City were looked at from a radio technology standpoint (Worrell, 2002, p.1).

He further states that, in March 2001, the Fire Department of New York made an attempt to switch to newer digital technology. While these radios were digital, they were not trunked. The department remained on their old frequencies but switched to digital radios. This can be likened to switching from analog cell phone service to digital. The department did minimal training, and the radios acted differently then the old analog radios. Since the users had minimal training, they were not aware of some of the operating characteristics of the new radios. Users soon complained of poor communications. After one week in the field, the digital radios were pulled from service. The New York City Fire Department conceded that they had moved too fast in an effort

to get the radios into the hands of the firefighters. The commission stated that the core problem was the failure of the fire department to properly train the firefighters about the characteristics of the new digital technology. These radios were reprogrammed back to the analog mode. The digital mode has not been utilized since March 2001 (Worrell, 2002, p.1).

It was also reported that communications were so poor that when a city engineer said buildings were at risk of imminent collapse, a runner had to be sent to notify the ranking fire chief. What was not mentioned is that the chief who received the report was FDNY Chief Peruggia of the EMS Bureau. The EMS Bureau does not have the same radios as the fire department. The other options the chief had were to send a runner or obtain a fire department radio so that he could notify them of the buildings conditions. This was an inter-operability problem between city departments (Worrell, 2002, p.1).

When the aircraft hit the World Trade Center, a radio repeater was destroyed. This repeater had been installed on the tower to improve radio coverage in the area. This resulted in diminished radio coverage. To what extent this contributed to loss of life can only be guessed. It was reported that many did not hear the order to evacuate. The loss of a repeater could be a contributing factor (Worrell, 2002, p.1).

The New York Times, on the web, reported that at the time of the World Trade Center towers collapsed, the New York Fire Department had little idea how many firefighters were inside and could not communicate with a Police Department helicopter flying overhead. These and other shortcomings expose the need to reexamine emergency response policies, Deputy Chief Charles R. Blaich told emergency management

professionals at John Jay College of Criminal Justice for a forum on urban hazards (Lipton & Glanz, 2002, p.1).

Perhaps no fire department could prepare for an emergency on the scale of the trade centers attack, Chief Blaich said. But the Fire Department must find way to increase the amount of information at its disposal at the time of major disasters and, in particular, to communicate better with other agencies that are responding, said the deputy chief, who until recently was the logistics officer at the incident command center (Lipton & Glanz, 2002, p.1).

The inability to communicate with the police helicopter was particularly unfortunate, he said. Firefighters were ordered to evacuate the twin towers shortly before the collapse of the south tower, the first to fall. That order came only after a false rumor that a third hijacked plane might be on the way, Chief Blaich said (Lipton & Glanz, 2002, p.1).

Commanders directing the Fire Department response were initially inside the north tower and could not easily enter and exit that building because of falling bodies and debris. The evacuation might have come sooner if observations by police personnel in the helicopter had been available, he said. “Here we have their airborne antenna flying around without the capacity of transmitting to people on the upper floors to get out,” he said. “The officers at the incident command center were unaware of the severity of the condition of the buildings outside” (Lipton & Glanz, 2002, p.1).

Public Safety personnel must be able to coordinate over agency boundaries and wireless limitations, even for day-to-day incidents like fire suppression and emergency care. During five weeks in the summer of 1998, 6,500 firefighters from local, state and

federal agencies converged on Florida to fight 2,214 brush fires across the state. A variety of radio communications problems emerged and a lack of interoperability severely hampered efforts to coordinate a response to the disaster. There were also a limited number of channels available, which cut down the responsiveness of the public safety entities. EMS crews were often unable to coordinate locations with regional emergency response organizations and federal agencies. The state had mandated that although ALS providers had recently upgraded to a statewide 800 MHz system they should retain their vhf radios for coordination during disasters. While the radios were in vehicles, they often hadn't been maintained or personnel didn't know how to use them (Siegle and Murphy, 2001, p.1).

No man, woman or child should lose his or her life because firefighters cannot talk to one another. However, a recent study by the Public Safety Wireless Network Program (PSWN) shows that one-third of all firefighters have had difficulty responding to emergencies because of a lack of radio interoperability. Finding and implementing solutions that facilitate wireless interoperability is the primary mission of the PSWN Program. This joint initiative of the Justice and Treasury departments is an information resource and advocate for public safety agencies around the country (Siegle and Murphy, 2001, p.1).

After two separate incidents in which Boston firefighters had become trapped in burning buildings during structure fires, the circumstances surrounding the incidents were analyzed to determine the role that the lack of communications played in endangering personal safety. One of the two incidents resulted in a loss of life. It was determined that:

- All firefighters should be provided with portable radios so that they can communicate during an emergency.
- More channels are needed to support operational communications at the scene.
- A lack of adequate in-building coverage can prevent reception of critical communications between firefighters.
- Firefighters from different companies who respond to incidents have limited interoperability.
- A mobile command post can help improve fireground communications and resolve some interoperability problems (Siegle and Murphy, 2001, p. 4).

Seven years ago the Baltimore City Fire Department met with Mayor Kurt L. Schmoke to make the case for a new communications system. The transition to the new system began with the mayor's approval to hire a consultant to identify the specific needs of city agencies and the technological options. He made the commitment to involve the agencies that would use the system in its design. The mayor recognized that communications needs differed among city agencies, sometimes dramatically (Torres, 1999, p.1).

According to Mr. Torres, the city was realistic in developing the implementation plan. Particular attention was paid to financing, because sophisticated communications technology isn't cheap. The city realized it couldn't implement a city-wide system at one time, so implementation would need to be done in phases. "We structured the communications system as a capital project that we would complete over four years,"

explains Finance Director William Brown, "that enabled us to implement the system in clearly defined, logical phases we could afford" (Torres, 1999, p.2).

"A team driven process the road from the first brainstorming meetings to actual system implementation has been long, and it still continues. Teamwork, and the creativity that comes from groups dedicated to a common goal, has been the factor that has most distinguished this project" (Torres, 1999, p.2).

