

APPENDIX B: FIRE DEPARTMENT COMMUNICATIONS - EXPERIENCES FROM THE FIELD

The information contained in this appendix was gathered from a variety of sources. Much of the information comes from fire department management studies previously undertaken by TriData Corporation. Some information comes from individual fire department annual reports, websites, or other fire department literature. Wherever possible, the information from these studies was verified with the fire department to ensure that the most current data was reflected in this report.

TABLE 1: EXPERIENCES FROM THE FIELD – DEPARTMENT OVERVIEW

Jurisdiction	Resident Population ¹³	Land Area ¹ (sq. mi)	Land Area Protected	Fire Department Type	Uniformed Employees	Communications System
Austin, TX	656,562	252	Urban	Career	979	UHF (450 MHz)
Bellingham, WA	67,171	32	Urban/ Suburban	Career	140	VHF
Boston, MA	589,141	48	Urban	Career	1,600	UHF (483-MHz Conventional)
Boulder, CO Rural Fire Department	18,000	25	Suburban/ Rural	Combination	8 FTE; 35 Volunteer	VHF (153–155-MHz)
Brighton, CO	20,905	17	Suburban/ Rural	Combination	9 FTE; 60 Volunteers	UHF (400/800 MHz Trunked)
Charlotte, NC	540,828	242	Urban	Career	890	UHF (800 MHz Trunked)
Chicago, IL	2,896,016	227	Urban	Career	4,000	VHF (Conventional)
Clark County, NV	1,375,675	8,000	Urban/ Rural	Combination	1,300 Career; 400 Volunteer ¹⁴	UHF (800 MHz Trunked)
Dallas, TX	1,188,580	385	Urban	Career	1,700	UHF (400 MHz)
Detroit, MI	951,270	139	Urban	Career	1,296	UHF (400 MHz)
Everett, WA	91,488	48	Urban/ Suburban	Career	158	VHF
Fairfax County, VA	969,749	395	Urban/ Suburban	Combination	1,166	UHF (460/800 MHz Trunked))
Gettysburg, OH	3,700	60	Rural	Volunteer	50 Volunteers	VHF (154-MHz)
Los Angeles, CA	3,694,820	469	Urban	Career	3,200	UHF (800 MHz Conventional)
Milwaukee, WI	596,974	96	Urban	Career	1,100	UHF (400 MHz)
Phoenix, AZ	1,321,045	475	Urban	Career	1,366	UHF (Conventional)
Pittsburgh, PA	334,563	56	Urban	Career	896	UHF
Portland, OR	529,121	134	Urban	Career	680	UHF (800 MHz)
San Antonio, TX	1,144,646	412	Urban	Career	1,018	UHF (800 MHz Trunked)
San Diego, CA	1,223,400	324	Urban	Career	1,100	UHF (800 MHz)

¹³ Data from U.S. Census 2000 was used for consistency and comparison. Data may not agree with that reported by the jurisdiction.

¹⁴ Many fire departments that operate within Clark County, NV including but not limited to Las Vegas, North Las Vegas, Henderson, and the Clark County Fire Departments. These numbers are estimates, based on information gathered from department websites.

Jurisdiction	Resident Population ¹³	Land Area ¹ (sq. mi)	Land Area Protected	Fire Department Type	Uniformed Employees	Communications System
San Francisco, CA	776,773	49	Urban	Career	1,700	UHF (800 MHz)
Schaumburg, IL	75,386	19	Suburban	Career	138	UHF (800 MHz)
Springfield, NJ	14,429	5	Suburban	Combination	33 Career and Volunteer	UHF (470 MHz)
Wichita, KS	344,284	136	Urban	Career	371	UHF (800 MHz Trunked)

Austin, TX

The all-career Austin Fire Department (AFD) serves a population of 663,000. Its nearly 1,000 uniformed firefighters operate out of 39 fire stations strategically located throughout the department's 234-square-mile response area. That area includes portions of two neighboring counties (Travis and Williamson) as well as Austin-Bergstrom International Airport.¹⁵

Located in the Central Texas hill country, Austin is approximately 230 miles from Mexico and less than 200 miles from Dallas, Houston, and San Antonio. It is also the State Capital of Texas.

Its downtown area has high-rise buildings (8 – 10 of which are over 20 stories), below-grade structures such as tunnels (Capitol building), basements, and underground parking garages, and diverse terrain—all of which pose communication challenges. Austin is also home to many computer chip manufacturing plants.

For the past 15 years, radio communications have been spread over six radio channels on the 450 UHF band. One channel is designated for dispatch, while the other five are devoted to tactical operations. Channels are assigned geographically, and each channel has a repeater.

Communication problems are sometimes encountered by the fire department. Some are technical issues related to various structures (e.g., high-rise buildings, tunnels, concrete buildings, etc.) and others are related more to interoperability – where communications with other city departments or neighboring jurisdictions is sometimes compromised. Overcapacity and training are not issues, as the department conducts training programs and employs standard operating procedures (SOPs).

To remedy the interoperability problem, the Austin's public safety agencies are upgrading to an 800-MHz trunked system. Reconfiguration to the 800 MHz is expected to solve the interoperability problem. The improvement in interference may be achieved through a modified system design and infrastructure and should improve other interference caused within structures, as well.

¹⁵ Austin Fire Department Fact Sheet (www.ci.austin.tx.us/fire/fdfacts.htm). Data may not agree with that reported by the U.S Census 2000.

Bellingham, WA

The Bellingham Fire Department (BFD) provides fire suppression as well as emergency medical services. Bellingham, Washington, is located in Whatcom County, which is the last county on the Washington coastline bordering British Columbia. Bellingham's full-time, career firefighters serve a population of approximately 78,000.¹⁶ This includes citizens of Bellingham and some fire protection districts in unincorporated Whatcom County.

