Leading Community Risk Reduction

Evaluating the Use of Escape Systems for the Evacuation of High-Rise Structures

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Certification Statement

I herby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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Abstract

The problem was a lack of evacuation contingency plans in the event of an emergency where primary escape routes were compromised in high-rise buildings, increasing the probability of injury or death. The purpose of this Applied Research Project (ARP) was to identify escape systems currently available for the evacuation of occupants from high-rise buildings during emergencies.

Descriptive research was used to explore present technology and answer four fundamental questions: a) What is the definition of a high-rise structure?, b) What is the risk rating of injury or death associated with high-rise emergencies?, c) What rescue escape systems are available for use in high-rise building evacuations? and d) What are the potential challenges of implementing the use of a rescue escape system?

Personal communications, a feedback instrument, and a literature review were used to gather the necessary information that provided a list of recommendations to the Seminole County Fire Department (SCFD) for review.

The research showed there are escape systems available, as a last means of egress, for evacuation from high-rise structures during all hazard emergencies.

Recommendations presented to the SCFD suggested these systems may be viable options needing further action oriented research.

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Evaluating the Use of Escape Systems for the Evacuation of High-Rise Structures

Rapid urban development and revitalization projects have increased the number of high-rise structures located within the geographical area of Seminole County. The problem is a lack of evacuation contingency plans in the event of an emergency where primary escape routes are compromised in high-rise buildings, increasing the probability of injury or death. The purpose of this Applied Research Project (ARP) is to identify escape systems currently available for the evacuation of occupants from high-rise buildings during emergencies.

Descriptive research will be used to explore this industry and answer four fundamental questions: a) What is the definition of a high-rise structure?, b) What is the risk rating of injury or death associated with high-rise emergencies?, c) What rescue escape systems are available for use in high-rise structure evacuations? and d) What are the potential challenges of implementing the use of a rescue escape system? The knowledge gained by this research will enable Seminole County to take the next step through future action research and determine the best method of secondary means of escape from high-rise buildings.

Background and Significance

Seminole County, established in 1913, is located in the northwest portion of Central Florida. The community is a thriving economic model of residential, commercial, and industrial use. The current population is meeting the expected growth from 1990 to 2010 of 34% (Orlando Economic Development Commission, 2004). Just fewer than four hundred thousand residents live within the County today.

Population growth and the need for community redevelopment have lead to an increase in current and proposed vertical urban development, high-rise buildings. One area that has seen a significant change “overnight” is the City of Altamonte Springs’ Central Business District

(CBD). Steven Peavey, Deputy Fire Marshal of Altamonte Springs, Fl Building and Life Safety reported the CBD currently has six buildings under construction exceeding seven stories with an additional half dozen in planned development (Peavey, personal communications, March 21, 2006). Additionally, the US 17-92 Corridor plan lays out proposed urban redevelopment along US highway 17-92, which runs through the center of the County as well as several Cities. Specifically, rezoning the areas roadside to allow for multi-story professional office buildings is one of the plans recommendations (Ivey, Harris, & Walls, Inc., 1997).

The Seminole County Fire Department's (SCFD) procedures for evacuation of high-rise buildings exist in the Seminole County and Cities Incident Management System (SCCIMS) Manual. These procedures include establishing an Evacuation Group to secure one stairway and assist with evacuation of occupants (Seminole County and Cities, 2004, p. 3.26-29). Drills at high-rise structures mainly focus on the personal accountability report (PAR) system and firefighting operations. SCFD's high-rise procedures are rarely exercised. There is no recall of a training drill that allowed for the evacuation of numerous occupants while fire suppression crews attempted to stage resources and initiate an aggressive fire attack.

On September 11, 2001, the collapse of the World Trade Center (WTC) Towers changed the way fire departments respond to high-rise emergencies. Thirty recommendations are listed in the National Institute for Safety and Technology's (NIST) report on the WTC disaster. These recommendations were driven by eight subgroups. Five of the 30 recommendations fall under "Group 5 Improved Building Evacuation". The 20th recommendation states that "a full range of current technology of escape systems should be evaluated" (National Institute for Safety and Technology [NIST], 2005, p. 218).

Evaluating the use of escape systems for the evacuation of high-rise structures specifically applies to Unit 2 and Unit 4 of the National Fire Academy's Leading Community Risk Reduction student manual. Unit 2, Assessing Community Risk, provides three matrixes for determining community risk. Matrix 1 Hazard Identification, Matrix 2 Vulnerability Assessment, and Matrix 3 Risk Rating assist individuals with identifying hazards and determining the probability, severity, and risk rating an event might have on a particular community. Unit 4, Intervention Strategies, provides tools to assist in determining intervention strategies along with implementation concerns (National Fire Academy [NFA], 2004). External escape systems are directly impacted by current technology and implementation concerns.