Fire Chief Mike Merwick explains that the Lincoln Fire Department has a 20 channel, two-site simulcast with pc-based consoles and a Global Positioning System feature that synchronizes the timing of the two radio sites. Although he doesn't believe that mobile data terminals are that beneficial for control or suppression in this size area, he does expect the digital AVL to be a great help. "The system is not designed, but evolves, to serve the needs of the biggest users." Merwick says. "We, as firefighters, have never felt shorted with technology or attention from those planning installation and upgrades. The Users' Committee has representation from all agencies: police, sheriff and fire. The system works well for us." He also points out that each of his firefighters is assigned a portable radio to carry on the fireground in a vest pocket on the turnout coat (Lee, 1999, pp.1-2).

Planning breeds interoperability in Fairfax County, Virginia according to Captain Paul Nichols. The new system, which was designed with the help of communication consultants, is to be fully operational by the fourth quarter of this year. All of the radios from participating jurisdictions will be programmed with each other's fireground operational talk groups. Units responding on a mutual aid call will be assigned a communications channel from the controlling dispatch center; they then simply enter that

jurisdiction's radio system for the duration of the incident. Two factors played heavily into the selection of the radio system. Coverage was the number one concern, and interoperability with neighboring jurisdictions to simplify communications during mutual aid incidents was a close second," say Nichols (Lee, 1999, p.2).

"We have formed a mutual aid interoperability working group," explains Nichols, "and all six fire chiefs have agreed to certain rules and procedures to take optimum advantage of the system. We've renumbered our apparatus and assigned specific channels and explicit policies so that the system will operate seamlessly" (Lee, 1999, p.3).

The August 1994 edition of Emergency Medical Services magazine featured an article on amateur radio operators. Generally considered to be nuisances, there is a group that the authors of the article, "Are There Amateurs at Your Disaster?" consider valuable. Kenneth Phillips, Charles Steward, and Ronald Deutsch state that "there's one group of amateurs you should welcome at your disaster site: amateur radio operators – hams in their lingo – who are often more professional and better equipped than the best of professionals themselves" (Phillips, Steward, Deutsch, 1994, p.35).

In the May 2002 Public Safety Communications, APCO Bulletin, Tom Gibson authored an articled titled "Using Amateur Radio Operators for Emergency Communications," he stated, "Since the completion of the Limerick Generating Station in Limerick Township, Montgomery County, Pennsylvania, the Montgomery County Radio Amateur Civil Emergency Service (RACES) organization has been integrated into the response procedures for an emergency arising from an event occurring at this plant. Three communications channels are provided for in the plan: RACES, Office of Emergency

Preparedness (OEP), radio and the public telephone system. When all RACES operators are in place at the EOCs, communications will be handled by RACES" (Gibson, 2002, p.26).

Just after hurricane Hugo hit Charleston, South Carolina in September 1989, one of the major concerns was communications. In the February 1990 APCO Bulletin article, "Reestablishment of Two-Way Communications Vital To Recovery After Hurricane Hugo," author Terry Bonneau states that Southern Bell central telephone offices were jammed with everyone in Charleston County making calls. The Motorola 800 MHz trunked system was the answer to immediate communications" (Bonneau, 1990, p. 57).

Radio communications also played a major role in the January 17, 1994 earthquake in Los Angeles, California. In the June 1994 APCO Bulletin article "Effective Radio Communications Helped Los Angeles Cope with Devastation", author Ken Gadd describes a statement from Richard Granado, Chief of the Radio Systems Division of Los Angeles County's Internal Services Department. Mr. Granado stated, "during the first 24 hours following the earthquake, we logged more the 118,000 calls on one 800 MHz countywide integrated radio system. That's three times more than normal traffic load, and there's no way our former analog radio system could have handled such a volume of calls"(Gadd, 1994, p.12).

According to Mary Jane Dittmar, she states, "If this were a perfect world, perfect fireground communications would be a given: You would be able to rely on your radios 100 percent of the time. Alas, the world of the fireground is far from perfect, and no communications system can be guaranteed to be flawless. Moreover, a communications emergency can occur for a variety of reasons. A failure of fireground communications –

even if it occurs once in the lifetime of a system – could be fatal. Therefore, the concepts of a backup plan, a plan B, redundancy, preplanning, training and even innovation are as critical to successful fireground communications as to other fireground functions. But, this does not mean that you cannot achieve successful fireground communications" (Dittmar, 2002, p.55).

"Even though 100 percent radio propagation (which is statistical in nature) is impossible to achieve, the on-scene commander should always be able to talk to the firefighters at the end of the hose or in the structure with a short range (fireground) channel," says Frederick G. Griffin, P.E., president of the Frederick G. Griffin, P.C., consulting firm based in Lynchburg, Virginia (Dittmar, 2002, p.55).

When beginning the process of searching for or designing a communications system, it might help to begin with realistic expectations (Dittmar, 2002, p. 55). "If you approach the implementation of a digital-based system methodically and without trying to apply analog experiences and expectation to the process, the transition to this technology can be made far less complicated," says John M. Buckman, chief of the German Township (IN) Volunteer Fire Department in Evansville, Indiana, and president of the International Association of Fire Chiefs (Dittmar, 2002, p. 55).

"Often, the assumption is that a fire department has 100 percent coverage with the system that is being replaced," observes Leif Anderson, captain, technical services, Phoenix (AZ) Fire Department. "There is not a single fire service radio system today that has 100 percent coverage," he says. "Firefighters know of many places within their city where they cannot talk with a fire radio." As Anderson sees it, "… fire departments need to design a modern system for exceptional coverage, at least 95 percent for analog

[Editor' note: and 97 percent for digital] by contract, and commit to installing bi-directional amplifiers in those buildings where testing reveals communications to be problematic. These kinds of improvements must be completed before the system is used for emergency situations where firefighters' lives are on the line" (Dittmar, 2002, p. 55).