Bellingham is 90 miles north of Seattle and 50 miles south of Vancouver. To the east are the Cascade Mountains, and to the west is Puget Sound. The area covered by the BFD has a diverse topography with extremely mountainous areas to the east, and wide lowland floodplains near the marine shoreline. The BFD is the primary provider of emergency ambulance service throughout the county, and frequently responds to areas deep within the county where radio coverage is limited.

Currently, the BFD uses a VHF radio system with relatively good coverage of their response area. However, the department reports various "dead spots" within the city where firefighters cannot communicate with dispatch or with one another. There is one particularly troublesome spot—a large mall in the City where firefighters cannot communicate using their portable radios and where pagers will not activate. For all incidents above a second alarm, the BFD uses mutual aid companies from nearby jurisdictions. All of these companies are dispatched by the same communications center, which facilitates communications prior to and during incidents.

Like many departments, the BFD reports that communications from below grade are intermittent. In addition, communications with the Police Department are difficult, due to the lack of interoperability between the two agencies' radio systems.

With such close proximity to the Canadian border, there is a limit on the strength of the radio signals the BFD can use. A recent communications study for Whatcom County recommended transitioning all emergency service providers in the county to an 800 MHz system; the BFD is working with the county to identify possible sites for radio towers and repeaters. . In the interim, they are exploring the possibility of installing a repeater near the mall to improve communications in that part of the City. The Department also uses Nextel cellular phones. However, after an earthquake several years ago, they discovered that the radio system functioned, but the Nextel phones did not.

In addition, BFD personnel reported difficulty using portable radios while wearing PPE (personal protection equipment), particularly gloves. To address this problem during emergency incidents, all BFD radios are programmed so that the first and last positions on the frequency dial are the same and are a channel that is always monitored by dispatch. With this scheme, if a firefighter becomes trapped or disoriented, etc., and

¹⁶ The population served differs from the resident population as report by the U.S. Census 2000 because the Bellingham Fire Department protects citizens in parts of unincorporated Whatcom County.

cannot communicate with units on the scene, he can always communicate with the dispatch center.

Boston, MA

The Boston Fire Department (BFD) is one of the oldest career fire departments in the United States. Its 1,600 firefighters serve in 35 stations, protecting 575,000 people spread over 47 square miles.¹⁷

The fire department operates a conventional UHF 483 conventional system. One channel is dedicated to dispatch and four channels are for fire operations (all with repeaters). Each channel operates in duplex mode. There are 20 satellite receivers strategically placed throughout the city to support communications. The system has additional capabilities for use in tunnels and underground areas; special receivers and transmitters are dedicated to subterranean communications.

Imperfections within the system design has led the department to upgrade or replace some of its communication system equipment – base stations, receivers, etc. Essentially the department now has a new infrastructure.

Prior to the upgrade, BFD was plagued with unwanted signals out of the system. Like other cities, Boston experiences dead spots in high-rise buildings and basement or sub-basement areas, as well as in some residential structures. The hilly terrain tends to cause dead spots in residential areas. To combat this problem, the BFD uses transmitter steering, which moves communications from one transmitter to another.

Communications in underground structures also presents a problem. For more than a decade, the City of Boston has been undergoing major transportation changes. The plan is to eliminate the Central Artery, an elevated six-lane highway that runs through the center of downtown, with an underground expressway directly beneath the existing road. This project is known as “The Big Dig.” This new tunnel will present considerable challenges to the public safety departments of Boston, including the fire department.

The walls of the tunnel create a man-made barrier to radio frequency signals that carry radio communications. In 1995, when the construction the Ted Williams Tunnel, which extends from Logan Airport to the Greater Boston area, was complete, the City implemented a state-of-the-art communication device (i.e. leaky cable) that could operate 31 channels simultaneously. The city installed a leaky cable running along the roof of the tunnel. A leaky cable is a “by-product of conventional coaxial cable with small slits cut through its layers that allow RF signal to seep out in amounts strong enough to cover small areas of square footage.” [296]

Many new buildings in Boston have bi-directional amplifiers incorporated within their structures. Bi-directional amplifiers, commonly known as BDAs, are used for

¹⁷ Boston Fire Department Overview (www.cityofboston.gov/bfd/overview/overview.htm). Data does not agree with U.S. Census residential population data.

improving/correcting portable radio communications to, from, and within (large) structures. These BDAs provide the fire department the ability to operate all four fire department channels within a building.

Interoperability is another serious issue in Boston. Boston is part of a metro fire district that includes 34 other cities and towns. The district lacks a system for direct communication with all of the other departments. When a major incident occurs, a BFD chief, acting as the incident commander, will be collocated with an incident commander from another department.

Boulder, CO Rural Fire Department

Boulder Rural Fire Department is located to the north of the City of Boulder in unincorporated Boulder County, Colorado. It protects a population of approximately 18,000, spread over 25 square miles. The region is suburban and rural, and includes mountains, heavily forested areas, as well as some light industrial areas.

The Boulder Rural Fire Department is a combination department, with volunteer and career personnel. There are eight full-time paid staff and more than 35 volunteers who work out of two fire stations.

The department operates on a VHF 153–155-MHz radio system. It is suitable to the local geography and terrain as its signals readily bend around obstacles. Each firefighter in the department carries a voice pager. Portable radios are located on each seat of the fire apparatus ensuring that each person staffing apparatus (e.g., fire engine) has a portable radio.

The area is a mixture of mountains, valleys, and flat terrain. In the mountains, communications are sometimes limited, and in some cases, blocked out entirely.