The United States Fire Administration's (USFA) Operational Objective #4, "to respond appropriately in a timely manner to emerging issues" (United States Fire Administration [USFA], 2002), directly relates to the emerging issues of Seminole County's rapid urban development leading to a potential increase in high-rise structure emergencies and higher risk rating.

Literature Review

Research shows several groups define high-rise buildings differently. Fire Service Operations, codes and standards organizations, and high-rise enthusiast are three such groups. Each group provided reasons for their determining height or floor requirements. These seem to be directly related to their field of study.

The first group is Fire Service Operations. FireScope defines a high-rise structure as a multi-story tall building. High-rise in this case is used generically (Firescope, 1999). Phoenix's Fire Ground Command System uses 4 stories or 75 feet due to the limiting reach of aerial apparatus (Brunacini, revised 2004). SCCIMS further defines a high-rise as "buildings 7 floors or 75 feet" and mid-rise "building 4-7 floors", however when dealing with emergencies in either building the high-rise procedures are followed (SCC, 2004, p. 3.26-29).

The second group included those responsible for codes and standards. Paragraph 3.3.28.7 of NFPA 101 *Life Safety Code®, 2006 edition, defines a* high-rise building as "a building more than 75 feet (23 meters) in height, measured from the lowest level of fire department vehicle access to the floor of the highest occupied story" (National Fire Protection Association [NFPA], 2006, p. 101-27). This definition was shared with several sources found in the literature review that included the NIST final report on the WTC, National Conference of States on Building Codes and Standards (2004), International Fire Code (International Fire Code , 2006) and Architectural Building Code (Scott, 1997). NIST further defines buildings over 100 stories as tall buildings (NIST, 2005,).

The third group the researcher categorized as high-rise enthusiast. This group was unique because the definition was based on the need of a mechanical device for occupants to reach the top floor. Specifically, if a person would be willing to walk to the top floor via the stairway, the building would not be a high-rise. The minimum criteria of eleven or twelve stories were commonly shared amongst this group (Stormgrove Press, 2004). No linear measurement was given.

It is important for the Fire Service to categorize high-rise buildings with minimums for both the number of floors and the linear height. The importance of using both criteria is clearly represented with the Majesty building in Altamonte Springs, Fl. The building stands 218 linear feet tall with only 15 occupied floors (Stormgrove Press, 2004). Calculating a rough estimate of 10 feet per floor, one would expect this building to be 21 floors tall. Although using either criterion would not change the fact this building's classification is a high-rise by any account, the understanding that floors do not always equate to height and vice-versa is extremely important in Fire Service Operations (Butterworth, Heinemann, 2003).

The second research question, regarding the risk rating of injury or death in high-rise structures, takes more than statistical data to answer. Anthony Apfelbeck, Fire Marshal of Altamonte Springs, FL Building and Life Safety explained the risk of high-rise fires is lowered by having aggressive code enforcement regarding active fire suppression systems, sprinkler systems and standpipe systems. "There is a need to evaluate escape systems; however fatalities in high-rise structures with working active and passive fire protection systems are rare" (A. Apfelbeck, personal communications, March 21, 2006).

The NFPA's comprehensive report on high-rise building fires provides data regarding fatality statistics in high-rise buildings. The data used to generate the statistical information found in this report is provided by thousands of Fire Departments throughout the United States through the National Fire Incident Reporting Systems (NFIRS). The report showed a decline of injury and death in high-rise structures over the last two decades mainly due to the wide use of fire protections systems. "Except for 2001, explained as an atypical year, a marked decline was shown in high-rise injuries and fatalities in the last seven years. Specifically, in 2002 there were roughly 10,200 fires in high-rise structures that accounted for two percent of all building fires and one percent of civilian deaths" (Hall, Jr., pp. 1-4, 16-20, 38).

Fire Departments can not depend solely on these statistics and fire protection systems in high-rise buildings to prevent injuries and death. These systems have traditionally been beneficial by providing sensor activation with audible and visual alarms, sprinkler activation, and standpipe connections for fire related emergencies in buildings under "normal" circumstances. Buildings under construction with fire protection systems out of service (O.O.S.) and older buildings lacking fire protection systems, HVAC systems and adequate egress present different challenges and increase risk to occupants in the event of an emergency requiring evacuation.

