HOUSE JOINT RESOLUTION 588

Studying the feasibility of adopting requirements within the Commonwealth of Virginia that will ensure buildings are constructed and equipped to permit effective and reliable public safety radio communications for emergency personnel operating within them.

PREFACE

During the 2003 Session of the Virginia General Assembly, the Virginia Department of Fire Programs—with assistance from the Departments of Emergency Management and Housing and Community Development—was requested in House Joint Resolution 588 (HJ 588) to study the feasibility of adopting requirements within the Commonwealth that will ensure buildings are constructed and equipped to permit effective and reliable public safety radio communications for emergency personnel operating within them.

The goals of the study included: broad stakeholder participation and input using an open process; use of a multi-agency project team; timely completion without sacrificing quality; identifying partnership opportunities for providing the Commonwealth with substantive guidance on technology/policy alternatives; and results useable for, but not constrained by, House Bill 2529 (HB 2529) directing the:

> "Board of Housing and Community Development to promulgate regulations as part of the Building Code requiring the installation in new commercial, industrial and multi-family buildings of emergency communications equipment for emergency service personnel to facilitate effective communications between emergency public safety personnel involved in emergency situations."

The *HJ 588 Task Force* created for this study includes participants from the Department of Housing and Community Development (DHCD); the State Fire Marshal's Office (within DHCD); the Virginia Department of Emergency Management; the Department of General Services; the Virginia Department of Fire Programs; the Virginia Association of Counties; telecommunications consultants and industry representatives; local fire, rescue and law enforcement personnel; local building officials; and stakeholder organizations representing builders/owners of retail and commercial office buildings, apartments, and condominiums.

Task Force staff from DHCD and the State Fire Marshal's Office includes Emory Rodgers, Charles "Ed" Altizer, and Rick Farthing. Participants from the Virginia Department of Emergency Management include Greg Britt, Tanya Brown, Parker Winborne, and Vic Buisset. Staff assigned from the Virginia Department of Fire Programs includes Adam Thiel, Aubrey W. "Buddy" Hyde, Jr., Ron Collins, Jennifer Cole, and Christy King.

The HJ 588 Task Force gratefully acknowledges the dedication and input of all study participants who volunteered their time. Many traveled great distances to participate in multiple meetings. This acknowledgement includes those organizations that volunteered staff members to participate in this endeavor. We also acknowledge the hospitality of Chesterfield Fire & EMS, the Henrico Division of Fire, and Hanover Fire & EMS for providing meeting accommodations.

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EXECUTIVE SUMMARY

During the 2003 Session of the Virginia General Assembly, the Virginia Department of Fire Programs (VDFP)—with assistance from the Department of Emergency Management and the Department of Housing and Community Development—was requested in House Joint Resolution 588 (HJ 588) to study the feasibility of adopting requirements within the Commonwealth that will ensure buildings are constructed and equipped to permit effective and reliable public safety radio communications for emergency personnel operating within them. (The full text of HJ 588 is included in this report as Appendix I.)

Resulting from this legislation, the VDFP formed the *HJ 588 Task Force* including participants from the Department of Housing and Community Development (DHCD); the State Fire Marshal's Office (within DHCD); the Virginia Department of Emergency Management; the Department of General Services; the Virginia Department of Fire Programs; the Virginia Association of Counties;[1] stakeholder organizations representing builders/owners of retail and commercial office buildings, apartments, and condominiums; telecommunications consultants and industry representatives; local fire, rescue and law enforcement personnel; and local building officials. (A complete list of participants is found in Appendix II.)

Goals for the study included: broad stakeholder participation and input using an open process; use of a multi-agency project team; timely completion without sacrificing quality; identifying partnership opportunities for providing the Commonwealth with substantive guidance on technology/policy alternatives; and results useable for, but not constrained by, House Bill 2529 (HB 2529) directing the:

> "Board of Housing and Community Development to promulgate regulations as part of the Building Code requiring the installation in new commercial, industrial and multi-family buildings of emergency communications equipment for emergency service personnel to facilitate effective communications between emergency public safety personnel involved in emergency situations." (The full text of HB 2529 is included as Appendix III of this report.)

The HJ 588 Task Force identified three principal areas affecting the feasibility of adopting requirements within the Commonwealth to ensure buildings are constructed and equipped to permit emergency public safety personnel to utilize effective and reliable radio communications while they are within buildings.

These three focus areas include: 1) policy, 2) implementation, and 3) technology.

1. **Policy –** The public policy issues associated with requiring in-building public safety radio communications solutions are complex and multi-faceted, but not insurmountable. Local governments across the United States have adopted ordinances requiring the installation of in-building public safety radio

[1] Participation was also invited from the Virginia Municipal League.

communications solutions since 1991.[2] However, Virginia would be the first state to implement such a requirement statewide.

2. **Implementation –** In Virginia, the implementation instrument for adopting such a requirement is the Uniform Statewide Building Code (USBC) development and change process. Given the relationship between the 2003 General Assembly's direction in HJ 588 and HB 2529, the Task Force spent substantial time discussing implementation issues that will be further explored in the USBC development process. In addition, DHCD and the State Fire Marshal's Office held meetings (outside the HJ 588 study) with Task Force participants to draft sample code language for emergency communications equipment in *new* buildings—this draft language is included in this report as Appendix IV.[3]

3. **Technology –** The technology behind public safety radio communications in the built environment is inherently complex and a comprehensive treatment is beyond the scope of this study. Therefore, the Task Force focused on studying the feasibility of potential technological solutions for addressing the challenge of providing effective and reliable public safety radio communications in buildings. A variety of alternatives was explored with the conclusion that no *single* technology will apply to every jurisdiction in the Commonwealth. However, a range of technology solutions is available with applicability to almost any situation in Virginia.

[2] The Jack Daniel Company (2003) http://www.rfsolutions.com/sbwp.htm
[3] It is critical to note that this *draft* language *has not* been through the prescribed USBC development/change process and is provided in this report as an exhibit only, with no warranty of Task Force, board, or agency consensus on any of its specific provisions.

SUMMARY OF KEY ISSUES	
POLICY	***New construction—***Applying in-building technology solutions to ensure effective and reliable public safety radio communications is generally less costly in new construction (or during renovations) than in existing buildings. Typically, owners and developers have more financing options for installing emergency communications equipment in new buildings or those undergoing extensive renovation. Computerized radio system models and measurement tools are available to forecast system performance with enough accuracy to effectively design in-building solutions for new construction projects.
POLICY	***Retrofitting existing buildings—***While many of the local in-building public safety radio communications ordinances adopted outside Virginia since 1991 have retrofit provisions, requiring the installation of emergency communications equipment in existing buildings could cost between 10 and 25 percent more than the cost of installing the same technology in new construction. For building owners, securing capital for retrofitting an existing building can be difficult, unless incentives are provided by public or private entities. In the event of a fire or other emergency, however, such a system could prove economically beneficial for helping reduce property damage and life loss.
POLICY	***Target hazards—***Requiring the installation/retrofit of emergency communications equipment in buildings (new and existing) with occupancies having a high potential for life loss or property damage could prove beneficial in the event of a fire or other emergency exposing the property and its occupants to harm. Retrofit provisions for specific "high-hazard" occupancy types have been previously incorporated in the USBC.
POLICY	***Funding—***The exact cost to install emergency communications equipment in buildings across Virginia is hard to define as several variables affect installation and maintenance costs. Research for this study suggests costs can range anywhere from $0.15 to $1.25 per square foot in new construction; with an additional 10 to 25 percent for retrofitting existing buildings. If required by the USBC for new construction, these costs would likely be added to initial financing arrangements and amortized over the life of the building. Securing funds to retrofit an existing building from operational cash flows could be difficult unless financial incentives are provided by public or private entities.

POLICY	***Responsibility—***The Task Force limited their scope of work, in accordance with HJ 588, by agreeing that local jurisdictions (as the federally licensed operators of public safety radio systems) are responsible for delivering adequate radio signal to the exterior of a (proposed or existing) building *before* requiring the installation of emergency communications equipment to overcome signal degradation inside the structure. The Task Force also agreed that changes to the local public safety radio system (environmental or technological) occurring after an in-building solution is accepted by authorities should not place an undue compliance burden on building owners.
POLICY	***Local government option—***The USBC can include provisions allowing local governments to "opt-in" or "opt-out" of specific code sections. An "opt-in" code section only applies to a jurisdiction if the local governing body adopts it; an "opt-out" code provision applies to a jurisdiction *unless* the local governing body chooses *not* to accept it. Given regional and local differences across Virginia, the Task Force recommended the local government option for inclusion in any USBC action on in-building public safety radio communications, but could not reach consensus for "opt-in" versus "opt-out."
IMPLEMENTATION	***Statewide code applicability—***As with any potential change to the Uniform Statewide Building Code, the principal implementation challenge facing the Board of Housing and Community Development (which promulgates the USBC) is crafting code language applicable across the entire Commonwealth.
TECHNOLOGY	***Radio spectrum availability—***A finite amount of radio spectrum is available for all uses, public and private. Public safety radio communication systems are currently restricted to certain "bands" of the spectrum as regulated by the Federal Communications Commission (FCC). While an additional band in the spectrum has recently been allocated for public safety use (700MHz), the burgeoning need for "space" on the airwaves makes fundamental change to public safety radio communications appear limited for the foreseeable future.

TECHNOLOGY	***Radio system trends*—**Public safety agencies nationwide, including those in Virginia, are progressively replacing older (VHF/UHF) public safety radio systems designed in the 1970s with newer, 800MHz "trunked" systems. These systems have features allowing more efficient utilization of limited radio frequencies (assigned by the FCC) and include safety features for emergency response personnel. Most of Virginia's more populous jurisdictions have recently replaced their older (first or second generation) systems, while others are in the planning or deployment stages. While these 800MHz systems have many advantages over their predecessors, overall system performance depends on the ability of mobile and portable radios to reach fixed antenna sites over distances, through building and terrain features, and from within buildings.
TECHNOLOGY	***Radio system lifecycles*—**Limited spectrum availability, coupled with the high cost and complexity of deploying a public safety radio system in a jurisdiction, markedly reduces the ability of public safety agencies to fundamentally change their basic communications technology over time. This leads to long system lifecycles as demonstrated by the fact that many of today's frontline public safety radio systems were designed and built up to 30 years ago; while newer systems (and therefore any in-building solutions designed to work with them) are projected to last many years into the future.
TECHNOLOGY	***External solutions*—**A variety of devices designed for use by emergency response personnel from outside the building are currently available with promise for reducing the difficulty of providing effective and reliable public safety radio communications within buildings during emergency incidents. Since radio signals are ultimately subject only to the laws of physics, however, it seems unlikely that a completely external "solution" is on the horizon. Nonetheless, existing buildings with marginal coverage can be positively affected by externally deployed technologies and Task Force members agreed that addressing the in-building communications challenge should include the continued research, development, and testing of external radio communications adjuncts.
TECHNOLOGY	***Internal solutions*—**Given the laws of physics governing radio energy, installing emergency communications equipment inside certain buildings will probably always be part of any comprehensive solution for providing effective and reliable public safety radio communications across Virginia. With the diversity of public safety radio systems around the Commonwealth, however, no *single* internal solution currently exists to guarantee effective and reliable public safety radio communications within *all* buildings. The selection, design, and installation of in-building solutions depends on a variety of factors such as construction type, architectural features, building materials, and existing public safety radio system characteristics.

TECHNOLOGY	***The future*—**The continued advancement of technology will undoubtedly affect the future of public safety radio communications in buildings. Whether or not these changes improve or degrade the current situation faced by emergency response personnel in many jurisdictions remains to be seen. The basic principles governing public safety radio systems are stable enough, however, that the installation of emergency communications equipment in certain buildings to provide effective and reliable communications for emergency response personnel need not be postponed.

CHAPTER 1. INTRODUCTION

Effective and reliable radio communication is important for both public safety personnel and building occupants during emergencies. The types of incidents to which first responders are called range from domestic disputes to hostage situations; fractured limbs to cardiac arrests; and smoke alarm activations to major fires involving a hundred or more firefighters. The efficiency and effectiveness of all these operations—whether law enforcement, emergency medical, or fire department mitigated (and frequently a combination of agencies and disciplines is involved)—depend on coordinated strategy and tactics that can only be achieved with effective and reliable radio communications, both inside and outside buildings. Furthermore, when situations become extreme and threaten responders' lives, the radio serves as their lifeline to "outside" help and back-up assistance. As resolved by the Virginia General Assembly in 2003:

> "The lives of those emergency public safety personnel who respond to such emergencies, as well as the lives of those persons who may be within a building in which an emergency occurs, frequently depend solely upon the ability of those public safety personnel to communicate by radio transmissions with others who are within such buildings and others who are outside such buildings."[4]

Property owners and managers have a related interest in the efficiency and effectiveness of public safety operations conducted in their buildings. Simply stated, the sooner the suspects are apprehended, the patients are transported, and the fire is out…the sooner business returns to normal. Particularly in a fire or hazardous materials incident, the degree of property damage and life loss can depend greatly on the effectiveness of communications among emergency responders. Building owners and operators also have a vested interest in the safety of their tenants and are often willing to go the "extra mile" to provide safety features for preventing emergencies.

Emergency public safety personnel use handheld/portable radios ("walkie-talkies") as the primary form of tactical communications on incident scenes; using them for communications with both other responders and their public safety communications ("dispatch") center. First-arriving units use portable radios to describe conditions found at the scene and also to request additional assistance/back-up. As incidents increase in size and complexity, communications systems must be able to "scale-up" to handle increased message traffic. Typical, day-to-day "routine" incidents can often be managed on a single channel, but larger incidents may require several channels to allow for clear and timely exchanges of information. Separate channels may also be needed for command, tactical, and support functions.

Public safety radio systems are designed to cover a specific service area. Transmit/receive sites in a radio system are capable of putting certain amounts of radio "signal" on the ground (measured in decibels or "dBs"), where it is possible to receive and transmit signals between mobile radios, portable radios, and fixed sites. In most

[4] Source: Text – House Joint Resolution 588

modern portable radio-based public safety radio systems, the areas covered by a site for transmitting and receiving are about the same; this is known as a “balanced path” approach to system design. This essentially means that if a portable radio can “hear” the system from a given location, the system should also be able to “hear” the portable radio when it transmits; the converse of this situation is also true.

The overall amount of radio coverage provided by a system is expressed in terms of the area covered, signal strength in that area, and the reliability of the coverage.

Area covered is the geographic area where the signal strength of radio signals from a system exceeds a certain value. This value is based on two parameters – the sensitivity of the receiver in the portable radio (how well the radio can “hear”), and the amount of additional margin required in the system to overcome natural and man-made obstructions. Margins are also included which take into account how a user carries and operates a portable radio. For example, consider one radio site with an antenna on a tower, and a radio user with a portable (hand-held) radio at a location near the tower. If the user is outside the building, the system design must include enough margin to overcome any man-made or natural obstructions (e.g., terrain, foliage, buildings) that may interfere with the ability of the signal to reach the portable radio user once it has left the tower. If the portable radio user needs to operate from inside the building, the system design must also include sufficient margin to penetrate the structure.

Reliability is the statistical probability that signal strength will exceed a minimum acceptable value and is expressed in percentages. Public safety radio systems are typically designed for 95 percent signal reliability. The usual goal of a public safety radio system design is to provide signal strengths exceeding minimum acceptable values 95 percent of the time, in 95 percent of locations within the defined service area.

System designers use computer modeling to predict the radio coverage that a specific system design will provide. These sophisticated systems use digitized terrain data, digitized land use data, and radio wave propagation models.

Problem Statement

As identified in House Joint Resolution 588 (HJ 588), “reliable emergency public radio transmissions between those who are within a building and to others outside of buildings have been a significant and continuing problem for emergency public safety personnel.”[5] HJ 588 also identified modern construction techniques and materials as a contributor to this life safety issue, “modern construction materials and techniques often make it more difficult for emergency public safety personnel to communicate with other persons within buildings and with other persons outside of buildings because those materials and techniques sometimes block or impede the transmission of radio signals.”[6]

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[5] Source: Text – House Joint Resolution 588
[6] Source: Text – House Joint Resolution 588

All radio systems have inherent limitations caused by the physics of radio waves and their propagation characteristics. These limitations are particularly salient in buildings, where modern construction materials can impede the radio signal from sender to receiver and vice versa. While a complete discussion of radio physics, signal propagation and attenuation is beyond the scope of this study, many people are familiar with wireless communications through their mobile phones, pagers, and personal digital assistants (PDAs). A "dropped call" or signal interference during a mobile telephone conversation is an inconvenience to most people. Public safety personnel can experience the same difficulties in buildings during emergency response activities—with negative impacts on their operational efficiency and effectiveness. Communications difficulties are often implicated in firefighter line-of-duty death investigations such as those listed in Appendix V of this report. (It is important to note that not all these difficulties can be attributed to radio signal attenuation in buildings; however, the recurrent theme underscores the importance of effective and reliable communications for emergency public safety personnel.) Recognizing the causal link between inadequate public safety radio communications and fatal incidents, the National Institute for Occupational Safety and Health (NIOSH) contracted for an extensive study of firefighter radio communications; the final results of which are still forthcoming.