William Goldfeder, battalion chief of the Loveland-Symmes (OH) Fire District states, "It is critical that radios work well under the worst conditions. Make sure those specifying your radios cross every "t" and dot every 'i' to ensure your safety. It is worth the time. If you don't, you are losing before the game even starts" (Dittmar, 2002, p. 61). Goldfeder continues: "Make sure the system is working before is it accepted and, even before that, make sure the specifications fully match firefighters' requirements and needs. Make the manufacturers prove it, and not to some 'suit' in the budget office. Consider using your most experienced company fire officers (field officers, not the training bureau or other who don't use the system under the toughest conditions), and have them participate in the testing of the system. They know where the system will be stressed and needed, the toughest spots, the deepest basements, the highest floors, the most remote rural areas, and so on. We are talking about a radio system that will be firefighters' lifeline. It must be designed with that in mind" (Dittmar, 2002, p. 61).

Ms. Dittmar reported that a fire department should develop positions on the project committee so its members can serve as department advocates (Dittmar, 2002, p. 68).

In Phoenix, Anderson says research has shown that a lack of user input and involvement directly lead to problems. Each department needs to have full-time representatives who can track the project, participate in decision making, and forecast

risk assessment, he adds, “Somebody needs to be there to force the technical people to translate what they are saying and doing into firefighter-friendly language. It will slow them down but improve the project by eliminating problems before they occur,” Anderson says (Dittmar, 2002, p. 68).

Summary

The Literature Review revealed that effective and reliable public safety radio systems have always been an essential component of emergency services. Considerable thought and planning should be given to selecting and implementing the proper radio system. Emergency services have unique communications needs that require effective and reliable radio systems to work 100 percent of the time, even under the most difficult conditions. Technology advances have greatly enhanced and improved radio systems but many departments have experienced problems with implementing new systems. The literature review revealed that most of the problems encountered were related to poorly designed systems, lack of user input, moving too fast, failing to properly train the users, not developing an effective implementation plan, and by having unrealistic expectations. The departments that have had successful results in implementing new 800 MHz radio systems can attribute their success due to the following reasons: properly designed systems, getting the users involved early, understanding that coverage and interoperability are critical, proper training of users, developing an effective implementation plan, having realistic expectations and by having backup plans developed should the system fail.

Realizing that we do not live in a perfect world and thereby understanding that a perfect radio system also does not exist. Having realistic expectations, knowing the

capabilities and limitations of your system and having backup plans available are also important keys to success. The solution to all future problems you may encounter with your radio system does not rely on technology as the answer but with the people who will be relying on the radio system. The more users you get involved with designing and implementing the radio system, the better the radio system will perform.

PROCEDURES

The desired outcome of this applied research project was to develop a successful implementation plan for a new 800 MHz radio system for the Prince William County (Virginia) Fire and Rescue Department. The research method used was action research and consisted of a literature review and personal interviews. The process of gathering information from a variety of sources proved to be beneficial and provided a broad base from which to formulate ideas and to suggest recommendations for implementing an 800 MHz radio system.

First, a literature review was initiated during February 2002 at the National Emergency Training Center's Learning Resource Center during the author's attendance at the National Fire Academy. Additional searches were conducted through the Management and Government Information Center (MAGIC) of the Prince William County Public Library Center. Several published resources were also obtained from the Prince William County Public Safety Training Center in Prince William County, Virginia and through the Internet. Source material dated from 1985 to 2002. A review of nationally recognized texts, Executive Fire Officer's research papers, technical reports,

newsletters, bulletins, newspaper articles and trade journal articles concerning public safety communications radios was conducted.

The literature review primarily determined the historical background regarding radio communications systems. The literature review revealed advances in technology applicable to the fire service and provided examples for Prince William County to consider as it prepares to transition to an 800 MHz radio system.

A list of eight (8) interview questions was developed by this researcher (Appendix D).

The personal interviews conducted were designed to solicit feedback from both users and those responsible for managing radio systems. These individuals are a representation from within Prince William County and neighboring jurisdictions to Prince William County (Appendix B) some of who have experience implementing 800 MHz radio systems. Personal interviews were conducted with John Maddox (Manager, Prince William County Public Safety Communications Center), Joe Mize (Radio Systems Administrator, Prince William County), Sam Somer (Communication Engineer, Prince William County, Office of Information Technology), Captain John Diamantes (Fairfax County, Virginia, Fire and Rescue), Lisa Thompson (Radio System Manager, Arlington County, Virginia), Deputy Chief Matt Partlow (Loudoun County, Virginia, Fire and Rescue), Randal Browning (Communications Coordinator, Alexandria, Virginia, Fire and Rescue), Philip Myer (Emergency Services Coordinator, Fauquier County, Virginia), Assistant Chief Dennis Raines (Marine Corp Base, Quantico, Virginia, Fire and Rescue), and Chuck Thompson (Emergency Services Coordinator, Stafford County, Virginia), using a predetermined list of questions (Appendix D) as a general guide. Most of the

discussions involved the major issues they experienced in implementing an 800 MHz radio system and how the upgrade impacted fire and rescue operations. Each of the interviewees has a strong background in fire service radio communications either from a user background, a support background, or both. Each of them is a stakeholder in a fire and rescue communications radio system.

The interviews were conducted between May 21, 2002 and June 6, 2002. The length of time varied for each interview due to the specific area of expertise of the interviewee. They ranged from twenty (20) minutes to ninety (90) minutes, averaging forty-five (45) minutes overall. Eleven (11) interviews were conducted, eight (8) by telephone and three (3) in person (Appendix E).

The purpose of the interviews was to determine how an 800 MHz radio system should be successfully implemented into the Prince William County Department of Fire and Rescue. The questions listed in Appendix D, along with the literature review, provide the information necessary to determine the proper course of action. A list of recommended strategies will be created from these results. Those recommendations will be utilized by a committee given the task to implement the 800 MHz radio system.

Assumptions and Limitations

The literature review consisted of a number of trade magazine articles, textbooks, technical reports, newsletters, bulletins, newspaper articles and Executive Fire Officer research papers. It is assumed that the information described in these publications is honest and accurate. A limiting factor is the ability of the researcher to validate the information described due to my inexperience in my new assignment as the Public Safety Communications Center Battalion Chief.