Terrorism and arson events present greater challenges and greater risk when they result in the elimination of effective life safety protection systems. The Fire Service understands the need to think *all hazard*, however change is slow and difficult.

The One Meridian Plaza fire, required reading for the NFA EFOP Executive Analysis of Fire Operations in Emergency Management, confirmed that fire will burn unchecked and often overwhelms local fire department resources if the building does not have a working fire suppression system. In this case study the fire spread eight floors, which were not protected by an automatic sprinkler system. Ten sprinkler head activations put the fire out on the 30^{th} floor. This was not before the tragic loss of three firefighters on the 28^{th} floor, Captain David P. Holcombe, Firefighter Phyllis McAllister, and Firefighter James A. Chappell (Routley, Jennings, & Chubb, 1991).

Daryl Winter, in his EFO ARP on *Development of a high-rise risk assessment table for the city of Rochester Fire Department*, describes six areas that are most significant when assessing risk in high-rise structures. These are sprinkler protection systems, building evacuations, delayed alarm, unprotected openings, knowledge of building fire systems, and Fire Service elevators (Winter, 2003). Some of these risks have unpredictable variations due to the "human factor" regarding the knowledge and experience of the crews responding to such emergencies. The performance skills of responding firefighters are important even with working fire protection systems in place.

The National Fire Academy's *Leading Community Risk Reduction Student Manual* Unit 2, Assessing Community Risk, provided the researcher with three matrixes for determining community risk (NFA, 2004). Matrix 1 Hazard Identification, Matrix 2 Vulnerability Assessment, and Matrix 3 Risk Rating assist with identifying hazards and determining the probability, severity, and risk rating an event might have on a particular community (NFA).

It is important to note that Dorrie Forrest, the SCFD Red Alert administrator, reports that there were one hundred and fifty structure fires in 2005 resulting in five civilian fatalities and eleven injuries. None of these fatalities or injuries occurred in buildings greater than three stories (D. Forrest, personal communication, April 6, 2006). The lack of injuries or deaths in buildings over three stories in 2005 should not eliminate the need to develop emergency evacuation contingency plans for such buildings.

In regards to research question three, 19 escape systems were identified for use in high-rise structure emergencies. Research drove these devices to be grouped into four categories; Controlled Descent Devices (CDD), Chutes, Platform Rescue Systems and Non-Structural Dependent Devices (Appendix A).

Product information was gathered from company web sites when available. No conclusions were drawn by the researcher regarding product availability by information gathered on company or product web sites alone. Information gathered by the feedback instrument when compared to product websites made it clear that many company's marketing strategies lead viewers to believe products are available that simply do not exist in the market place.

It is surprising to note that using escape systems for the evacuation of occupants in a high-rise building is not a new idea. Operational Chutes and CDD were found as far back as 1982. The fact that "alternate escape routes are essential at a fire" has been well known (Keller, 1982, p. 29). Ten years later another push for escape chutes made its way into the Fire Service. Marketing the chutes to augment aerial apparatus appeared to gather support (Industrial Fire

World, 1993). The Kansas City, KS Fire Department still claims to have EVAC Rescue Chute Teams on their website (Wyandotte County, 2005). These devices are known to be taken O.O.S. due to maintenance issues.

Chutes and CDD have been common place in Japan and Asia (Asia Pacific Fire [APF], 2004).

Many devices can be used for offensive firefighting operations as well as evacuations (Shimshoni, 2005). This is particularly useful when fire floors are out of the reach of aerial apparatus.

Discussions outside the escape system arena regarding use of elevators for evacuation have been actively moving the concept forward. It will take a radical rethink of emergency services for this idea to be successful in the evacuation of occupants in high-rise buildings during an emergency event. Emergency Lift Escape (EEL) is a protected elevator used to evacuate occupants by stopping at designated staging areas (Gibb, 2002).

The Literature Review regarding the last research question revealed there are several challenges to implementing the use of an escape system, specifically, in the United States.
The Support Anti-terrorism by Fostering Effective Technologies (SAFETY) Act of 2002, part of the Homeland Securities Act of 2002, qualifies anti-terrorism technologies and places products on Designation or Certification lists. Risk and litigation management protects manufacturers who produce technology that work as intended and are as safe as possible. The *Rescue Escape System* is the only rescue escape system on the Designation list of 6 CFR Part 25. The Designation will expire on September 30, 2010 (Code of Federal Regulations [CFR], 2005).
Even with Public Law 107-296 in place, liability issues, lack of cooperation from Fire Service officials, and endorsement from codes and standards officials has left the industry frustrated.