Appendix VI provides data presented to the HJ 588 Task Force from Fairfax County highlighting several buildings with reported and tested in-building public safety radio communications problems[7]. These data suggest the difficulty of providing effective and reliable public safety radio communications in buildings is not confined to any particular construction or occupancy type.

Appendix VII and Appendix VIII provide anecdotal descriptions of in-building public safety radio communications difficulties from the Tidewater area and Fairfax County, respectively.

Study Methodology

The HJ 588 Task Force convened its first official meeting on March 26, 2003. (Many of the participants were previously involved in a Statewide Fire-Rescue Radio Communication Task Force meeting on November 7, 2002, which aimed to address fire-rescue department concerns related to the planning and deployment of new two-way radio communications systems.)

During the March 26, 2003 meeting the Task Force identified three principal areas of consideration and outlined some general goals for the study.

The three broad areas for study included: 1) policy, 2) implementation, and 3) technology. General goals included broad stakeholder participation and input using an

[7] These data are not all-inclusive and represent only a sample of these buildings within Fairfax County where problems with effective and reliable public safety radio communications have been identified.

open process; use of a multi-agency project team; timely completion without sacrificing quality; identifying partnership opportunities for providing the Commonwealth with substantive guidance on technology/policy alternatives; and results useable for, but not constrained by, House Bill 2529 (HB 2529) directing the:

> "Board of Housing and Community Development to promulgate regulations as part of the Building Code requiring the installation in new commercial, industrial and multi-family buildings of emergency communications equipment for emergency service personnel to facilitate effective communications between emergency public safety personnel involved in emergency situations."

The HJ 588 Task Force met five times to discuss and policy, implementation, and technology considerations affecting the feasibility of adopting requirements to ensure buildings are constructed and equipped to permit effective and reliable in-building radio communications for emergency public safety personnel. Several members of the task force additionally participated in code discussions relating to House Bill 2529.

It is essential to note that every HJ 588 Task Force meeting was an open meeting, participants were continually encouraged to bring other interested parties to the meetings, and to contribute any information they felt important for inclusion in the study.[8] Staff working on HJ 588 also conducted an extensive literature review and repeatedly asked participants to provide any essential, relevant literature.

Table 1. Study Chronology

Chronology	
August 15, 2002	The Virginia Fire Services Board Committee on Fire Prevention and Control was approached regarding the issue of 800MHz radio system difficulties in buildings. At the request of the Virginia Fire Services Board, the Virginia Department of Fire Programs began coordinating (in cooperation with the Virginia State Fire Marshal's Office) a statewide task force to address fire-rescue department concerns related to the planning and deployment of new two-way radio communications systems.
November 7, 2002	After 2 months of collecting information on coverage concerns and potential solutions from departments with radio systems (800 MHz and otherwise) deployed within the last five years, the Virginia Department of Fire Programs and the Virginia State Fire Marshal's Office host an Statewide Fire-Rescue Radio Communication Task Force.

[8] Participation was also invited from the Virginia Municipal League.

January 8, 2003	Delegate Vincent F. Callahan, Jr. introduced House Joint Resolution 588 – *Reliable radio communications for emergency public safety personnel. Requesting the Virginia Department of Fire Programs to study the feasibility of adopting requirements within the Commonwealth that will ensure that buildings are constructed and equipped in such a way that will permit emergency public safety personnel to utilize effective and reliable radio communications while they are within buildings. The Department of Fire Programs shall complete its work by December 1, 2003, and shall submit an executive summary and report of its written findings and recommendations to the Governor and the 2004 Session of the General Assembly.*
January 8, 2003	Delegate James F. Almand introduced House Bill 2529 - *Uniform Statewide Building Code; installation of communication equipment for emergency public safety personnel. Requires the Board of Housing and Community Development to promulgate regulations as part of the Building Code requiring the installation in new commercial, industrial and multi-family buildings of emergency communications equipment for emergency service personnel to facilitate effective communication between emergency public safety personnel involved in emergency situations. The bill defines emergency communications equipment and emergency public safety personnel.*
January 30, 2003	The Virginia House of Delegates passed HJ 588 (97-Y 0-N).
February 4, 2003	The Virginia House of Delegates passed HB 2529 (100-Y 0-N).
February 13, 2003	The Senate of Virginia passed HJ 588 (40-Y 0-N).
February 17, 2003	The Senate of Virginia passed HB 2529 (37-Y 0-N).
February 21, 2003	HB 2529 bill text as passed by House and Senate.
February 22, 2003	HJ 588 bill text as passed by House and Senate.
March 26, 2003	HJ 588 Task Force held its initial meeting to begin exploring issues and reliable radio communications for emergency public safety personnel and identified three general topic areas: policy, implementation, and technology.

April 21, 2003	HJ 588 Task Force met to further define issues within the three broad topic areas.
July 28, 2003	HJ 588 Task Force met to detail and discuss issues relating to any potential code change relating to in-building radio coverage in new construction and to discuss issues relating to the three broad themes of HJ 588 – policy, implementation, and technology.
September 8, 2003	HJ 588 Task Force met to discuss further issues around any proposed code change and to identify steps to move forward.
October 16, 2003	HJ 588 Task Force held its final meeting to discuss potential costs associated with implementing types of in-building solutions and to discuss the retrofit policy issue.

What Others Have Done

Since 1991, local ordinances in communities across the United States have addressed in-building public safety radio communications. Many cities and counties are supplying a remedy to reliable in-building radio coverage issues by passing ordinances requiring certain structures to have provisions to provide internal radio communications for the purpose of public safety communications. Examples include:

Table 2. What Others Have Done[9]

What Others Have Done	
Burbank, California	No person shall maintain, own, erect, or construct any building or structure or any part thereof or cause the same to be done which fails to support adequate radio coverage for City emergency service workers, including but not limited to firefighters and police officers. **NOTE**: This is the earliest known example of such a local ordinance. effective 9/21/91.
Fort Lauderdale, Florida	Requirements of a Radio Signal Booster System which will correct for a reduction in the radio signal to a level below that required amount to assure the 95% coverage reliability needed for public safety communications caused by a new building development.

[9] The Jack Daniel Company (2003) www.rfsolutions.com/sbwp

Broomfield, Colorado	To provide minimum standards to insure a reasonable degree of reliability for emergency services communication from within certain buildings and structures within the city to and from emergency communication centers. It is the responsibility of the emergency service provider to receive the signal to and from the building structure.
Sparks, Nevada	No person shall maintain, own, erect, or construct any building or structure or any part thereof or cause the same to be done which fails to support adequate radio coverage for City emergency service workers, including but not limited to firefighters and police officers.
Grapevine, Texas	No person shall maintain, own, erect, or construct any building or structure or any part thereof or cause the same to be done which fails to support adequate radio coverage for City emergency service workers, including but not limited to firefighters and police officers.
Hampshire, Illinois	Fire Protection District – Establishing requirements for fire communications enhancement systems.
Tempe, Arizona	To provide minimum standards to insure a reasonable degree of reliability for emergency services communications from within certain buildings and structures within the city to and from emergency communications centers. It is the responsibility of the emergency service provider to get the signal to and from the building site.
Scottsdale, Arizona	No person shall maintain, own, erect, or construct any building or structure or any part thereof or cause the same to be done which fails to support adequate radio coverage for City emergency service workers, including but not limited to firefighters and police officers. A certificate of occupancy may not be issued for any building or structure which fails to comply with this requirement.
Ontario, California	No existing or future wireless communications facilities shall interfere with any public safety radio communications systems including, but not limited to, the 800 MHZ radio system operated by the West End Communication Authority which provides public safety communications during emergencies and natural disasters.
Ontario, California	No person shall maintain, own, erect, or construct any building or structure or any part thereof or cause the same to be done which fails to support adequate radio coverage for City emergency service workers, including but not limited to firefighters and police officers.
Roseville, California	No person shall, erect, construct, change the use of or provide an addition of more than 20% to, any building or structure or any part thereof, or cause the same to be done which fails to support adequate

	radio coverage for the City of Roseville Radio Communications System, including but not limited to firefighters and police officers.
Folsom, California	No person shall erect, construct, change the use of or provide an addition of more than 20% to, any building or structure or any part thereof, or cause the same to be done which fails to support adequate radio coverage for Sacramento Regional Radio Communications System, including but not limited to firefighters and police officers. **NOTE:** This goes beyond the coverage requirement by defining a performance confirmation procedure; scheduled periodic verification of performance; a forward looking technical requirement that anticipates potential interaction with cellular services.
Broward County, Florida	To ensure uninterrupted operation of Broward County's public safety, law enforcement, other emergency-related and county operational telecommunications networks by making it a violation of Broward County Code of Ordinances for a property owner, lessee, licensee, contractor, or government entity not otherwise exempt by law, to erect a building or other structure, or portion thereof, or cause a building or other structure, or portion thereof, to be erected or constructed in a manner that creates interference with Broward County's public safety, law enforcement, other emergency-related and county operational telecommunications networks.
West Hartford, Connecticut	(Code change) No person shall erect, construct, change the use of, or construct an addition of more than 50% in gross floor area to any building or structure of Type I or Type II construction which exceeds 10,000 square feet in gross floor area, including any portions thereof which may be located below grade, which fails to support adequate radio coverage.
Sarpy County, Nebraska	No person shall erect, construct, remodel, renovate, or provide an addition of more than 20% to, any building or structure or any part thereof, or cause the same to be done which fails to support adequate radio coverage for the Sarpy County Communications Systems (SCRCS), including but not limited to emergency service workers, firefighters and police officers.
Schaumburg, Illinois	No person shall erect, construct, maintain or modify any building or structure or any part thereof, or cause the same to be done which fails to support adequate radio coverage for village public safety services, including but not limited to police, fire, and public works departments. A certificate of occupancy may not be issued for any building or structure which fails to comply with this requirement. The frequency range which must be supported shall be 806 to 816 MHz and 856 to 866 MHz, or as otherwise established and required in writing by the

	village as being necessary for public safety purposes.
Bayside, Milwaukee County, & Ozaukee County Wisconsin	No person or organization shall maintain, own, erect, or construct any building or structure which is used for commercial, multi-family, or institutional use or any part thereof or cause the same to be done which fails to support adequate radio coverage to public safety service workers, including, but not limited to firefighters and police officers.

CHAPTER 2. POLICY

The Task Force explored several policy issues affecting the feasibility of requiring the installation of emergency communications equipment in buildings. This chapter summarizes their findings.

New Construction

Applying in-building technology solutions to ensure effective and reliable public safety radio communications is generally less costly in new construction (or during renovations) than in existing buildings. Typically, owners and developers have more financing options for installing emergency communications equipment in new buildings or those undergoing extensive renovation. Computerized radio system models and measurement tools are available to forecast system performance with enough accuracy to effectively design in-building solutions for new construction projects.

Retrofitting Existing Buildings

Retrofitting involves the addition of new equipment, which was not available at the time of initial construction, to a building to bring it up to current code requirements. Retrofit measures to address specific requirements are typically mandated by the legislature.

Table 3 is a summary of retrofit measures previously applied in the Uniform Statewide Building Code (USBC) governing:

Table 3. USBC Retrofit Applications[10]

Retrofit Applications	
Colleges and Universities	Battery-powered or AC-powered smoke detector devices installed in college and university buildings containing dormitories for sleeping purposes.
Juvenile Care Facilities	Battery-powered or AC-powered smoke detectors shall be installed and maintained in all local and regional detention homes, group homes, and other residential care facilities for children and juveniles which are operated by or under the auspices of the Virginia Department of Juvenile Justice.

[10] Uniform Statewide Building Code 2000 Edition

Deaf and Hearing Impaired	Smoke detectors providing an effective intensity of not less than 100 candela to warn deaf or hearing impaired individual shall be provided, upon request by the occupant to the landlord or proprietor, to any deaf or hearing-impaired occupant of any of the following occupancies: dormitory buildings, multiple-family dwellings, or one-family or two-family dwelling units.
Assisted Living Facilities	A fire protective signaling system and an automatic fire detection system meeting the requirements of the USBC, Volume I, 1987 Edition, Third Amendment, shall be installed in assisted living facilities.
Assisted Living Facilities	Battery or AC-powered single and multiple station smoke detectors meeting the requirements of the USBC, Volume I, 1987 Edition, Third Amendment, shall be installed in assisted living facilities.
Dwelling Units	AC-powered smoke detectors with battery backup or an equivalent device shall be required to be installed to replace a defective or inoperative battery-powered smoke detector located in dwelling units or rooming houses offering to rent overnight sleeping accommodations.
Nursing Homes and Facilities	Fire suppression systems as required by the edition of this code in effect on October 1, 1990, shall be installed in all nursing facilities licensed by the Virginia Department of Health.
Nursing Homes and Facilities	Fire alarm or fire detector systems, or both, as required by the edition of this code in effect on October 1, 1990, shall be installed in all nursing homes and nursing facilities licensed by the Virginia Department of Health.
Hospitals	Fire suppression systems shall be installed in all hospitals licensed by the Virginia Department of Health as required by the edition of this code in effect on October 1, 1995.
Hotels and Motels	Smoke detectors shall be installed in hotels and motels as required by edition VR 394-01-22, USBC, Volume II, in effect on March 1, 1990.
Hotels and Motels	An automatic sprinkler system shall be installed in hotels and motels as required by the edition of VR 394-01-22, USBC, Volume II, in effect on March 1, 1990.
Dormitories	An automatic fire suppression system shall be provided throughout all buildings having a Group R-2 fire area which are more than 75 feet or six stories above the lowest level of exit discharge and which are used, in whole or in part, as a dormitory to house students by any public or private institution of higher education.

Care Facilities	In each kitchen there shall be installed and maintained at least one approved type ABC portable fire extinguisher with a minimum rating of 2A10BC. The facility shall provide and maintain at least one battery operated, properly installed smoke detector as a minimum (i) outside each sleeping area in the vicinity of bedrooms and bedroom hallways, and (iii) on each additional floor.
Adult day care centers	Battery-powered or AC-powered smoke detector devices shall be installed in all adult day care centers licensed by the Virginia Department of Social Services.

A great deal of discussion occurred concerning retrofit and its potential impacts such as the fiscal impact to building owners, who would absorb retrofit costs, and whether incentives could be offered to ease the way for retrofit. The estimated cost to retrofit a building with an in-building solution is 10 to 25 percent over that of new construction. Therefore if in new construction the cost to provide an in-building solution is $1.00 per square foot, the cost to retrofit the same building can be estimated to range anywhere from $1.10 - $1.25 a square foot. This estimate does not take into account historic structures and instances of unique construction (e.g., cinderblock building with a plaster roof), where the retrofit cost could range even higher than 25 percent over the cost of installing a like system in a like structure.

Retrofit financing is a major concern. It was noted that once a building is constructed, retrofit costs must be funded from operational cash flows and substantial amounts of money are often difficult to absorb. As the costs associated with retrofit were of paramount concern, the Task Force entertained a great deal of discussion regarding the potential of offering tax credits or other incentives to building owners who retrofit to help absorb costs incurred.

It was also noted that the timeframe to implement and enforce a retrofit provision for installing emergency communication equipment in buildings would need to be lengthy.

Retrofit is logistically complex as many buildings, commercial office buildings, in particular, have multiple tenants. Each of these tenants has a unique set-up and diverse needs. In order to retrofit, a building owner must gain permission and coordinate with each building occupant as well as taking into account each of their security needs. Many buildings also lease their roof space to private telecommunications firms; before adding an in-building solution radio interference concerns would need to be reconciled.

Target Hazards

Requiring the installation/retrofit of emergency communications equipment in buildings (new and existing) with occupancies having a high potential for life loss or property damage could prove beneficial in the event of a fire or other emergency exposing the property and its occupants to harm. Retrofit provisions for specific "high-hazard" occupancy types have been previously incorporated in the USBC, as listed in Table 3.

Over time, various retrofit measures have been applied to structures including assisted living facilities, nursing homes, colleges and universities, juvenile care facilities, hospitals, hotels and motels, dormitories, state-regulated care facilities, and adult day care centers. The Task Force agreed that government-owned buildings, including schools, should not be exempt from any retrofit measures. There was also discussion as to whether or not buildings such as historic structures should be included in any retrofit action.

Funding

The HJ 588 Task Force spent a great deal of time discussing funding issues around the installation of emergency communications equipment in new construction, as well as for retrofitting existing buildings.