Both the shadowing of the mountains and limited numbers of repeaters often lead to these communication problems. Yet, the fire department reports that these pockets of limited radio communications are small enough to not cause serious problems. Most large ranges of dead spots are restricted to unpopulated areas.

Where communications are problematic, the department uses “human repeaters.” That is, each portable radio carried by a firefighter rebroadcasts or radiates the signal. Mobile repeaters are never used.

Another issue for the Boulder Rural Fire Department is interoperability. All of the surrounding counties use the 800 MHz radio systems. Therefore, firefighters from the Boulder Rural Fire Department are not capable of communicating directly with other firefighters working on an incident.

Brighton, CO

Brighton, Colorado is located approximately 20 miles northeast of Denver. The combination Greater Brighton Fire Protection District (GBFPD) has nine career and 60 volunteer uniformed personnel. The district is adjacent to Denver International Airport (DIA) and encompasses approximately 160 square miles of mostly rural Adams and Weld Counties, with a total population of 25,000.¹⁸

Recently, the GBFPD migrated from a 400 MHz radio system to an 800-MHz trunked system. However, due to the large number of volunteer personnel who rely on pagers, the District continues to simulcast its dispatch information on the 400-MHz band to activate those pagers. Nextel is gaining popularity in the region, particularly as more tower sites are added.

The GBFPD is currently working out some coverage issues with the 800 MHz system. Additional radio towers have reduced the number of “dead spots,” but communications into and out of schools in the district remain a problem.. For interior operations, the district generally uses simplex mode, rather than the trunked system, to enhance communications.

Interoperability in the region is also a struggle, as the high cost of 800MHz has deterred many city agencies and surrounding jurisdictions from adopting it. Several departments continue to use 400 MHz, while nearby Weld County remains on its 100 MHz system.

Finally, the emergency activation feature of the radios is not enabled; the district is in the process of developing procedures for emergency radio communications, e.g., Mayday situations.

Charlotte, NC

The City of Charlotte, N.C. is home to over 500,000 people who live within the 242 square miles of urban land area. It is surrounded by rolling hills.

According to the Charlotte Convention and Visitors Bureau, nearly 300 Fortune 500 companies have offices in Charlotte, as do 340 foreign firms.¹⁹ The downtown includes high-rise buildings and other large structures (e.g., convention center, football stadium, etc.). There are no underground tunnels or subway systems.

The all-career Charlotte Fire Department provides services throughout the City of Charlotte and Mecklenburg County. It protects a population of over 600,000 and covers 270 square miles. There are 890 uniformed personnel in the department.

¹⁸ The City of Brighton has a resident population of 20,905. The remaining population served by the GBFPD is from Adams and Weld Counties.

¹⁹ Charlotte Convention and Visitors Bureau (www.charlottecvb.org/visitor.cfm.)

For the past 14 years, the fire department has used an 800-MHz trunked system. The entire city government of over 11,000 people is on the network. The fire department operates on 28 channels, shared with the police department. Each firefighter has a portable radio.

Like many fire departments around the nation, Charlotte reports problems with transmitting signals outside of a high-rise building or basement structure. It is testing a mobile repeater to alleviate this problem. To date, it has had some success with the mobile repeater. For interior operations, the department uses simplex mode – radio to radio – to communicate to, from, and within a building or structure. The mobile repeater has added robustness to the core of the structure, allowing better communications among firefighters on the simplex mode. Without the mobile repeater, the portable radios do not have the strength to reach the stationary repeaters.

Interoperability between outlying counties is another problem. As a solution, the city has provided neighboring jurisdictions with Charlotte radios.

The Charlotte Fire Department does not have overcapacity troubles. The department has standard operating procedures designed to shut down various parts of the system (i.e., private line on the radio, interconnect system, etc.) to ensure no overcapacity.

Lastly, a proposal to improve fire communications in high-rise buildings by requiring a built-in communications infrastructure was defeated.

Chicago, IL

The Chicago Fire Department is one of the premier firefighting organizations in the world. It is one of the largest in the United States with nearly 4,000 uniformed personnel, protecting 3 million citizens over nearly 240 square miles. In addition, the department provides fire suppression services to one of the world's busiest airports – O'Hare International.

Communications are provided to the Chicago Fire Department by a separate department, the Office of Emergency Communications (OEC), otherwise known as the "9-1-1 Center."

Chicago uses a conventional VHF system with two dispatch channels, one reaches citywide. Three simplex channels are used for fire operations and one command channel. Company officers all carry portable radios, and the department is in the process of issuing more – one radio for every two persons.

As a whole, the Chicago Fire Department reports that it experiences few communication problems because it deploys a multi-simulcast radio system and 10 transmitter sites (per channel). The system has diversity: up to 32 receivers are within any 12 square miles area. Unlike many urban departments, Chicago has no plans to change its communication system to 800 MHz. Because of number of receivers around the city, communications with dispatch via portable radios functions well.

One challenge the department has is the inability of the fire department to talk directly with law enforcement and emergency medical services (EMS), which they operate on a different radio system (UHF). EMS and the fire department respond jointly on most incidents, so the fire department does have some access to the UHF system. A more permanent solution to this problem is being worked on, which will use technology to patch the systems together. The department deploys a command vehicle to every major incident. These vehicles have a suite of radios installed for communications by the incident commander with the various departments (e.g., fire, EMS, police, etc.).

Considering the large number of high-rise buildings, the Chicago Fire Department is advocating built-in infrastructure within the structures. Currently, most in-building coverage is achieved with portable, simplex radios. There are occasional “dead spots” within some high-rise structures, basements, etc. These are considered “incident specific problems,” not system-wide.