Even with legislation in place it is not hard to find companies of such devices discouraged and frustrated. NYC Officials prevented testing of the Rescue Escape System stating the project did not meet necessary building permits (Heightman, 2006). Personal communications with many of the industry leaders realized we still have a long way to go (Appendix D).

Sections 7.2.10. entitled “Slide Escapes” of *NFPA 101* Building *and Life Safety Code®* states the “Each slide escape shall be of an approved type” (NFPA, 2006, p. 101-63). Chapter 40 of *NFPA 101* goes on to state these slides can be used in high hazard occupancy as long as the users are trained and drills are exercised (NFPA). This implies there are some minimum requirements that define an approved slide. The NFPA’s “means of egress” technical committee has tried unsuccessfully to develop minimum criteria regarding design, reliability, and maintenance (Clayton, 2005, p. 1). Additionally, it appears the concern is that if money is spent on rescue escape systems there will be less available for proven effective code mandated features, fire protection systems.

One organization that is trying to move standards and acceptance forward is the American Society for Testing and Materials International (ASTM). “ASTM is a voluntary standards development organization and formed the E06.77 Subcommittee on High-rise Building External Evacuation Devices” (The McGraw-Hill Companies, 2004, p. 2). The Subcommittee is divided into three Task Groups that mirror the three categories of devices. The E06.77 Task Group on Controlled Decent Devices is completing a second ballot and a draft standard is expected to be submitted to the ASTM, for approval, in the near future. The draft standard for Platform Devices is nearing its first ballot and the Task Group on Chutes is stagnant. The researcher has been asked to become a voting member of the E06.77 Subcommittee

(W.C.Christensen, personal communication, March 31, 2006). The E06.77 Subcommittee meeting being held on April 24 in Canada is not expected to move the standards forward (Baker, personal communications, April 5, 2006).

Several escape system manufacturers claim their product is Underwriter's Laboratories (UL) Listed. This is misleading in the fact the UL Listing is for mechanical operation only and not intended for use as a means of egress in a fire (Zicherman, 2003, p. 50).

Procedures

The internet was accessed using Google and the phrase escape rescue system. Additionally, research materials were obtained from a web based search using the same search description at Learning Research Center (LRC) located at the NFA. The researcher compared the results and developed a list of 19 devices (Appendix A). Many of these systems used a form of the term *evac* or *chute* in their name. This led to disparities in referenced articles having the proper name for each device. A search specific to each device and company was completed. Yielded web sites were visited to obtain a description of each device for categorization and any additional contact information.

Seventeen of the 19 devices found (%) had email contact information (Appendix B). A feedback instrument, with three questions, was generated by comparing knowledge gained during the literature review and LCRR class to assist in answering the last two research questions (Appendix C). This information request yielded zero (0%) of 17 responses (Appendix C). The researcher had learned through the research process some of these companies were producing devices, so telephone contact was made to ten companies (Appendix E). These were the only 10 companies with U.S. contact information. Contact was made with eight (80%) of these companies (Appendix D). Additional information was obtained by conducting personal interviews following the "Guideline for Conducting Personal Interviews" Section of the *Executive Development Student Manual* (National Fire Academy [NFA], 1998). This information confirmed the email addresses were correct for eight companies contacted via telephone. When questioned confirmation of receiving the email, the majority of the companies stated they have been busy.

The internet search proved to be a valuable resource for government and agency reports and committees related to the research topic.

Personal observations, informational gatherings, and personal communications assisted with obtaining additional information specific to Seminole County's emerging hazard.

Definitions of Terms

Platform Devices are escape systems that use a platform(s) that is guided by cables or tracks externally mounted on the side of a building. Occupants simply step onto the platform and are carried to safety. Gondolas and external elevators describe two subgroups in this category.

Controlled Descent Devices are escape systems that use a simple harness, cable, and braking device to control the rate of descent.

Chutes are rescue escape systems that provide a vertical tube of material that controls the rate of descent by friction of one's body against the sides of the tube.

"*Designation*-The term "Designation" means a designation of a qualified anti-terrorism technology under the SAFETY Act of 2002 issued by the Under Secretary under authority delegated by the Secretary of Homeland Security" (Code of Federal Regulations [CFR], 2005, p. 88).

Enthusiast refers to people who have interest in high-rise building for entertainment purposes only.