It was assumed that the interviewers had a genuine stake in the quality of fire service radio communications and that their professional positions provide them with ample knowledge to offer constructive feedback to this research. Limiting factors of the interview process include the relatively small number of people interviewed and the inability of this researcher to determine if the number of interviewers was an accurate sampling of fire service radio communications users/managers. While the personal interviews provided valuable opinions, each respondent has a somewhat different stake in the use and/or management of a fire and rescue service radio communication.

Definition of Terms

AVL – Automatic Vehicle Locator: assists the dispatcher in determining the location of the closest most appropriate fire and rescue unit to the emergency incident.

BDA – Bi-directional Antenna: assists the microwave system in providing reception between the emergency scene and the dispatch center.

Conventional Radio System – A system where a single channel or a pair of channels is employed, which may require the end user to wait for a break to seize the channel.

Digital Computer – Electronic device which processes information based on whether a circuit is on or off; contrast to analog computer which processes information based on continuous smooth or linear operation of a circuit.

F.C.C. – Federal Communications Commission.

I.A.F.C. – International Association of Fire Chiefs.

I.A.F.F. – International Association of Firefighters.

Interoperability – An essential communications link within Public Safety and public service communications systems which permits units from two or more different agencies

to interact with one another to exchange information according to a prescribed method in order to achieve predictable results.

Megahertz (MHz) – A common technical term that refers to the frequency of the radio. One MHz equals 1,000,000 cycles, or hertz, per second.

PSWN – Public Safety Wireless Network.

Simplex – Communications circuit in which flow of information can proceed in only one direction at a time; compare to duplex.

Trunked Systems – Systems where multiple channel pairs are integrated into a single system. When a user wants to transmit a message, the trunked system will automatically select a currently unused channel pair and assign it to the user, decreasing the probability of having to wait for a free channel for a given loading.

RESULTS

1. **How have other departments implemented new 800 MHz radio systems**?

Many fire departments across the nation are updating their current obsolete radio systems with state of the art 800 MHz trunked radio systems. The failure or success of implementing these new radio systems have been determined more or less based on proper planning, training and involvement by the users.

Phoenix firefighter Tim Hill reported that they fought for and won, representation on steering committees that were designing the system. “The result will be the launch of a properly-funded and reliable radio system in which the firefighters have confidence, which is extremely important,” he said. “Funding for the proper radio infrastructure and

adequate user training are key elements to a reliable system, he stressed" (IAFF, 2001, pp. 1-2).

In Baltimore, Maryland, the mayor made the commitment to involve the agencies that would use the system in its design. "A team driven process from the first brainstorming meetings to actual system implementation has been long, and it still continues. Teamwork and creativity that comes from groups dedicated to a common goal, has been the factor that has distinguished this project" (Torres, 1999, p. 2). Chief Mike Merwick states, "The users committee has representation from all agencies: police, sheriff and fire. The system works well for us" (Lee, 1999, p. 2).

The departments that had bad results when implementing their 800 MHz radio system cited lack of participation and buy-in from the users, training and under funded systems as the primary reason for ineffective radio systems.

2. **What features should be incorporated into the technological upgrade of the PWCDFR radio system**?

The interviews and literature review revealed that a trunking system with digital signaling would best meet the needs of the department. Mobile data, automated vehicle locators, and status change heads would be enhancements to the current computer aided dispatch (CAD) system to improve response times and reduce the traffic congestion on the air.

A system to identify who or what unit is transmitting, i.e., unit identifiers and emergency activation button, would certainly add safety for field personnel, particularly if they become trapped in a hazardous situation.

Vehicle repeaters and bidirectional antennas (BDA's) can be obtained if improved coverage is required in specific buildings and remote areas of the county.

Occasionally, portable radios are misplaced or stolen. In the wrong hands, portable radio transmissions can interrupt and jam the radio frequency. To control the illegal use of portable radios, a device to disable the radio by the dispatch center would provide the proper protection.

3. **What are the major issues associated with transitioning to an 800 MHz radio system**?

One of the biggest issues associated with a change to an 800 MHz radio system is the cost. The commitment of $21 million dollars is one that must be justified to the taxpayers. This is a high profile project that has been under development for more than five (5) years.

Resistance to change is another major issue that will have to be overcome in order to successfully implement the new 800 MHz radio system. Any change in operating procedures must be managed properly. The fire service has typically been somewhat traditional and slow in implementing change. An 800 MHz radio system will undoubtedly have different characteristics than the current 154 MHz system. Ten years ago, the department implemented its first generation of Computer Aided Dispatch (CAD) system which necessitated computer terminals in all of the fire and rescue stations. Many of our personnel were not very computer literate and were literally afraid of touching the computer. Some initially refused to accept the fact that the department was transitioning into the age of advanced technology. Planning, training and support on the part of the

department management made that transition run smoothly. The change to an 800 MHz radio system will be no different and will require equal planning, training and support from senior management and other stakeholders.

4. **How will the changes to an 800 MHz radio system impact fire and rescue operations**?

Overall, the transition to an 800 MHz radio system should yield improved communications both within and outside of the county to a limited distance. We will be increasing our channel capability from three to fifteen. This should reduce radio congestion that we currently experience and thus make dispatching easier and more efficient. The digital technology should improve the quality of transmission and reduce the need to repeat messages which will increase safety for our personnel. Interoperability with surrounding jurisdictions will be improved since Fairfax County to the northeast and Loudoun County to the north currently have compatible 800 MHz radio systems and Fauquier County to the west will implement the 800 MHz radio system with eighteen (18) months. The 800 MHz radio system will have many safety features that we do not currently have, such as, unit identifiers, emergency activation buttons, repeater, and talk around channels to utilize.

One major concern will be the distance that our units will be able to transmit back to our dispatcher once they leave the county to assist other jurisdictions on request for mutual aid. 800 MHz signals cannot travel as far as 154 MHz signals and therefore we need to determine the realistic distances that we will have outside of the county. An

operational procedure for operating outside of the county out of range of our dispatcher will have to be developed.