Subway communications are accomplished on a UHF frequency (same as law enforcement and EMS). As a result, the fire department cannot use its radios to communicate within the subways with the necessary authorities. In such instances, department personnel use EMS radios.

Clark County, NV

Clark County is located in southern Nevada. On a regional level it has a population of more than 1.5 million residents spanning an area of 8,000 square miles. Most of the population lives within the Las Vegas valley. Some of its incorporated areas are Las Vegas, North Las Vegas, and Henderson. The county includes both urban and rural areas.

The Southern Nevada Area Communications Council, also known as SNACC, manages most fire department communications, including those for the City’s of Las Vegas, North Las Vegas, and Henderson and unincorporated Clark County. SNACC was created as a Joint Powers Authority by each of these jurisdictions. Each municipality buys into the system and pays annual operating costs. The communications network managed by SNACC covers approximately 4,000 square miles.

Each department operates on an 800-MHz trunked radio system. There are a total of 20 channels, with mobile radios are located in each piece of fire apparatus. Portable radios are located on each seat of the fire apparatus ensuring staffing personnel a means of communication.

Despite its desert environment, Clark County has high mountains that make communications difficult. The tallest mountain is 12,000 feet. There are some others that reach heights of 9,000 feet.

Casinos and other high-rise buildings present challenges. There are many in-building coverage issues. The size and construction of the buildings can shield RF signals, and, the Casinos are often very noisy (a combination of lots of people and slot machines), making it difficult for firefighters to hear radio communications. Interference from the Casino’s

own communication systems can disturb the fire department radio system. Lastly, each casino has at least one below ground level, in the basement.

To manage the communication problems, SNACC and the local fire department sometimes post a firefighter in the security office of a casino to use both the fire department radio communications and the built-in communications system of the casino.

Many of the casinos and other large buildings are wired with radio accessories, such as bi-directional amplifiers. SNACC and the participating fire departments recently purchased mobile repeaters. They have not been tested.

Like many other areas around the country, Clark County is experiencing interference with wireless communications towers, most notably Nextel. The county is awaiting final approval between the Federal Communication Commission and Nextel on a plan that addresses interference to public safety communications in the 800-MHz band. This plan is known as the Joint Commentors' Consensus Plan.

The goal is to eliminate interference to public safety communications on the 800-MHz band; to cause minimum disruption to existing services; and to provide sufficient spectrum for public safety users. It divides the 800-MHz band into two separate blocks of channels. The first is intended for public safety. The other block of channels would be used for Nextel and its wireless communications.

Dallas, TX

Dallas is one of the largest cities in the Southwest, and the seventh largest in the U.S. It is a major business and financial center, and also one of the top convention cities in the United States.²⁰ It has numerous tall buildings, (with 25 buildings greater than 30 stories). The elevation of the city is between 450-750 feet, and there are many below ground structures, such as basements, sub-basements, and parking garages.

Dallas Fire-Rescue (DFR) covers 378 square miles and a resident population of approximately 1.2 million. The department operates out of 55 fire stations, and currently has nearly 1,700 uniformed firefighters.

DFR operates on a 400MHz UHF radio system. Each firefighter has a portable radio. There are four simplex channels for operations. The simplex channels are limited by distance. Interior fire operations sometimes create a communications problem. To communicate outside a structure, DFR sometimes has to relay the message via a runner through an egress stairwell. .

Police and fire can communicate with each other, through a "patch system." Dispatch will patch police and fire together, and they can talk directly to one another.

²⁰ The Dallas Convention and Visitors Bureau (www.dallascvb.com/visotrs/today.php.)

The department has done some investigative research and considered upgrading to an 800 MHz radio system. However, the upgrade has not been pursued due to a lack of funding, and also because the department concluded that the 800 MHz radio system did not meet the needs of the city for 95 percent coverage.

Detroit, MI

Detroit has a residential population of over 950,000 across 139 square miles. The Detroit Fire Department (DFD) protects the city's population with nearly 1,300 career firefighters.

DFD uses a 400 MHz radio system, which has been in place for nearly 30 years. The Department is responsible for fire as well as EMS dispatching. Currently, DFD has one repeated channel for dispatch, four fire operations channels, and one channel for EMS. Some tactical fire operations channels are also repeated.

Commanding officers for each fire company have portable radios. Personnel at or above the rank of Battalion Chief are also issued cell phones and pagers.

Most communications problems are concentrated in the downtown area due to the high number of high-rise buildings, such as office buildings, apartment buildings, and other large structures. The Department has added repeaters to buildings and other areas of the City to alleviate these problems. Nonetheless, they still occur. There was an incident reported in which a firefighter used his cell phone to contact the command post outside.

Firefighters also report equipment problems, notably that the portable radios are not waterproof. Also, they report that down tower sites and broken repeaters have hampered communications.

The department is upgrading to an 800 MHz system at the end of 2003 to be able to communicate with all city departments (such as police, etc.). Some firefighters are opposed to the upgrade, as they fear that the new radio system will not work as well in sub-basements and other structures.

Everett, WA

The Everett, Washington Fire Department (EFD) is a full-time, career fire department that protects roughly 90,000 residents. Although the City boundaries encompass 41 square miles, only 28 square miles are land, the other 14 are water. Everett is home to the USS Abraham Lincoln Aircraft Carrier Group, as well as other marine vessels. Everett's coverage area includes a Boeing aircraft assembly plant, which is the largest enclosed structure in the world. Numerous warehouses and high-rise buildings complement the array of single-family homes throughout the city.

The terrain includes hills throughout the City limits, with the northwest part of the city, along the waterfront, sitting considerably below the rest of the city. Everett is 80 miles south of the Canadian border.