The exact cost to install emergency communications equipment in buildings across Virginia is hard to define as several variables affect installation and maintenance costs, such as labor rates, competition among qualified firms, complexity of installation for a specific building, and existing public safety radio system characteristics. Research for this study suggests costs can range anywhere from $0.15 to $1.25 per square foot in new construction;[11] with an additional 10 to 25 percent for retrofitting existing buildings (retrofitting costs for some buildings could be even higher.[12] If required by the USBC for new construction, these costs would likely be added to initial financing arrangements and amortized over the life of the building. Securing funds to retrofit an existing building from operational cash flows could be difficult unless financial incentives are provided by public or private entities. More detail on the costs of installing in-building solutions can be found in Chapter 5 of this report.

The possibility of alternate funding strategies for system installation in new or existing structures in the form of neutral host systems may exist. This potential strategy is not specific to any particular vendor or technology, but basically runs broadband services anywhere from 400 to 2.4 GHz, which essentially covers the entire spectrum of wireless applications, including public safety. The notion is that a public safety solution could "piggy-back" on the neutral host system, offering a "win-win" situation for the building owner. Currently, the market for this strategy is limited to large stadiums, shopping malls, convention centers, and coliseum type venues.

[11] Source: rfsolutions.com and HJ 588 Task Force Meeting on October 16, 2003
[12] Source: HJ 588 Task Force Meeting on October 16, 2003

It was noted that the cost to implement a neutral host system could add approximately 25 – 50 percent to the initial costs[13] of a public safety in-building solution.

Responsibility

When looking at the potential policy implications associated with requiring in-building solutions some questions regarding responsibility were presented.

The Task Force limited their scope of work, in accordance with HJ 588, by agreeing that local jurisdictions (as the federally licensed operators of public safety radio systems) are responsible for delivering adequate radio signal to the exterior of a (proposed or existing) building *before* requiring the installation of emergency communications equipment to overcome signal degradation inside the structure.

The Task Force also agreed that changes to the local public safety radio system (environmental or technological) occurring after an in-building solution is accepted by authorities should not place an undue compliance burden on building owners.

Local Government Option - Opt-In/Opt-Out

The USBC can include provisions allowing local governments to "opt-in" or "opt-out" of specific code sections. An "opt-in" code section only applies to a jurisdiction if the local governing body adopts it; an "opt-out" code provision applies to a jurisdiction *unless* the local governing body chooses *not* to accept it. Given regional and local differences across Virginia, the Task Force recommended the local government option for inclusion in any USBC action on in-building public safety radio communications, but could not reach consensus for "opt-in" versus "opt-out."

[13] Source: HJ 588 Task Force Meeting on October 16, 2003

CHAPTER 3. IMPLEMENTATION

The implementation instrument for adopting requirements within the Commonwealth to ensure that buildings are constructed and equipped in such a way to permit emergency public safety personnel to utilize effective reliable radio communications while they are within buildings is the Virginia Uniform Statewide Building Code (USBC).

The USBC prescribes mandatory regulations for the construction of buildings and structures and their internal equipment. Buildings constructed before the 1973 adoption of the USBC must comply with the Virginia Public Building and Safety Regulations (VPBSR). However, since the adoption of the USBC, local building inspection departments have been responsible for enforcing compliance with building code requirements during construction.

During the 2003 Virginia General Assembly, Session House Bill 2529 (HB2529) was passed, which specifically requires the*:*

> "Board of Housing and Community Development to promulgate regulations as part of the Building Code requiring the installation in new commercial, industrial and multi-family buildings of emergency communications equipment for emergency service personnel to facilitate effective communication between emergency public safety personnel involved in emergency situations."

While this is a separate and ongoing effort from HJ 588, given the similarity between the two tasks the Virginia Department of Fire Programs, the Department of Housing and Community Development, and the State Fire Marshal's office incorporated discussions of potential code language in the work of the Task Force. In order to facilitate this process members of the HJ 588 Task Force participated in formulating this proposed code change.

Given the extensive and required process for implementing changes to the USBC, this study was limited to discussions of "potential" (draft) code language – as described in Appendix III.[14]

The following is a brief summary of the USBC code change process.

The 2003 USBC and Statewide Fire Prevention Code (SFPC) update cycles will follow the requirements established by the Administrative Processes Act (APA), which requires the Department of Housing and Community Development to publish a baseline/proposed 2003 USBC/SFPC that is reviewed and approved by the Department of Planning and Budget, the Office of the Attorney General, the Board of Housing and Community Development (BHCD) and is published in the Virginia Register. Several

[14] It is critical to note that this *draft* language *has not* been through the prescribed USBC development/change process and is provided in this report as an exhibit only, with no warranty of Task Force, board, or agency consensus on any of its specific provisions.

comment periods will be provided to allow for submission of both administrative and technical code changes. The Codes and Standards Committee of the BHCD will review all code changes and make recommendations to the full Board as to what should be included in the 2003 regulations. Once the BHCD recommends approval the final regulations go through another set of reviews by applicable state agencies, another public hearing, and an open comment period. The BHCD then approves the final recommendations, which are subject to an appeals process of 30 days. It is estimated this process would encompass the majority of 2004 and resultant changes could possibly become effective in the Spring of 2005.

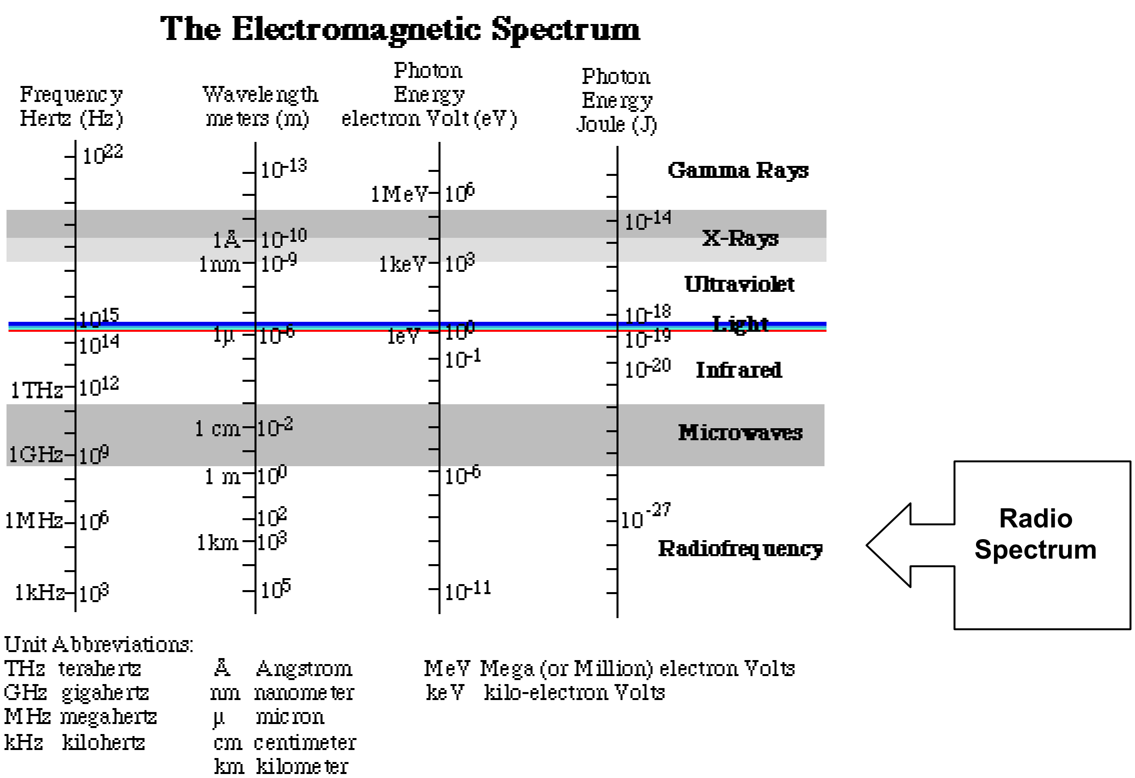
CHAPTER 4. TECHNOLOGY

A complete discussion of the underlying principles governing the design, installation, use, and benefits/limitations of public safety radio systems is beyond the scope of this report. (Several basic references are provided in the reference list at the end of the report). Therefore, this chapter relates primarily to issues identified by the HJ 588 Task Force as salient for studying the feasibility of requiring the installation of emergency communications equipment in buildings to provide effective and reliable communications for emergency public safety personnel.

Radio Spectrum Availability

A finite amount of radio spectrum (part of the overall electromagnetic spectrum that also includes visible light, infrared, x-rays, etc.) is available for all uses, public and private. Figure 1 illustrates the complete electromagnetic spectrum with the radio spectrum occupying approximately the bottom one-third of the diagram.

Figure 1. The Electromagnetic Spectrum[15]

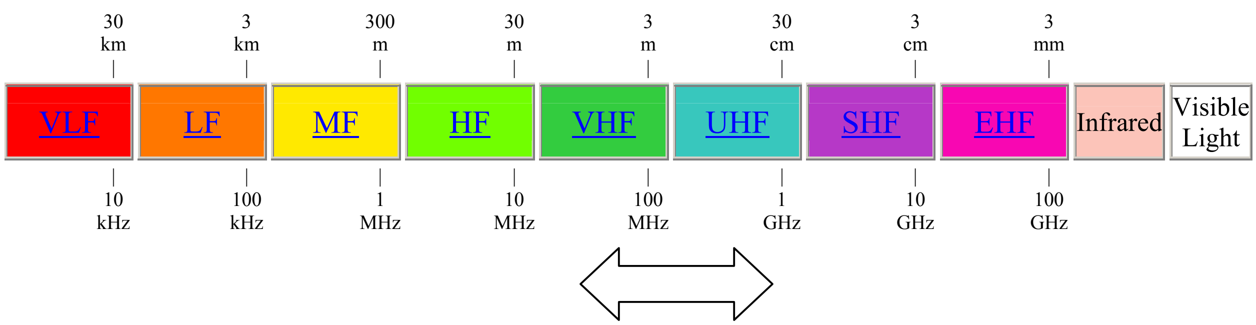


[15] National Aeronautics and Space Administration (1996) http://science.nasa.gov/newhome/help/glossfig1.htm

Within the radio spectrum, public safety radio communication systems are restricted to certain "bands" and are regulated by the Federal Communications Commission (FCC) in Title 47 of the Code of Federal Regulations (47CFR90.20). While additional spectrum has recently been allocated for public safety use (700MHz), the burgeoning need for "space" on the airwaves makes fundamental change to public safety radio communications appear limited for the foreseeable future.

Figure 2 illustrates just the radio spectrum with infrared and visible light for context at the extreme right; the arrow along the bottom approximates the range of frequencies allocated for public safety.

Figure 2. The Radio Spectrum[16]



Each band of the radio spectrum allocated for public safety use has different characteristics, as described in Table 4.

[16] Adapted from Neuhaus, John (2002) "Allocation of Radio Spectrum in the United States," http://www.jneuhaus.com/fccindex/spectrum.html#table_of_contents

Table 4. Public Safety Radio Characteristics[17]

	FREQUENCY RANGE	PROPAGATION CHARACTERISTICS	TYPICAL USAGE
VHF "Low Band"	30 MHz - 50 MHz	Low path loss, good refraction over terrain features, poor building penetration. Requires approximately 84" mobile or portable antenna for efficient transmission/reception. Compact (50") mobile antennas can be used with reduced efficiency.	Older technology that is still very effective for providing mobile coverage to large geographic areas. Vehicular repeaters operating on higher frequencies must be used if effective portable coverage is desired. Still used in Virginia by VDOT and some rural public safety agencies.
VHF "High Band"	148 MHz to 174 MHz	Somewhat higher path loss and reduced refraction over terrain features than VHF "Low Band." Requires approximately 19" mobile or portable antenna for efficient transmission/reception. Larger antennas can be used if higher gain is desired. Smaller portable antennas consist of approximately 8" of coiled spring coated with plastic to provide 19" electrical length, but are very inefficient.	Popular land mobile radio band, was used in a wide variety of public safety communications applications. Still used in many areas of the Commonwealth. Jurisdictions have left this band mostly due to congestion, lack of available frequencies, and difficulty implementing trunked radio systems here. Still used by many agencies in Virginia, including Virginia State Police.
UHF Band	450 MHz to 470 MHz	Again, higher path loss associated with higher frequencies. Poor refraction over terrain features. Requires 6" antenna for efficient transmission/reception. Larger antennas can be used if higher gain is desired.	Popular land mobile radio band, was used in a wide variety of public safety communications applications. Came into wide use in the 1970s for city and suburban county systems. Ideal for portable radio coverage in buildings. Still used in many areas of the Commonwealth. Jurisdictions have left this band mostly due to lack of new frequencies and difficulty implementing trunking systems.
UHF "T" Band	470 MHz to 512 MHz	Similar to UHF band above.	Expansion band created in major metropolitan areas. Uses spectrum shared with UHF TV channels 14-20. Usage similar to UHF band above. In Virginia, only used in metropolitan Washington, DC and Northern Virginia.
700 MHz band	764 MHz - 776 MHz 794 MHz - 806 MHz	Similar to 800 MHz band below.	New public safety spectrum taken from reallocated UHF TV channels 64-69, not available yet in most areas of the United States.
800 MHZ Band	806 MHz - 824 MHz 851 MHz - 869 MHz	Considerably higher path loss than lower frequency bands, but improved building penetration and portable radio coverage. Poor refraction over terrain features. Requires 3" mobile or portable antenna for efficient transmission/reception. Larger mobile and portable antennas are frequently used to obtain higher gain.	Very popular land mobile band in urban, suburban and suburban/rural jurisdictions. Use of trunking is mandatory, provides excellent system capacity and advanced features. Most urban, semi-urban and suburban jurisdictions use or plan to use systems in the 800 MHz band. Availability of new frequencies is limited, future use of 700 MHz will help.

Radio System Trends

Public safety agencies nationwide, including those in Virginia, are progressively replacing older (VHF/UHF) public safety radio systems designed in the 1970s with newer, 800MHz “trunked” systems. These systems have features allowing more efficient utilization of limited radio frequencies (assigned by the FCC) and include safety features for emergency response personnel. Most of Virginia’s more populous jurisdictions have recently replaced their older (first or second generation) systems, while others are in the planning or deployment stages. While these 800MHz systems have many advantages over their predecessors, system performance ultimately

[17] Anderson, Jack (2003) RCC Consultants, prepared for HJ 588 Task Force.

depends on the ability of mobile and portable radios to reach fixed antenna sites over distances, through building and terrain features, and from within buildings.

Table 5 displays selected results from a statewide interoperability survey in which respondents were asked to identify the public safety radio communications frequencies currently used by systems within their jurisdiction.[18]

Table 5. Selected Public Safety Radio Bands Used in Virginia—2003

Jurisdiction	Population	Low Band VHF (25 - 50 MHz)	High Band VHF (150 - 174 MHz)	UHF (406 - 512 MHz)	800 MHz	Notes
Accomack County	38,305	EMS, Fire, Law	EMS, Fire, Law			
Albemarle County	79,236	EMS, Fire	EMS, Fire, Law	Law		800 MHz in planning stages
Amherst County	31,894				EMS, Fire, Law	
Arlington County	189,453				EMS, Fire, Law	
Botetourt County	30,496			EMS, Fire, Law		
Charlottesville, City of	45,049	Fire		Fire		800 MHz in planning stages
Chesapeake, City of	199,184				Fire	
Chesterfield County	259,903				EMS, Fire, Law	
Colonial Heights, City of	16,897				EMS, Fire	
Covington City	6,303				EMS, Fire, Law	
Danville, City of	48,411		Law			
Fairfax City	21,498				EMS, Fire, Law	
Fairfax County	969,749				EMS, Fire, Law	
Franklin County	47,286	EMS, Fire, Law				
Frederick County	59,209	EMS, Fire	EMS, Fire			
Goochland County	16,863	EMS, Fire, Law	Fire			
Hampton, City of	146,437				Law	
Hanover County	86,320				EMS, Fire, Law	
Harrisonburg, City of	40,468	Law	Law	Law		800 MHz in planning stages
Henrico County	262,300				EMS, Fire, Law	
Henry County	57,930	EMS, Fire, Law	EMS, Fire, Law	EMS, Fire, Law		
Hopewell, City of	22,354				Fire	
Madison County	12,520	EMS, Fire, Law	EMS, Fire, Law			
Norfolk, City of	234,403				Law	
Petersburg, City of	33,740		Law	Law		
Portsmouth, City of	100,565				EMS, Fire, Law	
Prince William County	280,813			Law		
Richmond County	8,809	Fire				
Roanoke, City of	94,911				Fire	
Rockbridge County	20,808			EMS, Fire, Law		
Rockingham County	67,725	EMS, Fire		EMS, Fire		800 MHz in planning stages
Smyth County	33,081	EMS, Fire, Law	EMS, Fire, Law	EMS, Fire, Law		
Spotsylvania County	90,395				EMS, Fire, Law	
Stafford County	92,446	EMS, Fire, Law	EMS, Fire, Law	EMS, Fire, Law		
Staunton, City of	23,853			EMS, Fire		
Suffolk, City of	63,677				EMS, Fire, Law	
Surry County	6,829	Law	Law			
Virginia Beach, City of	425,257				Fire	
Waynesboro City	19,520			EMS, Fire, Law		
Westmoreland County	16,718	EMS, Fire, Law		EMS, Fire, Law		
Wise County	40,123	Law	Fire, Law			
Wythe County	27,599	EMS, Fire, Law	EMS, Fire, Law			

[18] The statewide radio interoperability survey—an effort unrelated to HJ 588—from which these samples are drawn is still ongoing. To prevent duplication of effort, these preliminary and unverified results are included here to give a general impression of the current state of affairs with respect to public safety radio communications in Virginia.