The interview questions listed in Appendix D were developed to solicit input from the surrounding jurisdictions about their radio systems and how they transitioned to the 800 MHz system. Local radio “experts” were interviewed to solicit their opinions also. Their responses to the questions can be seen in Appendix E. Eleven interviews were conducted, eight by telephone and three in person. A total of eight neighboring jurisdictions were contacted.

Fairfax County, Arlington County, Alexandria City, Fairfax City and Loudoun County all currently have implemented 800 MHz radio systems. Fauquier County plans to implement their 800 MHz radio system by December 2003. Stafford County, which has a 450 MHz system and the Quantico Marine Corp Base Fire Department, which has a 140 MHz system, do not have plans to switch to an 800 MHz radio system.

The interviewees overwhelmingly agreed that interoperability and coverage were the two major concerns of fire service radio communications. While no vendor will guarantee 100 percent coverage, the vendor for Prince William County is offering 95 percent or better coverage. Of the departments who have implemented 800 MHz radio systems they overwhelmingly agreed that training is the key to success in implementing any system. Those who have had difficulty attribute a lack of sufficient training as the main reason.

Resistance to change, accepting change and change in general were also major issues they encountered associated with transitioning to an 800 MHz system.

Reliability was noted as important to the users, particularly in those situations where priority radio traffic has safety implications. Firefighting and rescue work demand that all equipment has the capability to withstand prolonged rigorous usage. Portable radios must be able to withstand being dropped occasionally without breaking and meet the basic standards of public safety use.

All of the interviewees expressed great satisfaction with their current 800 MHz radio systems. More channel capacity has lessened radio traffic congestion and created a smoother, more effective dispatch process. The digital radio quality is better once you get used to the change of the tone. They all felt that it created a safer environment for the radio users on the scene of an emergency.

Advanced technology has yielded several features which should increase the reliability of a radio system according to most of the interviewees. The proposed trunking system will provide fifteen (15) channels to be shared by the public safety agencies. The trunking capability will allow numerous talk groups to operate simultaneously and provide more lines of communications than the present 154 MHz system. Most interviewees expressed a concern about recognizing the unit or person transmitting vital information. Technology is available to provide an operator identification function on all radio equipment which would quickly denote which unit is transmitting. Mobile data capability and automated vehicle locators were identified numerous times as worthwhile and recommended upgrades to a new system.

Five of the interviewees suggested that when implementing an 800 MHz radio system that a users group should be formed to plan, develop and provide effective training to all users before going live with the new system. Another key element

mentioned by several interviewees was the importance of getting buy-in from senior staff and for them to support the implementation plan.

Based on the feedback received from the interviews and in combination with the historical information that the literature review produced, a list of recommended strategies for implementing an 800 MHz radio system was developed (Appendix A). This list of recommended strategies will be provided to the implementation team to assist them with the responsibility of overseeing the implementation of the 800 MHz radio system in Prince William County.

These strategies include the creation of an implementation team made up of radio users throughout the department. By involving the departments' personnel we will be creating ownership and buy-in from the users who will be benefiting from the new radio system. Another strategy that is critical to the success of the implementation is the organizational support and commitment. This needs to be demonstrated from the top of the organization all the way down to the entry level person. Involving as many of the stakeholders as possible should insure the success of the implementation plan. A key element to any new program is the effectiveness of the training that needs to take place. A comprehensive training program will need to be developed, administered and evaluated for effectiveness so that the end users will know how to utilize the new radio system to its full advantage. The research determined that there is no such thing as a perfect radio system, and that 100 percent coverage 100 percent of the time is not possible. The important thing is that they need to have realistic expectations of their radio system. The users need to determine their systems capabilities and limitations and the only way to

determine that is by getting involved to learn and understand the features and advantages of the new radio system and how they can use them.

DISCUSSION

The research performed by this author supports the need to develop an effective implementation plan for the proposed 800 MHz radio system for Prince William County. The primary goal is to have a new state of the art 800 MHz trunked, digital public safety radio system will provide reliable quality radio communication 100 percent of the time for our personnel. It is obvious from the literature review and the interviews that proper planning, buy-in and training are key issues to insure that an effective implementation plan will be successful.

It is the opinion of this researcher that a radio system with additional frequencies, better coverage and increased reliability is needed for the PWCDFR. The system should be trunked to provide additional talk groups for multiple incidents or sectors with a given incident. The additional talk groups will require a major change in how business takes place in the dispatch center. Dispatchers will have to be able to manage more than one incident at a time or provisions must be made to staff additional positions at the dispatch center. This researcher believes that dispatchers should be trained and be able to handle more than one incident at a time.

A department wide commitment to the successful implementation of this important project is essential. The Fire Chief and her senior staff will have to show their support of this project to the rank and file.

It would be beneficial that all operational battalion chief vehicles be equipped with vehicle repeaters to insure that there will always be sufficient radio repeater

coverage on all major emergency incidents. It is also important that technological upgrades such as mobile data, automated vehicle locators, and status change heads be considered in the future to enhance the current computer aided dispatch center.

No jurisdiction is immune from disaster. Hurricanes, floods, earthquakes, and aircraft accidents can cripple even the best communications systems. It is important to plan for these rare occasions where the radio system is out of service or overloaded. The PWCDFR should develop contingencies to continue operations should the system become disabled or overloaded. The use of HAM radio operators, as well as cellular phones may be valuable in times of crisis.

The radio operators' identification and emergency activation features are valuable and have the possibility of saving the lives of fire and rescue personnel in a variety of situations from fires to hazardous materials emergencies to medical calls. Since portable radios are occasionally lost or stolen, the disable feature would provide protection against those who may try to disrupt our communications.

A plan to continue simulcasting on the current 154 MHz frequency should be included. This can provide a secondary means of emergency call back of off duty personnel who have minitors, monitors and scanners in their private vehicles or at home. The news media covers the fire and emergency medical services by monitoring our frequencies. One of our best public relations tools is the press reporting on our operations. The freelance photographers and reporters will be able to continue to monitor our dispatch channel if we continue to simulcast.