EFD has used VHF radios with fairly good success. Problems with building penetration have been rare. With a portable radio, personnel can talk throughout half of the city. As a result of Canada reclaiming some of the VHF frequencies and essentially narrowing the available bandwidth, the EFD is implementing a new 800 MHz system in summer 2003, which will provide 95 percent coverage throughout the city limits.

The communications problems encountered the current system are related to limited tactical channels and operation in a firefighting environment. Specifically, the EFD only has access to its dispatch channel and one tactical channel. When simultaneous incidents require a tactical channel, the incidents will need to share the one tactical channel or one will have the tactical channel while the second uses the dispatch channel for its operations.

The EFD has experienced numerous problems due to use of full personal protective equipment (PPE) and SCBA. Members of the EFD have experienced difficulty operating the portable radio, especially the channel selector and volume control while wearing the bulky firefighting gloves that limit dexterity. Radio transmissions have been difficult to understand from the interior of a firefighting operation because voice distortion is created through the mask. Also mentioned by EFD staff is that voices are often difficult to understand because the interior firefighter transmitting is often out of breath. And lastly, since all firefighters have a portable radio when assigned to fire department apparatus, they do not cover their radio microphones or turn them off completely, a situation not recommended from both a safety and operational perspective.

The EFD reports success during radio transmission in new buildings with leaky coaxial cables. The EFD is working diligently to have some older building retrofitted with this technology to further enhance the quality of radio transmissions.

Fairfax County, VA

Fairfax County, Virginia is located just outside Washington, D.C. The county encompasses nearly 400 square miles with a resident population of approximately 970,000. The Fire and Rescue Department has 1,166 uniformed staff who responded to 89,246 calls for service in FY2002.

The county includes various structures, ranging from standard residential and commercial buildings to secure government installations (e.g., the Central Intelligence Agency's Headquarters).

The fire department currently uses an 800-MHz trunked digital system for communications with 20 available frequencies. Communications are simulcast on the department's "old" 460 MHz channel as well. Dispatch and operations are separated; units are dispatched on one channel, while day-to-day operations are handled on another. Fairfax County is acquiring 20 additional analog channels, which will provide a back-up system should the digital system fail.

For working incidents, operations and command are assigned to additional channels to avoid impinging on tactical communications. The incident commander monitors the command and incident channels, as well as a talk-around channel for structures with communications problems. Fairfax uses two available talk-around channels, which are not repeated. In the event of communications problems during an incident, the incident commander can order all units on the incident to switch to the talk-around channel.

Recently, the department purchased the Incident Commander Radio Interface (discussed in more detail in Chapter III) for use by the communications officer and to interface the talk around channels with operational channels. The department is developing Standard Operating Procedures for using the device.

The department reports that there are a variety of dead spots in the county, particularly in and around a large regional mall as well as the local trauma center. To address these issues, the county is constructing three additional tower sites, for a total of 11 throughout the county. Also, a recent ordinance requires new buildings to maintain radio coverage throughout the structure. This has been accomplished in the county's new jail, which has a combination of a bi-directional amplifier and leaky coaxial cable in the ceilings (see Chapter III for more details).

Since transitioning to an 800 MHz system, Fairfax has had one failure, where the system entered "Failsoft" (a condition where specific channels are maintained, while the majority are offline). As a result, the dispatch center is preparing contingency plans to address such incidents in the future. More on such plans can be found in Chapter III

Fairfax County's public safety is experiencing system coverage degradation from Nextel (interference). The Nextel system, also operating on the 800-MHz band, appears to be incompatible with the pre-existing systems in the 800-MHz band. One proposed solution by the Department of Information Technology is to move Nextel out of the 800-MHz band. The county is opposed to reorganizing or restructuring its public safety radio system.

The fire department, has issued some officers Nextel cellular phones. The department is in the process of purchasing these phones for all front-line suppression and EMS apparatus (medic units are already equipped with a conventional cellular phone for hospital communications).

Gettysburg, OH

The Gettysburg Rural Fire Department is a private, all-volunteer department. Located in Darke County, the department protects a population of approximately 3,700 over a 60 square mile area. The department operates out of a single fire station. Total call volume is about 190 calls per year – 110 EMS calls and 80 fire calls.

Mostly rural, and residential with some commercial structures, Gettysburg's commercial structures are privately owned farmhouses. The tallest structure is about two stories. The geography and terrain of the area is mostly flat, with some hills.

The department operates on a UHF radio system (154-MHz) that includes four tactical operations channel and one dedicated dispatch center.

The biggest challenge for fire department radio communications is interference. In Gettysburg, firefighters often encounter radio interference from the neighboring Miami County. Miami County, located to the east of Darke County, sits at a higher elevation and has higher towers. Although Miami County uses the 800 MHz radio system, it dispatches off of UHF. During its dispatches, it virtually blocks out communications to the Gettysburg Rural Fire Department.

One solution is increased system design and infrastructure for Darke County. However, due to a shortage of money, the county cannot presently afford to add more system infrastructure.

Los Angeles, CA

The Los Angeles Fire Department (LAFD) protects approximately 3.7 million people who live in the second largest city in the United States. The department has over 3,200 uniformed personnel, operating out of 103 fire stations, covering a land area over 470 square miles.

The LAFD uses a conventional 800 MHz system, which has been in place for the past decade. Every firefighter is issued a portable radio while on duty. There are 18 channels; three of which are dispatch channels broken down by Metro and Valley area. The city is divided into three regions, and each has a channel. There is also one command channel for the chiefs.

The location of a Nextel tower is one challenge for the department. The Nextel operates on the same frequency and can cause radio interference.

It is hard to maintain radio coverage for a city of this size and diverse topography, Hills and mountains present challenges. These general challenges do not regularly occur... Still, the LAFD has worked carefully on the strategic placement of towers and repeaters to address coverage concerns. And, in those are where dead spots are more frequent, the city has back-up repeater sites. .