Table 5 shows the trend toward combining public safety radio systems for different agencies into a single system (to promote interoperability), with 800MHz "trunked" systems the current local favorite based on frequency characteristics and availability (from the FCC). In fact, many of the above listed jurisdictions enjoy regional interoperability where portable radios from one system are programmed to operate on an adjacent system; in these cases, in-building solutions designed for one system can actually serve (without modification or additional cost) emergency public safety personnel from adjacent localities.

In jurisdictions where public safety agencies have separate systems in disparate bands, without plans to combine them, determining the system for which an in-building solution must be designed is a salient and early consideration. The Task Force agreed that, instead of requiring building owners to install emergency communications equipment to serve multiple systems at potentially 2 or 3 times the expense, any USBC action should include provisions requiring the locality to designate a single (primary) public safety radio system.

Radio System Lifecycles

Limited spectrum availability, coupled with the high cost and complexity of deploying a public safety radio system in a jurisdiction, markedly reduces the ability of public safety agencies to fundamentally change their basic communications technology over time. This leads to long system lifecycles as demonstrated by the fact that many of today's frontline public safety radio systems were designed and built up to 30 years ago; while newer systems (and therefore any in-building solutions designed to work with them) are projected to last many years into the future.

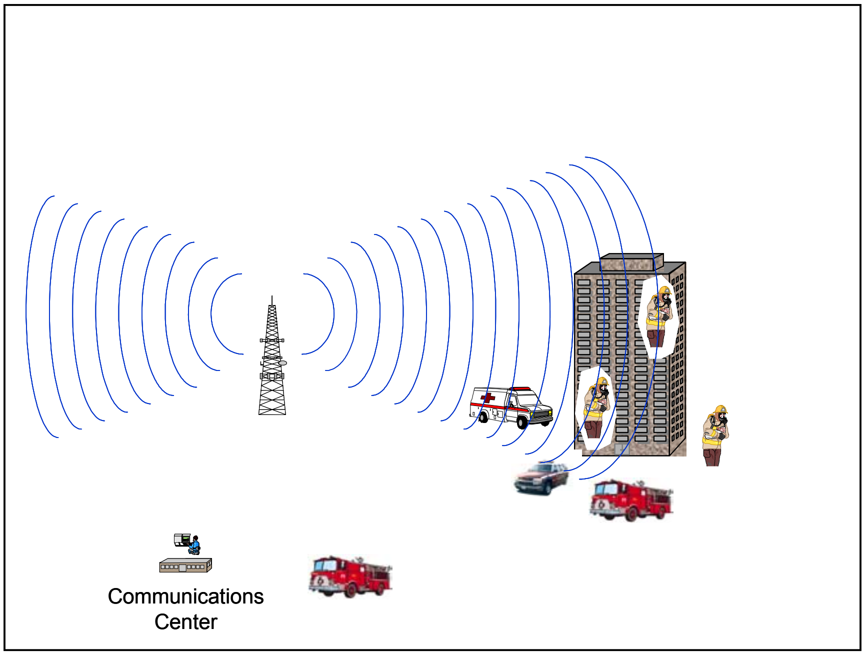
Basic Radio System Performance

Under ideal circumstances, public safety radio systems (conventional or trunked, in all bands) could penetrate all buildings using only their basic infrastructure, without assistance from internal or external adjuncts. In these cases, radio signal strength is sufficient to overcome attenuation from building materials (e.g., steel, concrete, window coatings, etc.) with enough margin to provide acceptable coverage and reliability, specifically, to allow portable radio use throughout 95 percent of the building, 95 percent of the time. (Even the most expensive radio system could not assure 100 percent coverage to all areas, at all times.) No specialized equipment or user training is required to operate within buildings, since the system functions the same inside and outside the structure.

In many buildings throughout Virginia, the local jurisdiction's basic radio system infrastructure provides adequate coverage and reliability for emergency public safety personnel to operate within while retaining the radio's safety features, the ability to communicate with other users, and the communications center ("dispatch").

The diagram in figure 3 illustrates radio system performance using only basic infrastructure.

Figure 3. Basic Radio System Performance[19]



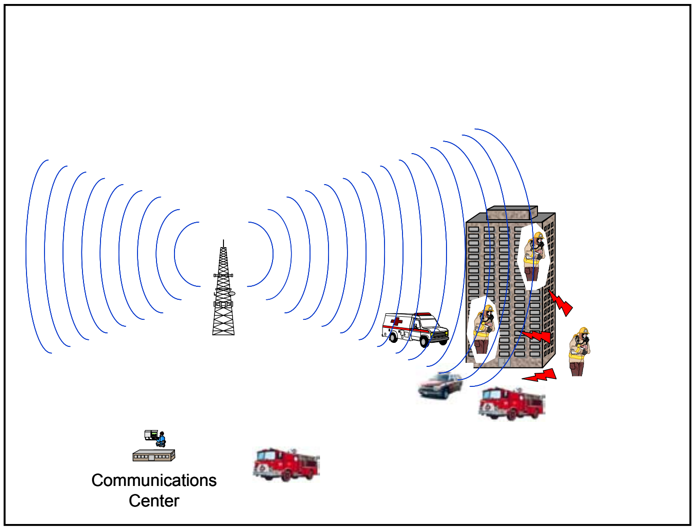
Direct/Talkaround Mode

Most public safety radio systems include a "direct" or "talkaround" mode allowing the radio user to communicate directly with other users when the basic system infrastructure cannot provide enough signal strength to "hear" the user's portable radio (and vice versa) in a given location, at a given time. (The "talkaround" term refers to talking "around" the system…which is usually designed to have all transmissions pass through an antenna/repeater site, thus ensuring message receipt by all users.) Radio functionality is markedly diminished in this mode since users lose safety features, can no longer talk with or hear their communications center, and may not be able to talk with or hear the incident commander and other units operating on the scene. Direct/talkaround mode provides only limited ability to penetrate all areas of large, dense structures and floor-to-floor communications are difficult over multiple floors.

Figure 4 illustrates the direct/talkaround mode.

[19] Anderson, Jack (2003) RCC Consultants, presented to HJ 588 Task Force.

Figure 4. Radio System Performance in Direct/Talkaround Mode[20]



External Solutions

Several devices designed for use by emergency response personnel from outside the building are currently available with promise for reducing the difficulty of providing effective and reliable public safety radio communications within buildings during emergency incidents. It is important here to note the difference between inter-operability and operability. Many of the external public safety radio communications adjuncts currently being marketed are primarily for enhancing *inter*-operability between agencies; before these can work, operability inside/outside the building must still be achieved.

Since radio signals are ultimately subject only to the laws of physics, it seems unlikely that a completely external "solution" is on the horizon. Nonetheless, existing buildings with marginal coverage can be positively affected by externally deployed technologies. Task Force members agreed that addressing the in-building communications challenge should include the continued research, development, and testing of external radio communications adjuncts.

Vehicular Repeaters

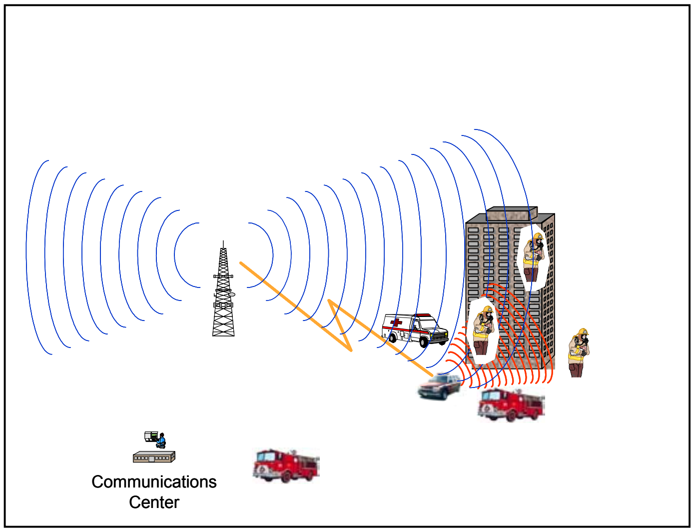
Vehicular repeaters are devices located on public safety vehicles with the ability to "boost" the signal received from either a fixed antenna site on the radio system or a portable radio located on the incident scene, thus enhancing basic system performance. The use of a vehicular repeater is more effective than direct/talkaround mode, but still provides limited ability to penetrate all areas of a structure since the active signal they produce is also subject to attenuation by

[20] Anderson, Jack (2003) RCC Consultants, presented to HJ 588 Task Force.

building materials and terrain. The relative cost and complexity of these devices limits their deployment potential within a public safety vehicle fleet, meaning initial emergency response operations would need to either await the arrival of a vehicle so equipped or begin without effective and reliable communications.

Figure 5 provides an illustration of vehicular repeater performance.

Figure 5. Vehicular Repeater Performance[21]



Internal Solutions

Given the laws of physics governing radio energy, installing emergency communications equipment inside certain buildings will probably always be part of any comprehensive solution for providing effective and reliable public safety radio communications across Virginia.

With the diversity of public safety radio systems around the Commonwealth, no *single* internal solution currently exists to guarantee effective and reliable public safety radio communications within *all* buildings. A viable alternative in densely populated urban areas may not be an option for sparsely populated rural areas. Simply put, "one size does not fit all."

The selection, design, and installation of in-building solutions depends on a variety of factors such as construction type, architectural features, building materials, and existing public safety radio system characteristics. The need to proactively address these variables suggests the need for an open, interactive, and continued dialogue between local emergency response personnel, building officials, property owners and managers, architects, plan reviewers, and radio system engineers. This dialogue is critical for

[21] Anderson, Jack (2003) RCC Consultants, presented to HJ 588 Task Force.

ensuring the design of any in-building solution meets the needs of the community in a cost-effective manner.

This section describes several current alternatives for providing effective and reliable public safety radio communication within buildings—without advocating for any particular vendor or system type.

Signal Boosters (BDAs)

Signal boosters, more commonly known as Bi-Directional Amplifiers (BDAs), appear the predominant in-building technology solution currently used to help remedy in-building radio coverage issues in areas served by trunked 800MHz public safety radio systems. A BDA system consists of one or more amplifiers located inside the building, an external antenna, and an internal antenna network. The external antenna, usually located on the roof of the building, receives the signal coming from the radio system antenna/tower site and brings it into the amplifier while radiating a signal back to the radio site. The internal antenna network then passes signal from the amplifier into the building, throughout all needed locations, and receives messages from portable radios being used in the building, passing them back to the amplifier, out through the external antenna, and into the public safety radio system.

Proper BDA system design is technically straightforward, but essential. Both the internal and external antenna systems are critical. Coverage requirements, interference with other equipment, interference with other radio sites, and general cost of materials needed are important design factors. It is possible for a BDA to amplify signals other than the signals desired by the application. BDAs are also capable of multi-band usage with the same antenna, but different amplifiers are needed. In the event of a fundamental change in the local public safety radio system, BDA systems would probably not require complete replacement to remain functional.

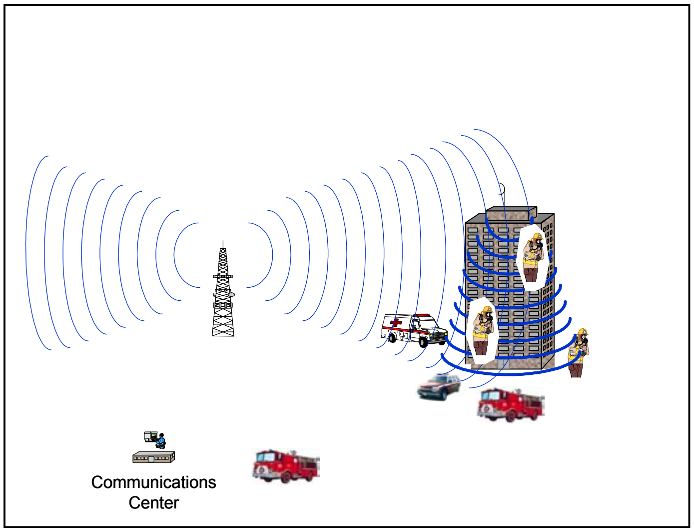
System cost factors include: design, the cost of the amplifier (usually a fixed cost), antennas, coaxial cable, fiber optic cable, splitters, labor to install the system, and annual preventive maintenance. BDA systems can be tailored to provide coverage throughout a building, or only in areas where radio coverage is marginal/non-existent.

BDAs provide a seamless link between the public safety radio system infrastructure and the distributed antenna/cable system in a building. BDAs are fully linked with system infrastructure and provide complete control over coverage reliability (signal is propagated throughout the structure by design). It is also important to note that with a BDA system if “dead spots” are discovered after installation (or caused by renovations) complete retooling is not always necessary as the addition of more cable (an possibly an additional amplifier) can usually provide remedy.

There are no additional training considerations for emergency public safety personnel with BDA systems and all system features are available to all users.

Figure 6 illustrates the performance of an in-building system using a signal booster (BDA).

Figure 6. Signal Booster (BDA) Performance[22]



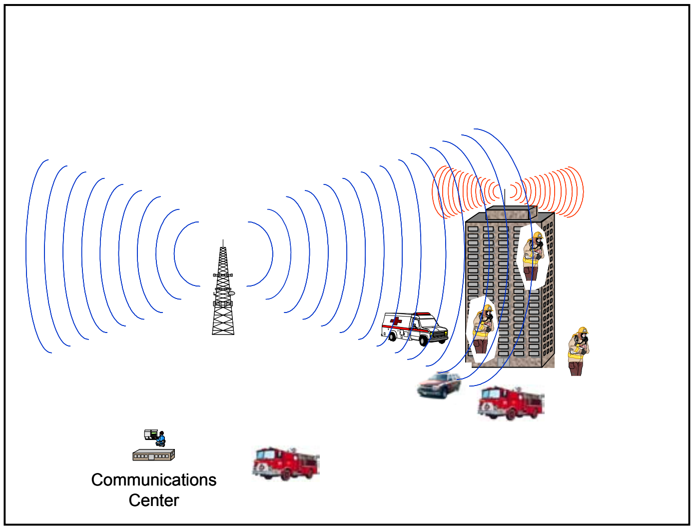
Special Repeater at Building/In-Building Portable Radios

Special repeaters at buildings, coupled with "unique" building radios passed out to emergency services personnel during an incident, can be an effective solution in rural areas with limited responses to an affected building. This requires the installation of an individual/special repeater (essentially a stand-alone radio system) with a cache of hand-held portable radios distributed on-site to emergency services personnel when they arrive at an incident. The number of portable radios required for a major incident is a limiting factor and this option also causes substantial training issues for the emergency services personnel in the locality and in surrounding localities delivering mutual-aid. Some solutions of this nature can provide a link to the public safety radio system infrastructure, but in general they provide only a limited communications capability.

Figure 7 provides an illustration of special repeater performance at a building so equipped.

[22] Anderson, Jack (2003) RCC Consultants, presented to HJ 588 Task Force.

Figure 7. Special Repeater Performance[23]



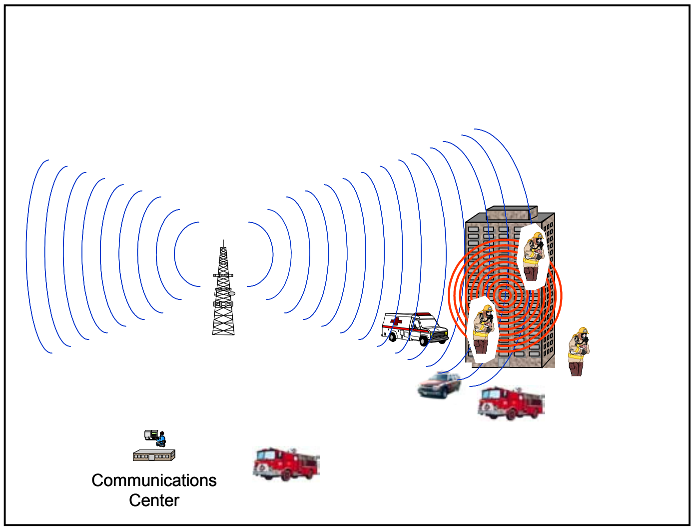
Voting Receivers Installed at Building

Voting receivers are essentially a series of repeaters feeding repeaters. Voting receivers are typically used for conventional VHF and UHF systems and require a very strong outside signal to blanket the structure; they are not a viable option for trunked radio systems in any radio band. Each individual radio channel requires a receiver and therefore multiple receivers may be necessary to cover all areas of the structure. Each individual receiver requires a dedicated leased telephone circuit back to the voting comparator. Voting receivers can enhance emergency communications, but require a great deal of maintenance.