The Public Safety Wireless Network committee commissioned by the Federal Communications Commission is continuously examining ways to deal with the

communications needs of public safety. Prince William County would be wise to get involved with the process to stay abreast of advances in the industry.

The organizational implications are severe if the department is not successful at implementing the proposed 800 MHz radio system. The financial outlay for conversion is expected to be approximately $21 million. Such an expenditure will justifiably be scrutinized by the government leaders, politicians and the taxpayers.

A failure in fireground communications – even if it occurs only once in the lifetime of a system – could be fatal (Dittmar, 2002, p. 55).

Chief Bruce Varner of the Carrollton, Texas, Fire Department stated that our communications are mission critical. Our communications need to work 100 percent of the time, anything less is unacceptable. The lives of not only our firefighters, but also the public depend on it (IAFF, 2001, p. 2).

RECOMMENDATIONS

The recommendations made based on the findings of this research project include the following:

1. A department wide commitment to the successful implementation of this important project is essential. The Fire Chief and her senior staff should demonstrate their support of this project to the rank and file by publicly promoting the values of the 800 MHz radio system every chance they have.

2. It is recommended that the Chief of the Department establish an implementation team made up of radio users, headed by a Battalion Chief assigned to the Office of the Chief. This will create a sense of ownership and buy-in from the individuals

within the organization. A chief level position involvement demonstrates organizational commitment and allows direct access to the departments resources.

3. The implementation team should consist of stakeholders from all of the user groups, i.e., fire, EMS, dispatchers, fire marshals, training and staff.

4. A comprehensive training program needs to be developed by training staff, radio technicians and users and will be provided to all users prior to implementation of the radio system.

5. A list of recommended strategies for successful implementation (Appendix A) will be provided to the implementation team to assist them.

REFERENCES

Brunacini, A.V. (1985). *Fire Command*. Quincy MA: National Fire Protection Association.

Bonneau, T. (1990, February). Re-establishment of Two-way Communications Vital to Recovery After Hurricane Hugo. *Public Safety Communications APCO Bulletin*. 57-60.

Delbridge, T.R., Paris PM: EMS Communications. In Roush WR(ed): *Principles of EMS Systems*. Dallas: ACEP. 1994, 245-261.

Dittmar, M.J. (2002, May). Fireground Communications: Strategies For Meeting Today's Challenges. *Fire Engineering*. 55-68.

Gadd, K. (1994, June). Effective Radio Communications Helped Los Angeles Cope With Devastation. *Public Safety Communications APCO Bulletin*, 12-22.

Gibson, T. (2002, May). Using Amateur Radio Operators For Emergency Communications. *Public Safety Communications APCO Bulletin*, 57-60.

International Association of Firefighters. (2001, September). *Redmond Symposium: Weapons of Mass Destruction and Fireground Communications* [on-line]. www.firefighting.com/articles/namfullview.asp?nam/D=4412, 1-2.

Lee, B.B. (1999, June). Travels with Trunking [on-line]. *Firechief*.http://industryclick.com/magazinearticle.asp?id=73211, 1-7.

Lipton, E. and Glanz, J. (2002, January). 9/11 Inspires Call to Review Response Plan for Crises [on-line]. *The New York Times* – on the web-www/23fire.html?ei=1. p. 1.

Phillips, K.L., Stewart, C.E., Deutsch, R.A., (1994, August). Are There Amateur At Your Disaster? *Emergency Medical Services*., 34-38.

Prince William County. 2002., *Prince William County Capital Improvements Program, 2002 – 2006*. Prince William, VA: Office of Executive Management.

Prince William County. 2002. *Prince William County Demographic Fact Sheet*. Prince William County, VA: Office of Information Technology.

Siegle, D., Murphy, J. (2001, March 1). Freedom of Speech [on-line]. *FireChief*.www.industryclick.com/magazinearticle=73580, 1-5.

Stauffer, Evan, E. (1991). Fire Department Emergency Communications Systems. *NFPA Handbook, 17th Edition*, Quincy, Massachusettes: National Fire Protection Association. 4-4, 4-5.

Torres, M.L. (1999, June). Cooperative Communications [on-line]. *FireChief*.http://industryclick.com/magazinearticle.asp?id=73212, 1-4.

Worrell, M. (2002, March). 800 MHz Radios – FDNY Questions [on-line]. www.*firetimes*.com/story.asp?Fragid=2460.

APPENDIX A

STRATEGIES FOR SUCCESSFULLY IMPLEMENTING AN 800 MHz RADIO SYSTEM

1. Create an implementation team made up of radio users, i.e., firefighters, paramedics, dispatchers, training staff and staff.

   - solicit stakeholders who want to participate.

2. Demonstrate organizational support and commitment.

   - assign Battalion Chief to oversee and assist implementation team.
   - Fire Chief and Senior Staff need to promote implementation and become advocates of the system.

3. Involve stakeholders by assigning them to:

   - implementation team
   - train the trainers
   - procedural development
   - quality assurance
   - coverage testing