A common problem in many cities, communications in subways and tunnels present few challenges for the LAFD because the subways and tunnels are wired with underground cables, which carry a signal for four or five of the fire department channels.

For major incidents, the LAFD reports no operational problems with the communication system per se; problems the department experiences are more of logistical issues. The system can handle the capacity, but since multiple channels may be used at the same time, firefighters are not always on the correct channel.

Interoperability is another difficulty for the fire department. Because the police and public works departments operate on a different radio system (500 MHz UHF band), the fire department cannot communicate directly with these departments.

Milwaukee, WI

The Milwaukee Fire Department protects a population of about 600,000 spread over 96 square miles. There are 1,100 sworn personnel in the department.

Currently, the Milwaukee Fire Department (MFD) uses a 400 MHz system with eight channels. Two channels are dedicated to dispatch; one is the main dispatch channel and the second is for the officers on the fireground to call dispatch. Five other channels are for fireground only. There is no interoperability with other city agencies.

Overall, the communications system works about 98 percent of the time. The technology and equipment were not reported as issues.

There are some spots (e.g., buildings and basement levels) where equipment does not work. For high-rise structure fires (anything over five stories), it is the department's policy to put the command center in the lobby of the building (if it is safe to do so). Typically, there is good communication within the building. If they experience problems, they will use a runner.

The single biggest problem the department has with communications is human error: firefighters do not know what channel they are on and do not communicate frequently with incident commander. The department considers this problem to be an issue of accountability and not a training problem.

Phoenix, AZ

The Phoenix Fire Department protects a population of nearly 1.4 million across 500 square miles. It has over 1,366 sworn personnel that operate from 47 fire stations. In 2002, the fire department responded to 133,519 calls – 104,635 EMS calls and 28,884 fire and non-EMS calls.

Currently, the fire department uses a conventional direct radio communication system in VHF. The primary infrastructure – two tower sites above the North Mountain and South Mountain and diversity receivers – does not use repeaters. The diversity receiver operates like a small radio tower and receives the emitted radio signal on several antennas. The department operates 24 VHF channels and there are 36 diversity receivers per channel.

The department has had much success with this system. However, there are some challenges. High-rise buildings, basements, and any other structure with dense concrete may cause communication problems. With this system, the two major difficulties are fade and feedback. Where people are clustered together and one person transmits, there is lots of feedback. Fade is more related to the distance between one radio transmitting a signal and the other receiving it. The sound is usually muffled and difficult to understand.

Like many departments, Phoenix has problems using portable radios in a hostile environment, a working fire incident with zero visibility and wearing full personal protective equipment. The Phoenix Fire Department had a fire fatality a few years ago. The Department determined three factors the department needs to ensure firefighter safety – airway management, firefighter rescue techniques, and radio communications. The firefighter did issue a “mayday,” and was heard over the radios. The fire department could not locate and rescue the firefighter before his death.

Dead spots are, for the most part, not a problem for the fire departments. The diversity receivers are strategically located throughout the City. There are a lot of them. Each receiver has the ability to receive a radio signal from within a 2-mile radius.

The City of Phoenix is incorporating an 800 MHz digital trunked radio communications study. This is not the fire departments preference, but rather a recommendation that was made by a consultant for the police department. In addition, there is a big cost savings for the City to operate on the 800 MHz system. The City only has to operate and support one radio system. Also, there is less combined infrastructure. The system is being split by Phoenix and Mesa, Arizona.

The conventional VHF radio system with diversity receivers has been successful. The fire department reports effective use on the fireground. While each channel on the 800-MHz trunked system is repeated, it must reach a tower to communicate. That is not the case for the current system. Even if simplex or talk-around channels are built in to the system (part conventional), firefighters wearing full PPE still have difficulty changing channels in a dark, hostile environment.

The department reports that transitioning to the new communications system puts firefighters lives at greater risk. The Department must train each firefighter on the new system, whole changing current behaviors and adapting new ones for the current system. Training is to begin soon on the new system, before it is implemented in 2005.

Pittsburgh, PA

Pittsburgh, a mountainous city, covers 57 square miles. The Pittsburgh Fire Department serves a population of 360,000. The largest concentration of commercial activity is in the downtown area where there are numerous high-rise buildings.

The fire department is part of a centralized UHF communications system for all city services—emergency, police, fire, etc, with a single, centralized dispatch. However, a single channel is dedicated to fire dispatch, another to fire ground communications, and then additional channels are available on demand, whenever necessary. This flexibility to use more or less channels has proved helpful for the department in the past.

Large and high-rise structures, below grade structural areas, and tunnels areas pose the greatest communications problems for the Pittsburgh fire department. If the firefighter inside cannot communicate to the outside, the department bypasses the repeaters and goes to two-way radio talk around system for communications. The department uses these

radios in other situations as well, whenever the mountains interfere with reception on the larger system. Pittsburgh's talk around radios have a ½-mile communications radius. Cell phones and pagers are used strictly for administrative purposes, although most of the firefighters carry one or the other.

The communications system for the City of Pittsburgh seems to work well. Department staff have noted that an improvement it would be "portable radios with built-in repeaters" for the fireground.

Portland, OR

Portland has a population of over 525,000 within city limits, and 1.8 million living within the metropolitan area. The city is approximately 130 square miles, situated 50 miles inland on the Columbia River midway between the Coast to the west and Cascade Mountain range to the east. The Columbia River is quite wide and Portland has one of the West Coast's largest ports. The city is surrounded by the West Hills. Also in the vicinity of the City are Mount Hood and Mount Saint Helens, two volcanoes over 10,000 feet.