Figure 8 depicts the performance of a voting receiver-based system.

[23] Anderson, Jack (2003) RCC Consultants, presented to HJ 588 Task Force.

Figure 8. Voting Receiver Performance[24]



The Future

The continued advancement of technology will undoubtedly affect the future of public safety radio communications in buildings. Whether or not these changes improve or degrade the current situation faced by emergency response personnel in many jurisdictions remains to be seen. The basic principles governing public safety radio systems are stable enough, however, that the installation of emergency communications equipment in certain buildings to provide effective and reliable communications for emergency response personnel need not be postponed.

[24] Anderson, Jack (2003) RCC Consultants, presented to HJ 588 Task Force.

CHAPTER 5. COST / BENEFIT ANALYSIS

The exact cost to install emergency communications equipment in buildings across Virginia is hard to define as several variables affect installation and maintenance costs. Research for this study suggests installation costs can range anywhere from $0.15 to $1.25 per square foot in new construction;[25] with an additional 10 to 25 percent for retrofitting existing buildings.[26] (In some buildings, particularly those with historical value or housing other complex systems, retrofit costs could significantly exceed 25 percent.)[27]

This extremely wide range ($1.10) for new construction (and by extension, for retrofitting existing buildings) is attributable to several factors including variable labor costs, different installation complexities, variable building sizes, the competitive environment in a given region, and the use of building materials with a high degree of radio signal attenuation in certain structures. Over time, as more installations are completed in Virginia, it seems likely the cost range will narrow.

Table 6 on the following pages contains cost *estimates* for installing emergency communications equipment in new and existing buildings based on notional scenarios suggested by the HJ 588 Task Force. While these estimates are based on the signal booster/BDA solution described in the previous chapter, given the wide range between the "low" and "high" estimates derived in the table it seems likely that most other in-building solutions would fall somewhere within this range.

The notional building parameters (including the estimated square footage) and the average cost per square foot estimates are from the website of Saylor Publications, Inc.[28] Saylor has provided construction cost data and consulting services for over 40 years.

<u>Table 6. Cost Estimates for Installing Emergency Communications Equipment</u>

[25] The Jack Daniel Company (2003) www.rfsolutions.com/sbwp AND presentation by Tim Dennis, et al. to the HJ 588 Task Force on 10/16/03.
[26] Presentation by Tim Dennis, et al. to the HJ 588 Task Force on 10/16/03.
[27] Presentation by Tim Dennis, et al. to the HJ 588 Task Force on 10/16/03.
[28] Saylor Publications, Inc. (2003) www.saylor.com/lacosts/csfpage1.htm

Property Type Building Parameters	Estimated Square Footage	Average Building Cost Per Square Foot (New)	Total Building Cost (New)	Low-Range Cost for In-Building Solution (New)	Mid-Range Cost For In-Building Solution (New)	High-Range Cost for In-Building Solution (New)	Mid-Range In-Building Solution Cost as % of Total Building Cost (New)	Mid-Range Cost for In-Building Solution (Retrofit)
Apartment, 2-3 Story 2 Story, 10 Ft. Story Height	15,000	$60.21	$903,142.50	$2,250.00	$10,500.00	$18,750.00	1.2%	$12,390.00
Apartment, 4-7 Story 6 Story, 11 Ft. Story Height	65,000	$67.29	$4,373,863.00	$9,750.00	$45,500.00	$81,250.00	1.0%	$53,690.00
Apartment, 8-30 Story 15 Story, 11 Ft. Story Height	175,000	$76.29	$13,350,102.50	$26,250.00	$122,500.00	$218,750.00	0.9%	$144,550.00
Auditorium 1 Story, 35 Ft. Story Height	25,000	$119.35	$2,983,785.00	$3,750.00	$17,500.00	$31,250.00	0.6%	$20,650.00
Bank 1 Story, 14 Ft. Story Height	4,000	$114.80	$459,193.60	$600.00	$2,800.00	$5,000.00	0.6%	$3,304.00
Convenience Market 1 Story, 12 Ft. Story Height	5,000	$64.78	$323,891.00	$750.00	$3,500.00	$6,250.00	1.1%	$4,130.00
Courthouse 2 Story, 12 Ft. Story Height	40,000	$105.93	$4,237,116.00	$6,000.00	$28,000.00	$50,000.00	0.7%	$33,040.00
Day Care Center 1 Story, 10 Ft. Story Height	6,000	$70.52	$423,146.40	$900.00	$4,200.00	$7,500.00	1.0%	$4,956.00
Dormitory 3 Story, 10 Ft. Story Height	30,000	$68.42	$2,052,618.00	$4,500.00	$21,000.00	$37,500.00	1.0%	$24,780.00
Fire Station 2 Story, 14 Ft. Story Height	9,000	$90.29	$812,616.30	$1,350.00	$6,300.00	$11,250.00	0.8%	$7,434.00
Garage Parking, Above Ground 4 Story, 10 Ft. Story Height	185,000	$28.67	$5,303,617.00	$27,750.00	$129,500.00	$231,250.00	2.4%	$152,810.00
Garage Parking, Underground 10 Ft. Story Height	90,000	$37.05	$3,334,680.00	$13,500.00	$63,000.00	$112,500.00	1.9%	$74,340.00
Government Building 2 Story, 12 Ft. Story Height	25,000	$90.57	$2,264,332.50	$3,750.00	$17,500.00	$31,250.00	0.8%	$20,650.00
Hospital, General 4 Story, 15 Ft. Story Height	140,000	$182.56	$25,558,344.00	$21,000.00	$98,000.00	$175,000.00	0.4%	$115,640.00
Hotel 4-7 Story 5 Story, 10 Ft. Story Height	100,000	$99.19	$9,919,260.00	$15,000.00	$70,000.00	$125,000.00	0.7%	$82,600.00
Hotel 8-30 Story 15 Story, 10 Ft. Story Height	470,000	$107.06	$50,317,401.00	$70,500.00	$329,000.00	$587,500.00	0.7%	$388,220.00
Jail 2 Story, 12 Ft. Story Height	20,000	$140.99	$2,819,720.00	$3,000.00	$14,000.00	$25,000.00	0.5%	$16,520.00
Manufacturing, Heavy 1 Story, 20 Ft. Story Height	40,000	$74.15	$2,966,044.00	$6,000.00	$28,000.00	$50,000.00	0.9%	$33,040.00
Manufacturing, Light 1 Story, 12 Ft. Story Height	35,000	$51.68	$1,808,954.00	$5,250.00	$24,500.00	$43,750.00	1.4%	$28,910.00
Medical Office 2 Story, 10 Ft. Story Height	8,000	$133.23	$1,065,841.60	$1,200.00	$5,600.00	$10,000.00	0.5%	$6,608.00
Motel 3 Story, 9 Ft. Story Height	46,000	$75.14	$3,456,449.20	$6,900.00	$32,200.00	$57,500.00	0.9%	$37,996.00
Multiple Residence 2 Story, 9 Ft. Story Height	7,000	$75.17	$526,201.20	$1,050.00	$4,900.00	$8,750.00	0.9%	$5,782.00
Office 2-3 Story 3 Story, 12 Ft. Story Height	23,000	$79.38	$1,825,721.60	$3,450.00	$16,100.00	$28,750.00	0.9%	$18,998.00

Property Type Building Parameters	Estimated Square Footage	Average Building Cost Per Square Foot (New)	Total Building Cost (New)	Low-Range Cost for In-Building Solution (New)	Mid-Range Cost For In-Building Solution (New)	High-Range Cost for In-Building Solution (New)	Mid-Range In-Building Solution Cost as % of Total Building Cost (New)	Mid-Range Cost for In-Building Solution (Retrofit)
Office 4-7 Story 6 Story, 12 Ft. Story Height	64,000	$95.85	$6,134,304.00	$9,600.00	$44,800.00	$80,000.00	0.7%	$52,864.00
Office 8-30 Story 20 Story, 12 Ft. Story Height	135,000	$111.75	$15,086,601.00	$20,250.00	$94,500.00	$168,750.00	0.6%	$111,510.00
Restaurant 1 Story, 12 Ft. Story Height	5,000	$102.54	$512,683.50	$750.00	$3,500.00	$6,250.00	0.7%	$4,130.00
Restaurant, Fast Food 1 Story, 10 Ft. Story Height	3,000	$113.26	$339,779.40	$450.00	$2,100.00	$3,750.00	0.6%	$2,478.00
School, Elementary 1 Story, 14 Ft. Story Height	43,000	$111.42	$4,791,184.70	$6,450.00	$30,100.00	$53,750.00	0.6%	$35,518.00
School, Secondary 2 Story, 14 Ft. Story Height	100,000	$108.97	$10,897,370.00	$15,000.00	$70,000.00	$125,000.00	0.6%	$82,600.00
Shopping Center, Strip 1 Story, 10 Ft. Story Height	6,000	$82.17	$493,042.80	$900.00	$4,200.00	$7,500.00	0.9%	$4,956.00
Social Club 1 Story, 12 Ft. Story Height	20,000	$72.83	$1,456,646.00	$3,000.00	$14,000.00	$25,000.00	1.0%	$16,520.00
Store, Department 2 Story, 16 Ft. Story Height	150,000	$75.16	$11,273,385.00	$22,500.00	$105,000.00	$187,500.00	0.9%	$123,900.00
Store, Discount 1 Story, 18 Ft. Story Height	80,000	$63.33	$5,066,704.00	$12,000.00	$56,000.00	$100,000.00	1.1%	$66,080.00
Store, Retail 1 Story, 14 Ft. Story Height	35,000	$65.00	$2,274,930.00	$5,250.00	$24,500.00	$43,750.00	1.1%	$28,910.00
Supermarket 1 Story, 12 Ft. Story Height	20,000	$62.03	$1,240,614.00	$3,000.00	$14,000.00	$25,000.00	1.1%	$16,520.00
Surgical Center 2 Story, 14 Ft. Story Height	10,000	$177.88	$1,778,810.00	$1,500.00	$7,000.00	$12,500.00	0.4%	$8,260.00
Theater, Movie 1 Story, 20 Ft. Story Height	16,000	$93.98	$1,503,683.20	$2,400.00	$11,200.00	$20,000.00	0.7%	$13,216.00
Warehouse 1 Story, 24 Ft. Story Height	45,000	$44.57	$2,005,753.50	$6,750.00	$31,500.00	$56,250.00	1.6%	$37,170.00

On the benefit side of the equation, installing emergency communications equipment in buildings has potential to meaningfully reduce life loss and property damage. The average fire dollar loss in a commercial building fire can reach hundreds of thousands of dollars. While the installation of in-building solutions alone will not *prevent* a fire, ensuring effective and reliable radio communications among emergency public safety personnel can increase the effectiveness of fire suppression and rescue efforts, thus reducing the risk exposure of building occupants and contents.

Further economic benefits could be realized if the investment in such a system helps prevent deaths and injuries to emergency public safety personnel while handling incidents in buildings so equipped.

GLOSSARY/DEFINITIONS

- First Responder: Fire, emergency medical personnel, law enforcement, and other identified entities who, by specialty or profession normally arrive first on the scene of an emergency incident to assess or take action to save lives, protect property, and/or mitigate the situation.[29]
- Interoperability vs. Operability – Simply stated, operability allows public safety personnel to reach other responders on the same radio system; while interoperability allows emergency responders on different radio systems to seamlessly communicate. (Interoperability solutions will not work without basic communications operability.)
- Emergency Communication Equipment: Emergency communication equipment, includes, but is not limited to, two-way radio communications, signal booster, bi-directional amplifiers, radiating cable systems or internal multiple antenna, or a combination of the foregoing.
- Emergency Public Safety Personnel: Emergency public safety personnel includes firefighters, emergency medical personnel, law-enforcement officers and other emergency public safety personnel routinely called upon to provide emergency assistance to members of the public in a wide variety of emergency situations, including, but not limited to, fires, medical emergencies, violent crimes and terrorist attacks.
- Trunking: Trunking a radio system helps with capacity issues. Trunking is used whenever a large number of mobile/hand-held radios need to share radio frequencies. In a trunked radio network, a large number of workgroups/talk groups can share fewer channels because the trunking equipment dynamically allocates an available channel when users key their radio.[30]
- Ultra High Frequency (UHF): A band of radio frequencies from 300 – 3000 MHz.
- Very High Frequency (VHF): Contains low and high band. A band of radio frequencies ranging from 30 -300. Low band is characterized as 39 -150 MHz and high band is characterized from 151 - 300 MHz.
- Voting receiver system: Is basically repeaters feeding repeaters with the strongest signal being the one transmitted. The advantage of a voting receiver system is that it is much more likely that at least one of the receivers will be able to receive the input signal[31].
- Vehicular repeater: A vehicular repeater is a mobile network repeater that provides extended network coverage and on-scene incident capability.[32]

[29] Source: Secure Virginia Panel – Radio Interoperability Working Group
[30] Source: http://www.zetron.com/pages/trunk/
[31] Source: http://www.ussc.com/~uarc/rptr.synfaq1.html
[32] Source: http://www.opensky.com/../network/vrepeater.asp

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APPENDIX I- House Joint Resolution 588

Requesting the Department of Fire Programs, with the assistance of the Department of Emergency Management and the Department of Housing and Community Development, to study the feasibility of adopting requirements within the Commonwealth to ensure that buildings are constructed and equipped in such a way that will permit emergency public safety personnel to utilize effective and reliable radio communications while they are within buildings. Report.

Agreed to by the House of Delegates, January 30, 2003
Agreed to by the Senate, February 13, 2003

WHEREAS, firefighters, emergency medical services personnel, law-enforcement officers, and other emergency public safety personnel routinely are called upon to provide emergency assistance to members of the public in a wide variety of emergency situations, including, but not limited to, fires, medical emergencies, violent crimes, and terrorist attacks; and

WHEREAS, responding to these emergencies frequently requires those emergency public safety personnel to enter offices, commercial facilities, apartments, condominiums, and other buildings under the most exigent and dangerous circumstances; and

WHEREAS, the lives of those emergency public safety personnel who respond to such emergencies, as well as the lives of those persons who may be within a building in which an emergency occurs, frequently depend solely upon the ability of those public safety personnel to communicate by radio transmissions with others who are within such buildings and others who are outside such buildings; and

WHEREAS, reliable emergency public radio transmissions between those who are within buildings and to others outside of buildings have been a significant and continuing problem for emergency public safety personnel; and

WHEREAS, modern construction materials and techniques often make it more difficult for emergency public safety personnel to communicate with other persons within buildings and with other persons outside of buildings because those materials and techniques sometimes block or impede the transmission of radio signals; and

WHEREAS, technology is available in the form of antennas and signal booster devices, which can be used to provide improved and reliable radio communications in buildings for emergency public safety personnel; and

WHEREAS, a number of jurisdictions elsewhere in the United States have enacted laws requiring developers and building owners to install and use antennas and signal booster devices to facilitate reliable radio communication by emergency public service personnel; and

WHEREAS, it is essential for the members of the public and for those emergency public service personnel who are required to enter into buildings during emergencies that the Commonwealth provide a means to ensure effective and reliable in-building radio communications; now, therefore, be it

RESOLVED by the House of Delegates, the Senate concurring, That the Department of Fire Programs, with the assistance of the Department of Emergency Management and the Department of Housing and Community Development, be requested to study the feasibility of adopting requirements within the Commonwealth to ensure that buildings are constructed and equipped in such a way that will permit emergency public safety personnel to utilize effective and reliable radio communications while they are within buildings.

In conducting this study, the Department of Fire Programs shall consult with and consider the views and comments from representatives of the Virginia Association of Counties, the Virginia Municipal League, and organizations representing builders and owners of apartments, condominiums, factories, and retail and commercial office buildings.

All agencies of the Commonwealth shall provide assistance to the Department of Fire Programs upon request.

The Department of Fire Programs shall complete its work by November 30, 2003, and shall submit an executive summary and report of its written findings and recommendations for publication as a document to the Governor and the 2004 Session of the General Assembly. The executive summary and report shall be submitted as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents and reports no later than the first day of the 2004 Regular Session of the General Assembly and shall be posted on the General Assembly's website.