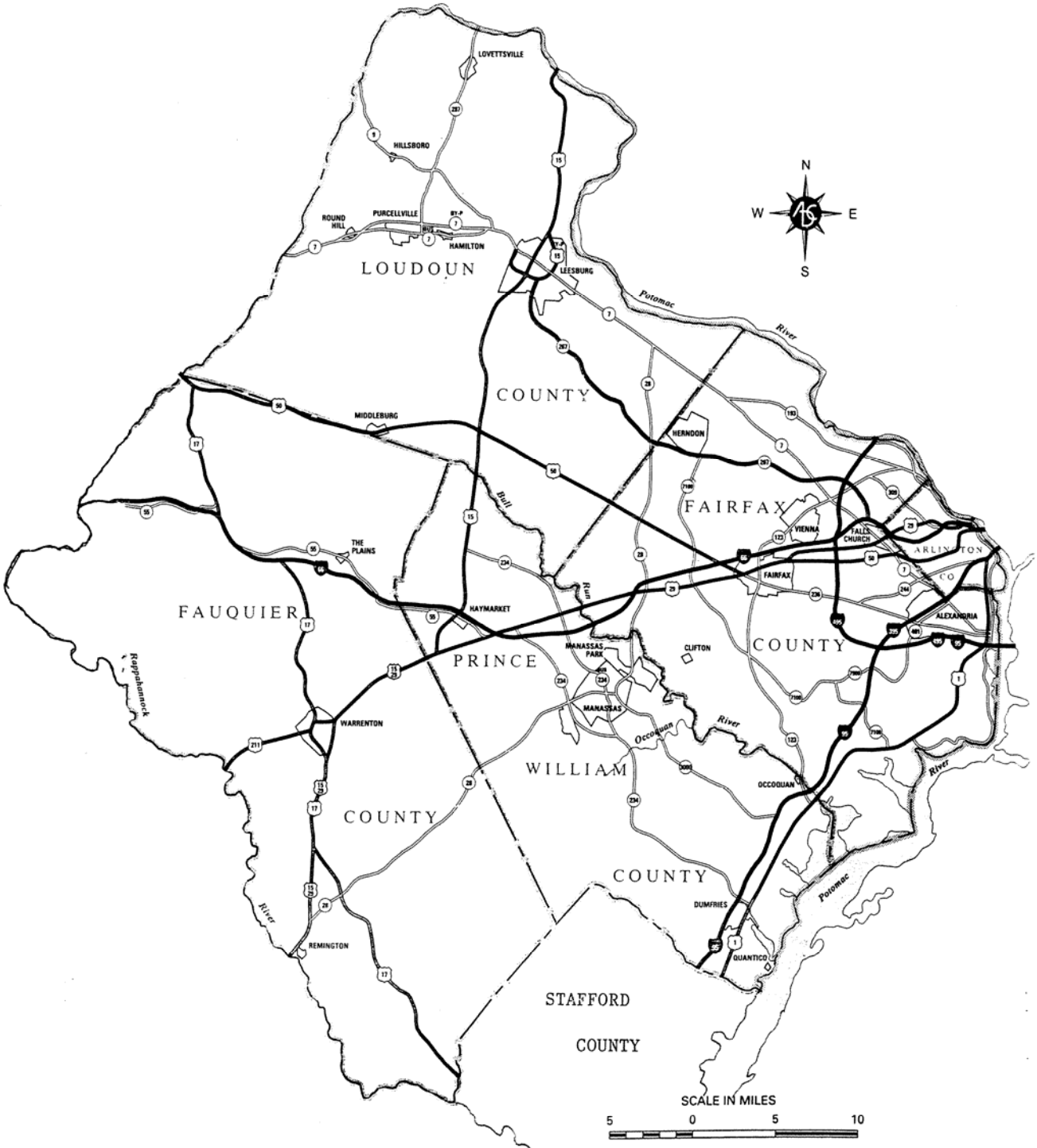
4. Keep everyone informed.

   - provide regular briefings/updates at worksites.
   - provide articles regularly in newsletter, info bulletin
   - provide regular updates to Fire Chief and Senior Staff with progress reports, problems, successes, etc.

5. Develop comprehensive training program.

   - assign at least two (2) train the trainers from each station and worksite. (1 career, 1 volunteer)
   - identify system/equipment capabilities and limitations
   - provide/assign plenty of training opportunities
   - provide training to all users prior to implementation

APPENDIX B



© 2002 Alexandria Drafting Company 6440 General Green Way, Alexandria, VA 22312-2447. All rights reserved. This publication may not be reproduced, in whole or in part, in any form or by any means, without written permission of the copyright owner.

ADC has attempted to verify the information contained in this publication, but no liability is assumed for damages, either direct or consequential, arising from errors or omissions. Users are requested to notify ADC of any errors or omissions observed. Phone (703) 750-0510 or write ADC, 6440 General Green Way, Alexandria, VA 22312-2447.

APPENDIX C

Prince William County, Virginia
Department of Fire and Rescue
Communications Division
Incident Growth

Year	Fire Incidents	Rescue Incidents	Service Incidents	Total Incidents	Previous Change Over Previous Year
1961	250	1190	0	1440	
1962	402	1350	0	1752	21.67%
1963	710	2060	0	2770	58.11%
1964	635	1645	0	2280	-17.69%
1965	750	2045	0	2795	22.59%
1966	951	2600	0	3551	27.05%
1967	799	2875	570	4244	19.52%
1968	1161	3260	335	4756	12.06%
1969	1280	3890	545	5715	20.16%
1970	1282	4820	790	6892	20.59%
1971	1279	4940	665	6884	-0.12%
1972	1581	5770	470	7821	13.61%
1973	1802	6190	553	8545	9.26%
1974	2378	6294	495	9167	7.28%
1975	2238	7042	636	9916	8.17%
1976	2390	7407	439	10236	3.23%
1977	2924	7833	395	11152	8.95%
1978	3105	8651	487	12243	9.78%
1979	2946	9025	550	12521	2.27%
1980	3447	9309	440	13196	5.39%
1981	3313	9538	409	13260	0.48%
1982	3003	9578	499	13080	-1.36%
1983	2938	9657	572	13167	0.67%
1984	3157	9744	560	13461	2.23%
1985	3631	10072	451	14154	5.15%
1986	3877	11703	414	15994	13.00%
1987	3761	11982	407	16150	0.98%
1988	4256	11843	266	16365	1.33%
1989	4156	13074	210	17440	6.57%
1990	3896	13175	226	17297	-0.82%
1991	4267	12984	307	17558	1.51%
1992	4292	13538	297	18127	3.24%
1993	4598	14883	394	19875	9.64%
1994	4992	13813	365	19170	-3.55%
1995	4718	14105	384	19207	0.19%
1996	4839	17135	531	22505	17.17%
1997	5052	16799	454	22305	0.89%
1998	5348	17387	650	23387	4.85%
1999	5800	17686	768	24254	3.70%
2000	5813	19238	833	25884	6.72%
2001	6069	20382	816	27267	5.34%

APPENDIX D

INTERVIEW QUESTIONS

IMPLEMENTING 800 MEGAHERTZ RADIO SYSTEM

Name of Department _____
Person Interviewed _____
Title/Position _____

1. What type of radio system does your fire and rescue department currently utilize?

2. If not an 800 MHz system is your organization contemplating such a change?

3. What are your major concerns regarding fire and rescue service radio communications?

4. How did your department implement their 800 MHz radio system? What worked well? What did not work well? What would you do different?