Portland has a citywide consolidated communications system on an 800 MHz Motorola "Smart Zone" system. Set up in 1994, the system has had several software upgrades.

There are 13-talk group channel and 1 administrative channel for the fire department. It is estimated that the system is running at 40 percent capacity. Each company has a mobile data terminal and three portable radios. The officer, the driver, and one two-person team have a radio (apparatus are staffed with four personnel). The city has four primary simulcast transmitter sites and 11 small repeaters. A fifth transmitter site has been planned, but has not been put into operation.

The terrain surrounding Portland creates communication problems in shadowing and dead spots. To curb such difficulties within the central area, the city placed a large antenna above the West Hills. Coverage is still a problem in high-rise buildings, basements and sub-basements, and the light rail system underground tunnels. The tunnels have built-in antenna system, which alleviates most of the communication problems.

In addition, the harbor provides significant communication problems. The fire department has many shipboard incidents and while the port also has antennas and other communication support equipment, communications are a problem below deck.

To resolve some of its communication challenges, the department uses its simplex talk around channels in areas where communications are challenging. The department has created specific SOPs for such incidents, and trains on them as well. The Department is also in the process of acquiring mobile repeaters for chief vehicles.

The city also experiences problems with the Nextel cellular phone system. As with other departments, the Nextel system, also operating on the 800-MHz band, is incompatible with the pre-existing systems in the 800-MHz band. To prevent major interference with fire department communications, Nextel and the fire department swapped frequencies to

resolve the problem. The fire department gave up a channel on the end of their radio band for Nextel's channel in the middle of the city's band.

San Antonio, TX

The City of San Antonio is the ninth largest city in the United States and third largest in the State of Texas. It has a population of over 1.1 million and a land area of more than 400 square miles. The San Antonio Fire Department serves the City with more than 1,000 uniformed firefighters operating out of 48 fire stations.

San Antonio is large, so, the fire department often provides fire protection and response to its many high-rise buildings (some 30-40 stories) and other large structures such as the Alamo Dome, SBC Center, a Convention Center, Coliseum, etc. There are no underground tunnels or transportation systems.

The San Antonio Fire Department uses a Motorola Simulcast System (UHF), with eight channels: one dedicated for dispatch, two for EMS, and the remainder for tactical fire operations. Each channel is repeated.

The city is upgrading to an 800-MHz Trunked system by the end of this year. It is upgrading because the old system is antiquated. Some parts are no longer made for the radios and other equipment is outdated. The radios are also less resistant when exposed to hazardous conditions, such as water.

There are no inadequate system capacity issues in the department. . However, there are some "dead spots" in the city, scattered about. There are also dead spots in some of the unincorporated type areas outside of the City (where the SAFD provides service). It is believed that the dead spots are generally caused by a lack of infrastructure – not enough repeaters, transmitters, etc. The department believes that adding new infrastructure (as part of the new 800 MHz upgrade) and strategically placing towers and repeaters, will resolve some of these issues.

Interoperability is important communication problem for the department. The fire department cannot communicate with other city agencies or neighboring jurisdictions. In order to communicate with other city department, the dispatch center will "patch" the various departments together.

The 800 MHz system has already been tested in the city, with 95 percent coverage. The All city agencies will be on the 800 MHz system, possibly the county's sheriff's office too. Other jurisdictions, if they choose, may also be on the city's system (by leasing space from the city). The new system will have a lot of built-in infrastructure – 11 Tower sites. The city will own the entire infrastructure. Each firefighter will be issued a portable radio.

San Diego, CA

The San Diego Fire-Rescue Department (SFRD) consists of 1,100 uniformed personnel who operate out of 44 stations and serves a population of 1.3 million people across 330 square miles. The Department's response area includes high-rise buildings, warehouses and other "typical" city hazards as well as miles of beach and shoreline.

The department uses a Motorola 800 MHz system, which has been in place for 11 years. The operations units also carry VHF portables because neighboring departments (to which SFRD provides mutual aid) use this system. Dispatch and operations channels are separate; channels are assigned by geography. Each battalion (7 total) operates on its own channel. There is also one channel for all medical calls and one channel for all traffic incidents. Each channel has repeaters that are located throughout the City, either on mountaintops, high-rise buildings, etc.

Until recently, SFRD used a VHF communications system. Unfortunately, the city was unsuccessful in eliminating VHF interference from Mexico and has since migrated to the 800 MHz system.

The 800 MHz system works, but the major challenge for the city is to train 1,000 firefighters and 2,000 police officers to use it. The system is more complex than the one it replaces, and there are some in the department who are very good with the radios while others are not.

To combat dead spots in structures, the department will use firefighters as mobile repeaters. In other words, a firefighter will stand at a stairwell support (within line of sight), another firefighter will be below him, etc. and the message is repeated to the outside.

For the Super Bowl, the department used a Mobile C.O.W. (Cellular on wheels), which acts as a mobile antenna to allow communications to be repeated outside a building. This technology is also used for the San Diego Convention Center. The Mobile C.O.W. is run through an underground tunnel, beneath the convention center.

Cruise ship fires also pose a challenge – ships have a radio on each deck at each door. The department typically needs to set up firefighters as mobile repeaters to facilitate communications.

The department also uses cell phones and issues personnel alphanumeric pages. Senior staff is issued Blackberry wireless devices.

San Francisco, CA

San Francisco has a population of more than 775,00 spread over a small area, 49 square miles. The San Francisco Fire Department (SFFD) has more than 1,700 uniformed personnel operating out of 42 stations.

The city operates an 800 MHz radio system and has for the past eight years. Prior to that, the city was using an older Motorola 400 MHz system. The newer system allows the department to have more working channels and interoperability. There are 16 channels; three controlled for dispatch. Each battalion has an assigned channel. There are 10 battalions.