APPENDIX II – HJ 588 Participants

Name	Representing
Duncan Abernathy	Virginia Society of the American Institute of Architects
Ed Altizer	Virginia State Fire Marshal
Jack Anderson	RCC Consultants
Matt Benedetti	Capital Strategies
Lt. R.W. Blystone	Prince George Police Department
Vic Buisset	Virginia Department of Emergency Management
Gregory Britt	Virginia Department of Emergency Management
Tanya Brown	Virginia Department of Emergency Management
Jeffrey Coffman	Fairfax County Fire & Rescue Department
Jennifer Cole	Virginia Department of Fire Programs
Ron Collins	Virginia Department of Fire Programs
Christy Cooper	Apartment and Office Building Association / Building Owners and Managers Association
Dave Dailey	Fairfax County Fire & Rescue Department
James Dawson	Chesterfield Fire & EMS
Glen Dean	State Fire Marshal's Office
Mike Deli	Fairfax County Fire & Rescue
Tim Dennis	CRE Partners
Rick Farthing	State Fire Marshal's Office
Rodney Gohn	Fairfax County Police Department
Cheri Hainer	Virginia Beach - VBCOA
Steve Hall	Chesterfield Fire & EMS
Aubrey W. "Buddy" Hyde, Jr.	Virginia Department of Fire Programs
Mark Ingrao	Apartment and Office Building Association
Norman Johnson	City of Richmond
Christy King	Virginia Department of Fire Programs
Patrick McCloud	Virginia Apartment Management Association / Richmond Apartment Management Association
Curtis McIver	Department of Housing and Community Development
Nelson Migdal	Apartment and Office Building Association
Jim Milby	Building Owners and Managers Association
Dennis Mitchell	Virginia Fire Services Board
Phillip Paquette	Virginia Fire Services Board
Darlene Pope	Apartment and Office Building Association/Building Owners and Managers Association
Todd Pugh	Henrico County General Services
Jack Proctor	Department of Housing and Community Development
Ed Rhodes	Virginia Fire Chiefs Association
Emory Rodgers	Department of Housing and Community Development
Bobby Schenk	Department of General Services – Division of Engineering and Buildings

Bill Shelton	Department of Housing and Community Development
Edwin Smith	Virginia Association of Counties / Henrico County Division of Fire
Jim Spradlin	SPRINT
Adam Thiel	Virginia Department of Fire Programs
Julie Cheyalier Walton	County of Prince George
Charles Werner	Charlottesville Fire Department
Chris Whyte	Virginia Association for Commercial Real Estate
Parker Winborne	Virginia Department of Emergency Management

APPENDIX III – House Bill 2529

VIRGINIA ACTS OF ASSEMBLY – CHAPTER

An Act to amend the Code of Virginia by adding a section numbered 36-99.6:2, relating to the Uniform Statewide Building Code; installation of communication equipment for emergency public safety personnel.

[H 2529]
Approved

Be it enacted by the General Assembly of Virginia:

1. That the Code of Virginia is amended by adding a section numbered 36-99.6:2 as follows:

§ 36-99.6:2. Installation of in-building emergency communication equipment for emergency public safety personnel.

The Board of Housing and Community Development shall promulgate regulations as part of the Building Code requiring such new commercial, industrial, and multifamily buildings as determined by the Board be (i) designed and constructed so that emergency public safety personnel may send and receive emergency communications from within those structures or (ii) equipped with emergency communications equipment so that emergency public safety personnel may send and receive emergency communications from within those structures.

For the purposes of this section:

"Emergency communications equipment" includes, but is not limited to, two-way radio communications, signal boosters, bi-directional amplifiers, radiating cable systems or internal multiple antenna, or any combination of the foregoing.

"Emergency public safety personnel" includes firefighters, emergency medical services personnel, law-enforcement officers, and other emergency public safety personnel routinely called upon to provide emergency assistance to members of the public in a wide variety of emergency situations, including, but not limited to, fires, medical emergencies, violent crimes, and terrorist attacks.

Legislative Information System
http://leg1.state.va.us/cgi-bin/legp504.exe?031+ful+HB2529ER 03/26/2003

APPENDIX IV – Draft Proposed USBC Code Change

HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM
(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us	Document No. ________________ Committee Action: ______________ BHCD Action: _________________

Submitted by: DHCD	Representing: DHCD for VDFP/Client Work Group
Address: 501 2nd Street, Richmond, VA	Phone No.: 804-371-7140
Regulation Title:2003 USBC/SFPC	Section No(s): 2003 USBC/IBC 902, 912 & SFPC 511

Proposed Change: USBC IBC 902.0 Definitions
Add 902.1 Definitions.
Emergency Communication Equipment. Emergency communication equipment, includes, but is not limited to, two-way radio communications, signal booster, bi-directional amplifiers, radiating cable systems or internal multiple antenna, or a combination of the foregoing.
Emergency Public Safety Personnel. Emergency public safety personnel includes firefighters, emergency medical personnel, law-enforcement officers and other emergency public safety personnel routinely called upon to provide emergency assistance to members of the public in a wide variety of emergency situations, including, but not limited to, fires, medical emergencies, violent crimes and terrorist attacks.

Add new section into the USBC IBC Section 912.0 In-building Emergency Communication Radio Coverage
912.1. General. The locality shall determine by a written policy that it is necessary to require an in-building emergency communication radio system to be designed and constructed so that emergency public safety personnel may send and receive emergency communications from within those structures or be equipped with emergency communication equipment so that emergency public safety personnel may send and receive emergency communications from within those structures within the locality or designated geographical areas of the locality. An in-building emergency communication equipment for emergency public safety personnel shall be provided in unlimited area buildings and buildings of Construction Types I, II, III, IV and V as regulated by the International Building Code.
Exceptions:
1. Local and state governments, federal space within private buildings and private buildings/spaces with top security clearance requirements where the building official has approved an alternate method to provide emergency communication equipment for emergency public safety personnel.
2. Where the owner provides documentation from a qualified individual approved by the building official where emergency communication equipment would not be required for two-way radio communication.
3. Above-grade single story buildings of 12,000s.f. or less.
4. USBC Group R-5 of the International Residential Code and Groups R-3 and R-4 of the International Building Code.
5. Construction Type IV and V buildings of combustible construction without basements.
6. Where the building official approves alternate technology to provide in-building emergency

communications for emergency public safety personnel.
912.1.1. Applicability. The provisions of this section shall apply to building applications filed on and after the set forth effective date of this code.
912.2. General. Where required, in-building radio coverage shall be designed, installed, inspected and tested in accordance with provisions of this section.
912.2.1. A minimum signal strength of –95dBm, as measured at the antenna terminal of the public safety portable transceiver, shall be available to receive and transmit in 95% of the area on each floor of the building from or to the designated public safety radio system. A minimum received signal strength of –95dBm, as measured at the designated radio system fixed end receiver terminal, shall result for portable radio transmissions made in 95% of the area on each floor of the building. The building official shall be permitted to accept lower minimum signal strength specifications where required for the radio system technology used in a jurisdiction.
912.2.1.1. Where bi-directional amplifier systems are installed, the proof of performance signal strength measurement for the downlink path shall be based on a control channel or traffic channel signal from the designated public safety radio system. Signal strength measurements for the uplink path shall be based on one input signal generated using a portable radio operated at the worst-case extremity of the distributed antenna system. Bi-directional amplifiers shall be maintained an out of band noise, intermodulation, and spurious emissions to desired carrier ratio of at least 35 dBc when measured against public safety system carrier signal levels.
912.2.2. The in-building emergency communication radio system shall be designed for a 95% reliability factor.
912.2.3. Where the installed in-building emergency communication radio system contains electrically powered components there shall be an independent power source to provide power for a period of twelve ours without external power input. Where a battery system is installed there shall be automatic charging in the presence of an external power input.
912.2.4. The in-building emergency communication radio system shall have the capability for self-monitoring of the emergency communication equipment. Where there is a requirement for a supervised fire alarm system the emergency communications equipment self-monitoring can be tied into the building fire alarm system. Where there is no required supervised fire alarm system, there shall be a visual/audible alarm for self-monitoring in the vicinity of the emergency communication equipment.
912.3. Acceptance test procedures. Upon completion of the installation, the performance of the in-building emergency communication radio system shall be tested to ensure that the 95% area and 95% reliability requirements are satisfied.
912.3.1. The text shall be conducted using a public safety portable radio with speaker microphone or equivalent portable radios approved by the building official.
912.3.2. Where bi-directional amplifier systems are installed, the gain value and output levels of all uplink and
downlink amplifiers shall be measured and documented, and the acceptance test results shall be kept on file with the building owner for verification each year during the annual inspection and tests.
912.3.3. A copy of the acceptance test records shall be kept on the premises and a copy shall be submitted to the fire official.
912.3.4. The acceptance tests shall be conducted and certified by a qualified individual approved by the building official.

Add new section to the SFPC 511.0. Maintenance of in-building emergency communication radio systems
511.1 General. In-building emergency communication radio systems shall be maintained in accordance with the USBC and the provisions of this section.
511.2. Annual inspection. The annual inspection shall test all components of the system, including but not limited to, amplifiers, independent power sources, antennas and wiring a minimum of once every twelve months.

511.2.1. The annual and five-year inspection tests shall be performed by the locality or by qualified individuals or agencies approved by the fire official.
.511.2.2. Amplifiers shall be tested to ensure that the gain and output levels are the same as designated on the approved acceptance test. The independent power source shall be tested under load for a period of one hour.
511.2.3. All components shall function in accordance with the manufacturer's specifications and intended purpose.
511.3. Five-year tests. No less than every five years, a radio coverage test shall be performed to ensure that the in-building emergency communication radio system meets the requirement of the original acceptance coverage test in accordance with the USBC under which the building was built. Note: The USBC requires on each floor 95% coverage and minimum signal strength of 95dBm for receiving and transmission.
511.4. Field tests. After providing reasonable notice to the owner or their representative the fire official, fire or police chief or their agents shall have the right during normal business hours to enter onto the property to conduct field tests to verify that the required level of radio coverage is present at no cost to the owner. Any noted deficiencies shall be provided in an inspection report to the owner or the owner's representative.
511.5. A copy of the annual and five-year inspection tests shall be kept on the premises and the fire official shall retain a copy.

Supporting Statement:
IBC 902 add definitions from the Code of Virginia
IBC 912 add new section
IBC 912.1 Scope Requires localities to have systems installed in Construction Types I, II, III, IV and V unless they fall into the 6 exceptions. Offers the opportunity for the locality to opt in. Another option that will be considered concurrently is to seek legislative action amending 36-99.6.2 to allow local optional enforcement. The exceptions provide for alternate means and new technology; allows the owner to provide data to contest the requirement; and, allows for most all smaller commercial and residential buildings to be exempted. Some commenters believe the 12,000 s.f. is too low and should be raised, but a substitute number has not been proposed. The VSAIA recommends that the Scope to be limited to Construction Types I which are the larger multi-story buildings. or very large one story unlimited area buildings such as retail box stores Multi-family mid-rise buildings of 3 to 5 story buildings of Construction Types IV and V without basements would be exempted and most of the ones with basements would probably not be designated for wiring/conduits. Some want Groups E and I exempted as they are generally not considered “commercial buildings” as referenced in the law.
IBC 912.1.1 Only applicable to buildings built after the effective date of this code.
IBC 912.2 Set forth the technical, inspection and testing requirements. These are industry standards used by multiple vendors and different type systems. Localities can use lower signal strengths per 912.2.1.
912.2.3 Provides separate power source to ensure operation with loss of building power.
912.2.4 Provides self-monitoring so maintenance personnel or public safety personnel can tell system is operable.
912.3 Provides the acceptance test criteria for new installations.
SFPC 511.0 to 511.5. Provides for an annual inspection and five-year tests of the entire system to be based on the standards and USBC built under.

This code change will increase the cost of construction for those building designated to have these systems installed. Cost estimates run from a few thousand dollars to several hundreds of thousands of dollars. Based on meeting discussions not every new building designated within 912.1 would need to be wired or provide amplification equipment. To date there isn't a consensus on this code change proposal.

APPENDIX V – Line-of-Duty Death Investigations

Incident	Citation and Communications Key Issue
Wood Truss Roof Collapse Claims Two Firefighters Memphis, Tennessee Incident Date: Dec. 26, 1992	*Source: United States Fire Administration, Technical Report Series, Report 069.* *Investigated by J. Gordon Routley.* **Communications Issue:** Incident Commander was unable to communicate with companies over tactical radio.
Four Firefighters Killed, Trapped by Floor Collapse Brackenridge, Pennsylvania Incident Date: Dec. 20, 1991	*Source: United States Fire Administration, Technical Report Series, Report 061.* *Investigated by J. Gordon Routley.* **Communications Issue:** Radio system was inadequate for current needs.
Indianapolis Athletic Club Fire Indianapolis, Indiana Incident Date: Feb. 5, 1992	*Source: United States Fire Administration, Technical Report Series, Report 063.* *Investigated by Mark Chubb.* **Communications Issues:** Communications Equipment – One firefighter was seriously burned attempting to activate the emergency notification button on his portable radio. Communications Systems – Problems in communication between the Incident Commander and the Communications Center may be related to the activation of a new radio system shortly before the incident. Additional training should have been conducted.
The East Bay Hills Fire Oakland-Berkeley, California Incident Date: Oct. 19-22, 1991	*Source: United States Fire Administration, Technical Report Series, Report 060.* *Investigated by J. Gordon Routley.*

	<u>Communications Issue:</u> Radio channels and Communications Center overwhelmed by situation.
Floor Collapse Claims Two Firefighters Pittston, Pennsylvania Incident Date: March 15, 1993	*Source: United States Fire Administration, Technical Report Series, Report 073.* *Investigated by J. Gordon Routley.* **<u>Communications Issue:</u>** Radio System is inadequate for the needs of the fire department. Entry crews did not have portable radios to communicate with Incident Commander.
Structural Collapse at Residential Fire Claims Lives of Two Volunteer Fire Chiefs and Once Career Fire Fighter New Jersey Incident Date: July 4, 2002 Report Date: Aug. 19, 2003	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200232.html* **<u>Communications Recommendation:</u>** Establish and maintain regional mutual-aid radio channels to coordinate and communicate activities involving units from multiple jurisdictions.
Volunteer Fire Fighter Killed and Career Chief Injured During Residential House Fire Tennessee Incident Date: March 1, 2002 Report Date: Sept. 3, 2002	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200232.html* **<u>Communications Recommendation:</u>** Ensure that fire fighters are equipped with a radio that does not bleed over, cause interference, or lose communication under field conditions.
Career Fire Fighter Dies After Becoming Trapped by Fire In Apartment Building New Jersey Incident Date: May 9, 2002 Report Date: March 21, 2002	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200118.html* **<u>Communications Recommendation:</u>** Establish and maintain multiple operating frequencies for emergency services, allowing portable radios at incidents to be equipped with two frequencies, one channel for tactical messages and one channel for command.