5. What were the major issues associated with transitioning to an 800 MHz radio system?

6. How did the change to an 800 MHz radio system impact fire and rescue operations?

7. What features do you think should be incorporated into the technological upgrade of the PWCDFR radio system?

8. How would you implement an 800 MHz radio system in a fire and rescue department such as Prince William County?

APPENDIX E

INTERVIEW QUESTIONS RESULTS
IMPLEMENTING AN 800 MHz RADIO SYSTEM

Eleven(11) interviews were conducted, eight (8) were by telephone and three (3) were in person. Eight (8) of the eleven (11) interviews were conducted with the surrounding jurisdictions with whom we currently exchange mutual aid

Five of the jurisdictions currently utilize 800 MHz radio systems. They are Fairfax City, Fairfax County, Arlington County, Loudoun County and Alexandria City. Two of the jurisdictions, Stafford County and Quantico Marine Corp Base, currently do not have plans to switch to an 800 MHz radio system. Fauquier County is planning to change over to an 800 MHz radio system by December 2003.

The following individuals were interviewed, they are:

John Maddox, Manager, Prince William County, Virginia, Public Safety Communications Center;
Joe Mize, Radio Systems Administrator, Prince William County, Virginia, Public Safety Communications Center;
Sam Somers, Communications Engineer, Prince William County, Virginia, Office of Information Technology;
Captain John Diamantes, Fairfax County, Virginia, Fire and Rescue Public Safety Communications Center;
Battalion Chief Joe Bailey, Fairfax City, Virginia, Fire and Rescue;
Lisa Thompson, Radio Systems Manager, Arlington County, Virginia, Public Safety Communications Center;
Deputy Chief Matt Partlow, Loudoun County, Virginia, Fire and Rescue Communications;
Randal Browning, Communications Coordinator, Fauquier County, Virginia;
Philip Myer, Emergency Services Coordinator, Fauquier County, Virginia;
Assistant Chief Dennis Raines, Marine Corp Base, Quantico, Virginia, Fire Department; and
Chuck Thompson, Emergency Services Coordinator, Stafford County, Virginia.

1. What type of radio system does your fire and rescue department currently utilize?

Jurisdiction	Type of Radio System
Fairfax County	800 MHz
Fairfax City	800 MHz
Arlington County	800 MHz
Loudoun County	800 MHz
Alexandria City	800 MHz
Fauquier County	46.5 MHz
Quantico Marine Corp Base	140 MHz
Stafford County	450 MHz
Prince William County	154 MHz currently

2. If not an 800 MHz system is your organization contemplating such a change?

Jurisdiction	Response
Fauquier County	Yes December 2003
Quantico Marine Corp Base	No
Stafford County	No
Prince William County	Yes April 2003

3. What are your major concerns regarding fire and rescue service radio communications?

Response/Comment	# of times suggested
Interoperability	7
Coverage	4
Safety	2
Technology upgrades	1
Radio Discipline	1
Training	1
Quality	1
Reliable	1
EMD	1
Too Crowded	1
Capacity	1
Staffing Levels at EOC	1

4. How did your department implement their 800 MHz radio system? What worked well? What did not work well? What would you do different?

Response/Comment	# of times suggested
TTT	2
Phased in	2
Radio users group formed	2
Training is key	1
3 month training at EOC	1
Power Point/handouts	1
More training needed	1
Took time, did not rush into it	1
More training needed	1
Went to the users (station)	1
Training feedback forms	1

5. What were the major issues associated with transitioning to an 800 MHz radio system?

Response/Comment	# of times suggested
Too much, too fast, i.e. 800 MHz, new SCBA, MCT's	1
Change, i.e. echoing/delay	1
Accepting change, i.e., analog to digital	1
Everyone having a portable – radio discipline needed	1
Resistance to change – completely different technology	1
Inventory control – more radios, assigned to specific apparatus	1
Paging/toning of volunteer members	1
Maintenance cost or two systems 800 MHz and 154 MHz	1
Coverage problems (repeaters)	1
Training	1
Implemented system without being complete	1
CDPD cost $40.00 per month per unit	1

6. How did the change to an 800 MHz radio system impact fire and rescue operations?

Response/Comment	# of times suggested
New operational policies needed	1
In-building coverage an issue – use of talk around channels	1
Reduced radio congestion - 3 channels to 15 channels	1
Improved quality	1
Safer environment since everyone has a portable	1
Sublevels an issue – need for talk around channels	1
More places (channels) to talk, you may lose someone – accountability tracking	1
Lots more channels – capacity	1
Frees up dispatch channel	1
Supplemental information available from CAD	1
Made dispatching easier	1
Safer with emergency activation feature and unit identifier	1
User knows if he is now out of range (honk)	1
More channel capacity – smoother operation	1
Lack of radio discipline	1

7. What features do you think should be incorporated into the technological upgrade of the PWCDFR radio system?

Response/Comment	# of times suggested
Mobile Data	9
AVL	6
Vehicle repeaters	1
BDA Bi-directional amplifier	1
Sufficient Tower sites coverage	1
Repeaters – coverage	1
Status change heads	1
Designated mutual aid channels	1
Mapping programs	1

8. How would you implement an 800 MHz radio system in a fire and rescue department such as Prince William County?

Response/Comment	# of times suggested
Effective training	5
Form a users' group	3
In phases	2
Present realistic expectations, limitations, systems capabilities	2
Obtain leadership buy-in	2
Hire consultant to be on-site to assist	2
Develop a feedback mechanism for problems/issues/recommendations	1
Sell it	1
Go slow	1
Single keeper of ID's	1
Formal forum	1
Buy-in from all agencies	1
Patience	1
Have a backup system available – i.e., repeaters lock up	1
Assign portable at training classes	1
Use technical types with training	1
Determine portable features ahead of time, disable the ABC switch	1