Despite the upgrade, the radio system is still limited inside high-rises. Dead spots still exist, but most have been eliminated.

The department has added more towers and repeaters. It is currently upgrading the system with portable repeaters. The city is moving repeaters to higher areas of the city, to prevent interference from other high-rise buildings.

BART, San Francisco's underground public transportation system (subway), does pose some communication problems for the SFFD. Radios for BART are issued to fire stations located near subway stations. These radios are also carried by some Battalion Chiefs.

There is no interference from the shipping channels.

Schaumburg, IL

The Schaumburg Fire Department (SFD) , a full-time career fire department, is located approximately 30 miles northwest of Chicago. Schaumburg has a resident population of approximately 75,000 people and encompasses roughly 20 square miles of mostly flat terrain. The SFD response district includes single-family residences, multi-story residential structures, including hotels, and high-rise commercial office buildings.

The SFD has used 800 MHz technologies since 1988. Its initial 800 MHz system had one antenna site for the entire Village. A new system, which went on-line in April 2003, uses four antenna sites. Under its old system, the SFD experienced numerous dead spots throughout the Village where firefighters could not receive nor transmit radio traffic. Personnel of the SFD also had difficulty transmitting out of and into structures that used Lexan glass as windows or buildings that used significant amounts of concrete in construction.

Most of the radio/communication problems the SFD experienced were in high-rise structures, which typically employ large amounts of concrete and Lexan glass during construction. The only reliable way the SFD could transmit out of high-rise structures was if the firefighter stood at the window. The SFD has experienced very few problems while operating at single-family residential structure fires.

The SFD, which shares the 800 MHz system with Law Enforcement and Public Works, frequently experienced busy signals under the old system that utilized only three trunks. In its research for expanding its network of trunks, the SFD found from the FCC that few trunks are available; the SFD was able to purchase a trunk from a bus company in New Jersey that went out of business.

The new radio system and its new antenna sites have dramatically improved communications during structural firefighting events for the SFD. New building codes required signal boosters during construction for certain types of buildings. This has also helped improve communications for the SFD.

Like many departments, the SFD struggles with the portable radio and the ease of using it in a zero-visibility environment, while wearing bulky fire department gloves. The only solutions that the SFD has come up with as a precautionary measure, as have other localities, is to program the extremes of the channel selector on the portable radio (selector turned all the way left or right) to the same, recognizable channel (usually dispatch) regardless of zone selection. If the firefighters operating in a zero-visibility environment accidentally change the radio from the tactical operations channel and are not able to find the appropriate channel, they can turn the selector all the way in either direction to ensure that they will be able to talk to a dispatcher in the event they need help.

The SFD has enhanced radio interface and operability with its mutual aid neighbors by utilizing transponders on the apparatus and command vehicles that can convert VHF radio to 800 MHz and vice versa. This way, the SFD can continue to operate with only one radio system.

Springfield, NJ

Springfield, New Jersey is located about 23 miles southwest of New York City. The township encompasses 5.06 square miles of mostly flat terrain, which contains a combination of residential, commercial, and industrial structures. Springfield has a resident population of 14,250 and a daytime population of 30,000.

The Springfield Fire Department (SFD) is a combination department, comprised of approximately 33 career and volunteer firefighters and officers. The SFD currently uses a high band radio system, at approximately 470 MHz. The Chief and Deputy Chief (as well as other senior Township officials) are issued also Nextel cellular phones to facilitate communication between these officials.

Unlike many departments nationwide, the township reported that the SFD does not typically experience difficulties transmitting in and out of structures or from floor to floor. Instead, the department contends with radio interference from two neighboring jurisdictions that operate on similar frequencies. In both cases, the jurisdictions are at a higher elevation than Springfield and have higher radio towers. Depending on the weather and time of day, transmission from these departments “step on” SFD operations, making it difficult for units to transmit or receive messages from dispatch.

To alleviate issues with neighboring jurisdictions, discussions are underway to study the feasibility of trunking the current radio system because there are not enough frequencies available for the SFD to completely modify their radio system (e.g., transition to 800 or 900 MHz).

Wichita, KS

The Wichita Fire Department (WFD) serves over 340,000 residents of Wichita. The city, located in Sedgwick County, has a diverse economy that includes agricultural services, aviation, and oil and gas production. The City serves a large hinterland in central Kansas. The Fire Department covers over 136 square miles of the City. The Department provides a full range of fire, rescue, hazardous materials, and other services.

The Wichita Fire Department operates on an 800-MHz trunked system. This system has been operating for approximately 10 years. The fire department has one dispatch channel, one operations channel, seven tactical channels, one channel for Administration, and one command channel (for multi-agency use). Each company has a portable radio (company officers).

Prior to the 800 MHz system, the city had an old 2-channel system. Even with additional repeaters and other modifications, problems stemmed from a lack of channels.

All of the public safety departments within the City are connected to the 800 MHz system.

Interacting with surrounding jurisdictions, also using an 800 MHz system, is a problem for the WFD. Some of the surrounding jurisdictions are not tied into the Wichita system.

The WFD also experiences problems communicating in elevators, large buildings, basements and sub-basements, and malls. There is often difficulty in transmitting a signal. The lower level of the mall has difficulty transmitting and receiving. To reduce the magnitude of the problem, firefighters must use the “talk around” channel, or simplex mode (radio to radio).

The department has added repeaters in the past, with some success. The department knows which buildings have problems and do their best to work around them. There are relative few “dead spots” around the city.

The WFD would like to try mobile vehicles, but does not have the financing. The city does not have any built-in radio ordinances for buildings.