Career Fire Fighter Dies After Falling Through the Floor Fighting a Structure Fire at a Local Residence Ohio Incident Date: March 8, 2001 Report Date: Feb. 28, 2002	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200116.html* **Communications Recommendation:** Ensure that personnel equipped with a radio, position the radio to receive and respond to radio transmissions.
Residential Fire Claims the Lives of Two Volunteer Fire Fighters and Seriously Injures an Assistant Chief Missouri Incident Date: March 18, 2001 Report Date: Nov. 20, 2001	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200115.html* **Communications Recommendation:** Provide adequate on-scene communications including fireground tactical channels.
Volunteer Fire Fighter (Lieutenant) Killed and One Fire Fighter Injured During Mobile Home Fire Pennsylvania Incident Date: Jan. 11, 2001 Report Date: Aug. 8, 2001	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200104.html* **Communications Recommendation:** Ensure that personnel equipped with a radio, position the radio to receive and respond to radio transmissions.
Roof Collapse Injures Four Career Fire Fighters at a Church Fire Arkansas Incident Date: Dec. 28, 2000 Report Date: Oct. 30, 2001	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200103.html* **Communications Recommendation:** Ensure that fire fighters are equipped with a radio that does not bleed over, cause interference, or lose communication under field conditions.
Residential House Fire Claims the Life of One Career Fire Fighter Florida Incident Date: Nov. 25, 2003	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200044.html* **Communications Recommendation:**

Report Date: Aug. 2, 2001	Consider providing all fire fighters with portable radios or integrated into their face pieces.
A Volunteer Assistant Chief Was Seriously Injured and Two Volunteer Fire Fighters Were Injured While Fighting a Townhouse Fire Delaware Incident Date: Oct. 29, 2000 Report Date: March 7, 2001	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200043.html* **Communications Recommendation:** Ensure that the assignment of a tactical channel is established by Central Dispatch prior to personnel entering a hazardous environment.
Residential Structure Fire Claims the Life of One Career Fire Fighter Alabama Incident Date: April 20, 2000 Report Date: Aug. 3, 2001	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200026.html* **Communications Recommendation:** Ensure that fireground communication is present through both the use of portable radio and face-to-face communications.
Structure Fire Claims the Lives of Three Career Fire Fighters and Three Children Iowa Incident Date: Dec. 22, 1999 Report Date: April 11, 2001	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face200004.html* **Communications Recommendation:** Ensure that fireground communication is present through both the use of portable radios and face-to-face communications.
Warehouse Fire Claims the Life of a Battalion Chief Missouri Incident Date: Dec. 18, 1999 Report Date: Nov. 6, 2002	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9948.html* **Communications Recommendation:** Ensure that fire fighters are equipped with a radio that does not bleedover, cause interference, or lose communication under field conditions.
Six Career Fire Fighters Killed in Cold-Storage and Warehouse Building Fire	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9947.html*

Massachusetts Incident Date: Dec. 3, 1999 Report Date: Sept. 27, 2000	**<u>Communications Recommendation:</u>** Ensure that standard operating procedures (SOPs) and equipment are adequate and sufficient to support the volume of radio traffic at multiple-alarm fires.
Two Firefighters Dies and Two are Injured in Townhouse Fire District of Columbia Incident Date: May 30, 1999 Report Date: Nov. 23, 1999	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9921.html* **<u>Communications Recommendation:</u>** Ensure that personnel equipped with a radio position the radio to receive and respond to radio transmissions.
Eight-Alarm Fire in a 27-Story High-Rise Apartment Building for the Elderly Nearly Claims the Life of One Fire Fighter Missouri Incident Date: Oct. 12, 1998 Report Date: Feb. 23, 199	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9826.html* **<u>Communications Recommendation:</u>** Ensure that procedures are established to record fireground radio communications.
Sudden Floor Collapse Claims the Lives of Two Fire Fighters and Four Are Hospitalized with Serious Burns in a Five-Alarm Fire New York Incident Date: June 5, 1998 Report Date: Nov. 30, 1998	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9817.html* **<u>Communications Recommendation:</u>** Ensure that communication equipment used on the fireground, e.g., handie-talkies, will remain operational in the event that one until malfunctions.
Commercial Structure Claims the Life of One Fire Fighter California Incident Date: March 8, 1998 Report Date: July 24, 1998	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9807.html* **<u>Communications Recommendation:</u>** Ensure sufficient personnel are available and properly functioning communications equipment are available to use to adequately support the volume of

	radio traffic at multiple-responder fire scenes.
Single-Family Dwelling Fire Claims the Lives of Two Volunteer Fire Fighters Ohio Incident Date: Feb. 5, 1998 Report Date: June 16, 1998	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9806.html* **Communications Recommendation:** Provide adequate on-scene communications including fireground tactical channels.
Floor Collapse in a Single Family Dwelling Fire Claims the Life of One Fire Fighter and Injures Another Kentucky Incident Date: Feb. 17, 1997 Report Date: April 27, 1998	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9704.html* **Communications Recommendation:** Ensure that fire fighters who enter hazardous areas, e.g., burning or suspected unsafe structures, be equipped with two-way communications with incident command.
Sudden Roof Collapse of a Burning Auto Parts Store Claims the Lives of Two Fire Fighters Virginia Incident Date: March 18, 1996 Report Date: April 27, 1998	*Source: The National Institute for Occupational Safety and Health (NIOSH)* *http://www.cdc.gov/niosh/face9617.html* **Communications Recommendation:** Fire departments should ensure that standard operating procedures and equipment are adequate and sufficient to support the volume of radio traffic at multiple-responder fire scenes.

APPENDIX VI – Fairfax County Data Sample

"Margin needed to cover 95%" indicates the amount of building penetration design margin needed to provide usable signal to 95% of the indoor test points, when ordered from lowest penetration loss to highest penetration loss.

-34	average
-55	max
-14	min
-32	median
9	stdev

Positive numbers in the "Min Loss" column indicate that indoor signal strength at one or more indoor test points exceed the outside average. These locations can be considered as having 0 dB penetration loss.

Building / Location	Description	Margin needed to cover 95%	Mean loss	Median loss	Min loss	Max loss	# of samples	Est. % covered w/ head portable	Est. % covered w/ SMA portable	Est. % covered w/ hip portable
							Averages	**91**	**71**	**48**
Tysons I Mall, Tysons	2 - 3 story large shopping mall	**-39**	-19	-18	9	-41	2434	86	69	48
Giant, Vienna	1 story grocery store on end of strip mall	**-26**	-19	-19	4	-31	404	88	29	3
Famous Dave's BBQ, Oakton	1 story restaurant on end of strip mall	**-14**	-6	-7	7	-21	92	100	100	91
Books A Million, Oakton	1 story strip mall storefront in middle of strip mall	**-28**	-19	-19	1	-34	143	97	71	20
Giant, Oakton	1 story grocery store on end of strip mall	**-28**	-19	-20	1	-35	621	98	69	20
Hallmark, Oakton	1 story strip mall storefront in middle of strip mall	**-26**	-18	-19	-4	-28	111	100	75	23
Toy Corner, Oakton	1 story strip mall storefront in middle of strip mall	**-24**	-14	-13	2	-27	95	100	87	53
Teacher's Store, Oakton	1 story strip mall storefront in middle of strip mall	**-24**	-16	-16	-4	-27	116	100	90	37
Oakmarr Rec Center, Oakton	2 story county recreation center, partial below grade	**-33**	-14	-12	13	-41	480	98	91	76
Oakton High School, Oakton	2 story large high school	**-43**	-24	-23	-1	-52	1289	98	90	76
Costco, Fair Oaks	1 story warehouse store	**-26**	-15	-15	8	-34	1507	100	100	100
County Radio Shop, Fairfax	1 story block/Butler service shop with offices	**-36**	-20	-21	5	-43	478	100	89	59
South Run Recreation Center, Pohick	2 story county recreation center, partial below grade	**-32**	-16	-13	3	-34	392	82	64	44
Fairfax PSCC, Annandale	First floor of 2-story 911 center, former elem. school	**-33**	-18	-17	3	-37	520	91	71	39
3701 S George Mason, Bailey's Crossroads	First floor of 26 story high rise apartment	**-30**	-23	-23	-7	-32	105	94	35	3
3701 S George Mason, Bailey's Crossroads	23rd floor of 26 story high rise apartment	*	*	*	*	*	143	100	100	99
Herndon Police HQ, Herndon	1 story brick police station and offices	**-26**	-15	-16	6	-35	510	100	92	49
Worldgate Garage, Herndon	Basement parking garage, at and below grade	**-40**	-36	-38	-5	-40	396	30	10	3
Herndon Museum, Herndon	1 story wood frame old train station	**-20**	-9	-8	5	-29	125	100	100	98
Herndon Municipal Center, Herndon	2 story brick and concrete office building	**-23**	-11	-11	4	-32	134	100	96	81
WalMart, Hybla Valley	1 story department store	**-31**	-21	-21	-4	-40	724	100	100	97
Mt. Vernon Hospital, Hybla Valley	First floor of six story hospital	**-48**	-26	-26	3	-55	516	98	91	71
Mt. Vernon Hospital, Hybla Valley	Below grade tunnel in six story hospital	**-55**	-45	-50	-9	-57	93	59	33	17
Mt. Vernon Hospital, Hybla Valley	Below grade tunnel and first floor, six story hospital	**-53**	-29	-29	3	-57	620	92	82	63
Fairfax Hospital, Merrifield	Emergency department treatment and waiting areas	**-49**	-38	-40	-12	-51	296	79	43	19
Fairfax Hospital, Merrifield	Radiology	**-49**	-37	-37	-18	-51	227	87	53	12
Fairfax Hospital, Merrifield	Women's center, neonatal 2nd floor	**-46**	-33	-34	-2	-51	370	95	58	27
Fairfax Hospital, Merrifield	Labor and delivery, 3rd floor	**-43**	-29	-29	6	-47	171	98	80	46
Fairfax Hospital, Merrifield	Original building, 2nd floor	**-37**	-23	-22	-8	-39	75	100	93	71
Fairfax Hospital, Merrifield	Original building, ground floor and cafeteria	**-40**	-23	-23	1	-47	192	99	85	67
Fairfax Hospital, Merrifield	Conference center	**-25**	-16	-16	1	-35	76	100	100	96
Fairfax Hospital, Merrifield	Warehouse	**-45**	-23	-23	7	-51	227	95	80	67
Fairfax Hospital, Merrifield	Cafeteria kitchen	**-51**	-44	-44	-30	-51	145	60	8	0
Fairfax Hospital, Merrifield	Linens	**-51**	-49	-51	-42	-51	87	8	0	0
Fairfax Hospital, Merrifield	Blood bank, oncology lower level	**-51**	-48	-49	-15	-51	226	27	3	1
Fairfax Hospital, Merrifield	Morgue	**-37**	-24	-24	-2	-51	96	99	92	65
Fairfax Hospital, Merrifield	Fire control room	**-31**	-20	-19	-13	-35	43	100	100	91
Fairfax Hospital, Merrifield	Critical Care Trauma	**-49**	-42	-43	-23	-51	180	75	15	6
Fairfax Hospital, Merrifield	CCU3	**-44**	-35	-35	-18	-48	62	97	56	23
Fairfax Hospital, Merrifield	Pharmacy, surgery	**-46**	-33	-35	-12	-51	191	93	55	34
Fairfax Hospital, Merrifield	Tower building, first floor	**-37**	-21	-23	2	-39	73	100	92	68

								Averages		
								91	**71**	**48**
Building / Location	**Description**	**Margin needed to cover 95%**	**Mean loss**	**Median loss**	**Min loss**	**Max loss**	**# of samples**	**Est. % covered w/ head portable**	**Est. % covered w/ SMA portable**	**Est. % covered w/ hip portable**
Fairfax Hospital, Merrifield	Pulmonary	**-39**	-28	-27	-5	-44	148	100	89	55
Fairfax Hospital, Merrifield	Entire visit	**-51**	-33	-35	7	-51	2886	83	55	34
8000 Towers Crescent Dr., Tysons	1st floor of 18 story large office building	**-32**	-13	-13	9	-36	235	100	93	77
Herndon Target, Herndon	1 story large department store	**-33**	-23	-23	3	-45	553	100	100	99
Belle Haven Marina, Belle Haven	Concrete block Natnl. Park Service Bathroom at Marina	**-18**	-9	-8	1	-20	43	100	72	28
Vienna PD 1st Floor, Vienna	1 story block/brick police station	**-22**	-14	-14	4	-24	137	100	65	20
Vienna PD Basement, Vienna	1 story block/brick police station, lower level	**>=-31**	-28	-31	-5	-31	120	21	8	3
Vienna PD Entire Building, Vienna	1story block/brick police station, entire visit	**>=-31**	-20	-19	4	-31	257	63	39	12
PJ Skidoos, Fairfax	Main floor bar/restaurant	**-35**	-23	-23	-3	-40	203	100	80	40
PJ Skidoos, Fairfax	Main floor bar/restaurant	**>=-44**	-38	-39	-3	-44	198	41	9	3
Fire Station 414, Burke	1 story block fire station w/ metal roof	**-35**	-25	-25	-5	-38	780	89	41	10
Centreville High School	3 story block high school - main office area	**-37**	-29	-31	-5	-41	122	97	38	14
Centreville High School	3 story block high school - main front corridor	**-29**	-20	-20	-5	-33	74	100	92	54
Centreville High School	3 story block high school - 1st fl. corridor 1A	**-27**	-15	-14	1	-34	39	100	97	82
Centreville High School	3 story block high school - 1st fl. corridor 1B	**-30**	-16	-17	1	-36	99	100	94	71
Centreville High School	3 story block high school - 1st fl. corridor 1C	**-32**	-17	-16	3	-38	64	98	89	66
Centreville High School	3 story block high school - 1st fl. corridor 1D	**-21**	-11	-10	2	-28	68	100	100	94
Centreville High School	3 story block high school - 1st fl. dining area	**-23**	-11	-10	4	-30	141	100	99	91
Centreville High School	3 story block high school - 1st fl. athletics area	**-34**	-21	-20	-1	-39	341	99	80	51
Centreville High School	3 story block high school - 1st fl. theatre/music area	**-33**	-22	-24	-6	-39	118	99	79	41
Centreville High School	3 story block high school - entire visit	**-34**	-19	-18	5	-41	1067	99	82	58
McNair Farms Elementary School	2 story new block elementary school 1st floor	**-30**	-16	-16	3	-34	753	97	69	42
McNair Farms Elementary School	2 story new block elementary school 2nd floor	**-27**	-13	-14	5	-31	229	100	84	48
McNair Farms Elementary School	2 story new block elementary school entire visit	**-29**	-15	-15	5	-34	982	97	73	43
Inova Urgent Care, Centreville	1 story medical facility	**>=-28**	-23	-24	-15	-28	189	55	2	0
Robinson High School	3 level, "super school", entire visit	**-37**	-24	-25	-1	-41	1727	92	57	25
Robinson High School	3 level, "super school", main hall and assoc. areas	**-37**	-25	-26	-1	-41	842	93	52	22
Robinson High School	3 level, "super school", north side, upper level	**-32**	-21	-21	-2	-37	430	100	76	38
Robinson High School	3 level, "super school", north side, lower level	**-39**	-28	-29	-8	-41	356	80	39	13
Robinson High School	3 level, "super school", gym and areas on south side	**-32**	-22	-21	-11	-34	99	100	77	32
Carson Middle School, Chantilly	2 level middle school, second floor	**-19**	-7	-7	13	-28	351	100	100	97
Carson Middle School, Chantilly	2 level middle school, first floor	**-30**	-16	-17	10	-36	670	100	96	76
Carson Middle School, Chantilly	2 level middle school, entire visit	**-28**	-13	-13	13	-36	1021	100	97	84
Westfields High School, Chantilly	2 level high school, first floor	**-33**	-22	-23	9	-35	1169	78	40	13
Westfields High School, Chantilly	2 level high school, second floor	**-29**	-20	-21	-1	-33	485	98	48	18
Westfields High School, Chantilly	2 level high school, entire visit	**-33**	-21	-22	9	-35	1654	84	42	14
Paul Springs Retirement Home, Ft. Hunt Rd.	1 - 3 story retirement home	**-24**	-17	-18	1	-27	428	93	23	2
5840 Cameron Run Terrace	5th floor of high rise apartment building	*	*	*	*	*	*	100	96	70
5840 Cameron Run Terrace	1st floor of high rise apartment building	**-30**	-24	-24	-8	-35	176	98	40	7
Chantilly Public Library	1 story public library, library (public) section	**-31**	-13	-12	14	-37	201	100	93	84
Chantilly Public Library	1 story public library, operations (private) section	**-36**	-27	-28	1	-40	275	99	61	18
Chantilly Public Library	Entire visit	**-35**	-21	-23	14	-40	476	99	75	46
Hayfield Secondary School	1st floor of large 2 story middle/high school complex	**-43**	-24	-25	12	-47	2287	94	71	53
Hayfield Secondary School	Basement of large 2 story middle/high school complex	**-35**	-23	-24	3	-44	250	100	89	59
Hayfield Secondary School	Entire visit of large 2 story middle/high school complex	**-43**	-24	-25	12	-47	2537	95	73	53
5366 Summit Drive (Pat's House)	3 level single family home, includes walkout basement	**-17**	-7	-7	6	-31	138	100	99	97

Building / Location	Description	Margin needed to cover 95%	Mean loss	Median loss	Min loss	Max loss	# of samples	Est. % covered w/ head portable	Est. % covered w/ SMA portable	Est. % covered w/ hip portable
							Averages	91	71	48
South County Government Center	5 story County office building, brand new construction	-39	-25	-25	-5	-47	820	99	88	56
GMU Field House	Concrete block/steel athletic house, main area	-26	-18	-18	-6	-29	263	100	79	17
GMU Field House	Concrete block/steel athletic house, weight room	-22	-15	-14	-5	-27	68	100	94	46
GMU Field House	Concrete block/steel athletic house, stairwell, rooms	-29	-20	-20	-4	-33	558	98	57	20
GMU Johnson Center	Concrete student union building, first floor	-25	-13	-13	-4	-32	253	100	100	91
GMU Johnson Center	Concrete student union building, lower level	-42	-34	-39	-1	-43	207	61	23	13
JDR Courtroom C	1st floor of two story brick courthouse/jail	-31	-24	-24	-14	-35	56	100	88	30
JDR Courtroom D	1st floor of two story brick courthouse/jail	-32	-23	-22	-13	-34	62	100	85	39
JDR Security Corridor	1st floor of two story brick courthouse/jail	-29	-19	-18	-5	-32	103	100	95	70
JDR vending machine area	Basement level of 2 story brick courthouse/jail	-39	-35	-37	-1	-40	137	77	15	7
JDR Courtroom B/C lobby	1st floor of two story brick courthouse/jail	-27	-18	-18	-5	-30	44	100	98	77
JDR Security Corridor	1st floor of two story brick courthouse/jail	-26	-16	-15	-7	-30	64	100	98	86
JDR entire visit	Entire visit	-39	-24	-22	-1	-40	466	93	70	45
JDR first floor only	1st floor of 2 story brick courthouse/jail	-30	-20	-19	-5	-35	329	100	93	61
FCWA Admin Building	Lower level of office building, below grade areas	-46	-30	-31	-9	-53	119	99	88	59
FCWA Admin Building	Main floor of office building, at grade	-31	-20	-22	-7	-35	35	100	100	100
FCWA Engineering Building	Lower level of office building, below grade areas	-28	-18	-18	-2	-36	140	100	100	99
FCWA Engineering Building	Main floor of office building, at grade	-17	-9	-7	-1	-22	74	100	100	100

APPENDIX VII – Operational Anecdotes From Tidewater, Virginia Area

Fire departments in the Tidewater area were polled for information regarding in-building radio communication problems experienced with emergency/non-emergency communications.

The following are the responses received.

James City County, Virginia

Has your department experienced radio communications failures in buildings in your city over the past 12 months? **Yes**

What type of construction was present when the problem was identified?

Type I, Fire – Resistive Construction **Yes**
Type II, Non-Combustible Construction **Yes**
Type III, Ordinary Construction **No**
Type IV, Heavy Timber Construction **Yes**
Type V, Woodframe **No**

What is the size of the building and number of floors? **1,000 square feet, 1 floor**

What type of occupancy is located in the building where the problem was encountered? **M – I Industrial**

Did you know that the Virginia Department of Fire Programs was conducting a feasibility study related to “Reliable In-Building Radio Communications for Public Safety” prior to receiving this survey questionnaire? **Yes**

Virginia Beach, Virginia

Has your department experienced radio communications failures in buildings in your city over the past 12 months? **Yes**

What type of construction was present when the problem was identified?

Type I, Fire – Resistive Construction **Yes**
Type II, Non-Combustible Construction **Yes**
Type III, Ordinary Construction **No**
Type IV, Heavy Timber Construction **No**
Type V, Woodframe **No**

What is the size of the building and number of floors? **24 story office and warehouse**

What type of occupancy is located in the building where the problem was encountered? **Mixed use office**

Did you know that the Virginia Department of Fire Programs was conducting a feasibility study related to "Reliable In-Building Radio Communications for Public Safety" prior to receiving this survey questionnaire? **Yes**

<u>Newport News, Virginia</u>

Has your department experienced radio communications failures in buildings in your city over the past 12 months? **Yes**

What type of construction was present when the problem was identified?

Type I, Fire – Resistive Construction **Yes**
Type II, Non-Combustible Construction **Yes**
Type III, Ordinary Construction **No**
Type IV, Heavy Timber Construction **No**
Type V, Woodframe **No**

What is the size of the building and number of floors? **Large commercial with multiple floors**

What type of occupancy is located in the building where the problem was encountered? **Hospital, research facilities, warehouse, and office complex**

Did you know that the Virginia Department of Fire Programs was conducting a feasibility study related to "Reliable In-Building Radio Communications for Public Safety" prior to receiving this survey questionnaire? **No**

NOTE: Additional problems exist in bridge tunnels and on large ships

<u>Portsmouth, Virginia</u>

Has your department experienced radio communications failures in buildings in your city over the past 12 months? **Yes**

What type of construction was present when the problem was identified?

Type I, Fire – Resistive Construction **Yes**
Type II, Non-Combustible Construction **Yes**
Type III, Ordinary Construction **Yes**
Type IV, Heavy Timber Construction **No**
Type V, Woodframe **No**

What is the size of the building and number of floors? **Large buildings and multiple floor buildings**

What type of occupancy is located in the building where the problem was encountered? **Shopping centers, tunnels, and apartment buildings**

Did you know that the Virginia Department of Fire Programs was conducting a feasibility study related to "Reliable In-Building Radio Communications for Public Safety" prior to receiving this survey questionnaire? **Yes**

<u>Hampton, Virginia</u>

Has your department experienced radio communications failures in buildings in your city over the past 12 months? **Yes – the City of Hampton and the Hampton Division of Fire & Rescue operate a GE/Ericsson 800 MHz Trunked radio system. This system operates via two transmitter/repeater sites. Once is located on Buckroe Avenue and the other on Pine Chapel Road. Most of our radio difficulties are concentrated in the northwest section of Hampton. It has been determined that these difficulties are not necessarily due to distance from the transmitter, but a combination of distance from the transmitter, building construction, and location within the building.**

What type of construction was present when the problem was identified?

Type I, Fire – Resistive Construction **Yes**
Type II, Non-Combustible Construction **No**
Type III, Ordinary Construction **No**
Type IV, Heavy Timber Construction **No**
Type V, Woodframe **No**

What is the size of the building and number of floors? **All occupancies are over 50,000 square feet**

What type of occupancy is located in the building where the problem was encountered?

- **Verizon Building, 5200 West Mercury Boulevard, two floors**
- **New Market Mall, 5200 West Mercury Boulevard, two floors**
- **AMC 24 - Theater Complex, Towne Centre Way, three floors**
- **Farm Fresh, Town Centre Way, one floor**
- **West Telemarketing, 247 Foxhill Road, one floor**
- **Farm Fresh, 247 Foxhill Road, one floor**
- **Food Lion, 3855 Kecoughtan Road, one floor**
- **Old Sentara Hampton General Building, 3120 Victoria Boulevard, six floors (anywhere below the ground floor)**
- **Hampton General District Court, 36 South King Street, three floors**

Did you know that the Virginia Department of Fire Programs was conducting a feasibility study related to “Reliable In-Building Radio Communications for Public Safety” prior to receiving this survey questionnaire? **Yes**

APPENDIX VIII – Operational Anecdotes From Fairfax County, Virginia

The following are anecdotes collected from firefighters in the Fairfax County area. These are displayed by individual and are unedited.

*****

One was a fire in 8's area at Ravenworth Towers. I was OIC of T410 when the IC called me to give me an assignment. I was in the stairwell making my way to the floor above the fire and could not get out to acknowledge his call. I made my way to the next floor and down the hall about 20 to 30 feet at which point I was able to acknowledge his transmission and get the assignment.

I had a similar situation at a 79 box on four mile run with the same basic situation. The radio would receive in the stairwell but not able to transmit.

I believe you were there when we were working on the preplan for Skyline Mall and parking garage. The radios would not receive or transmit. The truck left to go to Giant to get dinner. While we were in the store we (engine and truck) got a call for a fire in 8's area. Since I knew the radios didn't work in the garage and I knew the engine crew was still there working on the preplan, we paused at S. Jefferson/Leesburg Pike and made as much noise as possible so they would hear us and check their CAD.

*****

We learned quickly in the FM's office that we could not transmit from basements such as Commonwealth Care. During fire alarms testing, we would look to the contractor using a Nextel direct connect to communicate with a FM at the main fire alarm panel. Our 800 radio would hum at us when we tried to transmit from the basement.

In another case, we used the direct channel on our 800 radios to test the fire alarm at Daniel's Run Elementary School. This channel gave us instant connection on a limited basis. If one of us went to the end of a hallway or changed floors, we lost direct contact. If we are to depend on channel 0 to communicate with a fire fighter during an emergency, we better have several people staged around a building to listen for trouble.

Now, we use the Nextel direct connect during all of our fire alarm tests. This has limited our radio use, and our problems encountered, in city buildings

As our troops continue to test the regular 4-Adam and channel 0 in our city buildings, they will learn where the problem areas are.

*****

There are several buildings where I had to use 4-0 to get out on incidents. None of the incidents were noteworthy fire wise. The buildings are:

10701 Main Street, Floor 1
4315 Chain Bridge Road, Basement
10570 Main Street, Floor 1, 2 & 3
10306 Eaton Place, Basement 3300 Willow Crescent Drive, Terrace Level
3300 Willow Crescent Drive, Terrace Level

*****

No particular “war stories”, but our Retesting teams (4 2-person teams) have purchased two-way radios from Costco to communicate in high-rise buildings. The radios had such a “hit or miss” problem with reception, that the $50.00 Cobra walkie talkies are outstanding. They have been using them for months now, and are very pleased. They still carry our radio in hopes they hear an inadvertent dispatch of an engine company for a fire alarm test, but use the 2-ways for communication inside buildings.

*****

One “story” that comes to mind is when we were doing a walk-through at Huntington Metro. There is an 800’ service tunnel at the end of the station. Walk more than 15-20 feet into it, and you have no radio capability at all. Needless to say, if we had to operate in there, communications would become a major issue.

*****

Although I do not have the particular dates or incident numbers, I can relate two stories of this very nature. E409 was assisting our Medic unit with an ALS event at the Oak Meadows Nursing Home. As you know, we were on channel B. While we were involved in this ALS incident, unknowing to us, a house fire was dispatched in company 11’s area. The fire was on Memorial Street and was a mutual box using the L/M channel for communications. As we went AOR-09/11 the house fire was sent to our CAD and we responded. The L/M patch was extremely poor, if not non-existent. Somewhere between switching from B to A then to L and then to M at the top of the hill, we did not receive the radio transmission that E411 had a working fire. We also did not know that E411 was having trouble finding the fire in the thick smoke and had requested exterior ventilation. We were able to tell the lay-out by seeing the hose lying unattended in the street next to a hydrant. Apparently, several transmissions had been broadcast but missed by incoming units. Fortunately, nobody was injured and the blaze extinguished.

Again months later while at the Paul Springs retirement home, we missed another incident. Our radios default to the no signal tone throughout much of this building. Another ALS event had been dispatched near our location without our knowledge. Having packaged the patient and returning to quarters, we noticed flashing lights and a siren coming towards us. E424 soon passed us headed to an ALS event only blocks away. It was not serious but could have been.

I think you are familiar with Wakefield Towers in company 11's area. These are older non-sprinkled high-rise buildings with little or no radio communication abilities. When you go inside you must switch to -0- and operate in the walkie-talkie mode. That whole notion of switching to a command channel, a separate channel for the RIT team, press the red button for emergencies. For-get-about-it, you got 1 one channel and that's -0- Oscar.

*****

I use to like the fact that when I was assigned to work at Fire Station 23 and we would use the Jewish Community Center next door, that we would lose the ability to talk to PSCC. Considering that, we were less than a mile from PSCC and in a fairly small building. We still lost communications with PSCC.

Also, another quickie would have to be our training evolutions at Huntington Towers. We were doing an evolution and I was assigned to the fire floor ac the fire attack officer. As I was entering the building, still in visual touch with the IC, I would lose radio contact with him. I realize that we were going through the repeater but the fact of the matter is that I had only just crossed the threshold into the structure and had not gone more than 10 feet and was out of radio communication. This is more than a little disconcerting and even though we are attempting to address the situation, I just don't get that warm and comfy feeling anytime I have to enter a large building.

We ran a FVEHF in the parking garage at 5573 Seminary Road (Savory Park Condos) recently. It was a US Postal Service minivan about 300' inside the garage with the occupant compartment well involved. Once I was less than 50' inside the garage (which, as you know, is not truly below grade) I lost all ability to communicate on the operations channel with my driver, PSCC, and incoming units. I had to walk over near side A of the garage and get near an exterior wall before the radio came back in range. As a result, I had to resort to yelling to relay instructions and ultimately using the "0" channel, which of course was only of value once the BC got on the scene. In the interim, I was trying to transmit on the operations channel to have PSCC reduce the response of anything other than the truck and the second-due engine to priority 2. No one heard those transmissions, as I ultimately learned.

*****

On July 28, 2003, we were at a fire alarm sounding in a 16 story high-rise office building. When we reached the 12th floor we found smoke in the hallways. We could not contact PSCC via the radio. We tried several different channels with no success. Access to the surrounding offices was hampered because they were all high security defense department units, so we couldn't readily reach a window. We had to call the driver outside on the talk around channel and they had to relay all the information to incoming units and PSCC. There also have been many instances where personal cell phones have been used to either contact personnel outside or to contact PSCC directly.

*****

This past winter, assisted on a call for excessive amounts of CO on the 8th floor and above in a high-rise. Had units on multiple floors. I'm in the lobby talking with Hazmat. Units and my talk-group could not hear me unless I physically held the radio above my head. Being 6'5", you would think that would be good enough. Good thing I wasn't on a fire floor with heavy heat conditions.

*****

Two stories from the greater 2nd battalion:

Box alarm in a parking garage at Tyson's Corner Mall for a fully involved vehicle, extending to adjoining cars. I was transmitting my reports and requests to the battalion chief, sitting in his buggy that I could see less than 200' away, but he said he was unable to copy any of my radio traffic.

Second, event was reported fire in a high-rise. After gaining access to the reported apartment and determining it was only food on the stove, I attempted to contact Command with my report from the 13th floor apartment. Command said I was breaking up. I went to the balcony to retransmit my report and Command indicated they still had trouble understanding what units I wanted to hold.

*****

Parliament House a 9 story high-rise. As soon as you get 10 feet inside the front door all radio communication stops except for Channel "0" until one gets upper floors close to a window in an apartment. So, if you are in an elevator and get trapped and no one is listening to Channel 0, you are out of luck because no one will hear you. Ravenworth Towers is the same way. Rear of the K-Mart on John Marr is the same way.

Sleep Hollow Nursing Home…"Nursing Home". We had a fire in the laundry room. We entered the building on side C at ground level, by the time we made it back to the laundry room; we were under ground, which means the fire was in the center of the building underneath the majority of the patients. We were unable to talk to the outside units on the repeated channels. I had to position myself halfway down the hallway and carry 2 radios one on "0" and the other on the Fire Ground Channel.

While carrying a portable radio inside Station 8…"Inside Station 8" the radios will start to fade out, the voices sound like Charlie Brown's teacher…if the station radios are down and we are working off of a portable we might not hear the call if we are in the middle of the building.

*****

We make frequent runs to Greenspring Village, 2-3 times a day. This complex is still under construction. As a routine, I have to leave the engine driver outside communicating with him/her on: 4-Ocean" if I need to request anything from PSCC. For those calls involving the entire crew, I have to depend upon using the occupant's telephone.

*****

Dispatched to an ALS emergency for a severe asthma patient in the Bailey Cross Road area of the county. After accessing the patient, we were riding the elevator down from the 6th floor when the elevator car stalled. The radio would not transmit out, leaving us stuck in the elevator with a potentially critical patient. We were rescued when the engine crew that walked down came looking for the missing engine medic, most probably because they wanted to get back before dinner got cold.

*****

For what it's worth, I concur regarding the "0" radios. We ran a vehicle fire deep in the garage under 5573 Seminary our last day, and 30 feet into the garage I lost all ability to talk on the repeated channel. I had to walk to within 20 feet or so of one of the exterior walls to get back in range. We had to shout back and forth and ultimately resorted to the 0 channel so that I could talk to my engine driver. Of course, this took me off the repeated channel.

*****

On July 28, 2003 at 2257 hours Engine 10 and Truck 10 were dispatched to a fire alarm located at 5203 Leesburg Pike. As we were approaching the scene a supplemental MCT message indicated that a called had now seen fire from the 11th floor and that he could hear the fire alarm sounding as well. I called PSCC and asked them about the supplement; they seemed unaware of it.

PSCC then called T-10 and told them that the supplement was in fact accurate and they then asked the truck if they wanted the box filled out. It was at this time that I interjected on the radio and informed PSCC to fill out the assignment and that I would get back to them when I had determined what was going on.

After several minutes of investigation, I confirmed that an alarm was sounding, and I was still trying to determine the status of any fire. I again called PSCC; I asked them if they had filled out the box, if they had checked back with the caller for more information and what channel the incident had been moved to. They informed me that, no they had not completed the assignment, that they were still checking with the caller and that the incident had not been moved to another channel.

I again asked for the assignment to be completed and was informed that they had checked back with the caller and he no longer saw anything, and that the fire officer “recommended” not filling out the assignment. It was, at this point due in part, to my heightened level of frustration that I told them to do whatever they felt like doing. While this exchange was taking place E-10 Alpha was ascending, as ordered, to the #12 floor. Upon their arrival they encountered a moderate smoke condition with an unknown source. They repeatedly attempted to call both PSCC and myself on both the dispatch and fire ground frequencies, but their attempt went unheard. Eventually, one of their calls was heard and at 2311 hours PSCC finally realized that the assignment should be upgraded. They assigned us to fire ground channel 4-C for the remainder of the event.