Non-Structural Dependent Devices are escape systems that do not require contact points with the building or the ground during descent (i.e. parachute).

Red Alert is SCFD's reporting system software used to capture NFIRS information that is sent to the State of Florida's Fire Marshal's Office.

Limitations

The researcher did not evaluate any product performance or comparison.

Systems that were identified to specifically assist the physically disabled were not included in this ARP. Likewise, firefighter personal escape systems were not included. Both of these areas of interest warrant an ARP specifically dedicated to their needs. Many of the companies offering CDD for evacuation and egress of occupants were also working on firefighter personal escape systems or "bail out" systems.

Chutes in service for oil rigs or slides in service for airplane evacuations were not specifically identified. It should be noted however, that some of the devices identified in this ARP are in use for these special circumstances and are approved by NFPA for such (NFPA, 2006).

The feedback instrument yielded zero responses in writing. Completion of feedback instruments conducted by telephone allow for miscommunication and lack of a "paper trail" when clarification issues arise.

The feedback instrument process by telephone resulted in probable bias. Companies contacted by telephone are considered a "convenience sampling". These companies were contacted because they could be and were willing to give answers to the questions (Borg & Gall, 1989).

Results

The definition of a high-rise structure varies. Research showed when using lineal feet, a measurement of 75 feet is agreeable by most organizations in the Fire Service and code and standard organizations. When number of floors is the determining factor, buildings over four stories fall into the mid-rise or high-rise category. Regardless of terminology, high-rise procedures are commonly used by the Fire Service for buildings over three floor or 75 feet in height.

Organizations outside the Fire Service often define high-rises based on the ability to get to the top floor without having to use a mechanical means of transportation. This definition was based on traveling upward and not egress. Additionally, there was no consideration given to firefighting gear and equipment weight. Simply, this definition does not fit the Fire Service.

Results regarding the second research question showed the risk rating of injuries or death associated with high-rise emergencies to be lower than same occupancies that are not high-rises (Hall, Jr., 2005). These statistics are based on NFIRS data at time of entry. Accuracy in the reporting process by firefighters is questionable. The SCFD is currently developing an Operations Bulletin to ensure the expectation to complete incident reports accurately is known. This is only after several reports in recent months did not accurately display known figures for firefighter injuries (D. Forrest, personal communications, April 6, 2006). Specifically, a recent report on firefighter injuries showed a total of eight when Workman’s Compensations forms clearly showed over 100 injuries in the same time span.

Additionally, many large cities do not use NFIRS criteria to capture incident information. This is becoming less and less due to the process being tied to Grant monies. Seminole County is not a large city and this was not determined to be a limitation in this ARP.

Although, Seminole County did not experience any injuries or death in buildings four stories or taller in 2005, probability of such occurrences rises exponentially every time a new high-rise is built.

It is understandable that statistically the probability of injury or death due to fire is going down due to fire protection system codes and standards. Events involving terrorism however, must be appreciated when determining risk in high-rise structures. These events often times render the fire protection systems ineffective. This was the case with both acts of terrorism (1993 and 2001) on the WTC Towers (National Fire Protection Association [NFPA], 2003).

The National Fire Academy's *Leading Community Risk Reduction Student Manual* Unit 2, Assessing Community Risk, provides three matrixes for determining community risk (NFA, 2004). Matrix 1 Hazard Identification, Matrix 2 Vulnerability Assessment, and Matrix 3 Risk Rating assist with identifying hazards and determining the probability, severity, and risk rating an event might have on a particular community. The researcher calculated Seminole County's high-rise hazard with the knowledge and understanding of use of these matrixes. The Risk Rating of two was given to an event requiring emergency evacuation and a Risk Rating of four was given to an event involving terrorism (Appendix F).

The third research question regarding the availability of escape systems was answered using the search engine Google along with a literature review of books, articles, and professional journals. A feedback instrument also assisted in determining which devices were available today in the United States (Appendix C). This process identified 19 escape systems. Research drove the ability to group the evacuation escape systems into four categories. These are Controlled Descent Devices (CDD), Chutes, Platform Rescue Systems, and Non-structural Devices (Appendix A).

No company or product contact information was found on three of the 19 systems. Information on these devices led the researcher to the conclusion the devices are simply in the design phase or the companies are no longer in business.

The feedback instrument sent via email to 17 companies yielded zero responses.

The results from the feedback instrument initiated communication, via telephone, directly to 10 companies were: 8 answered the feedback instrument questions or 80%, 2 companies did not return the researchers phone calls or 20% (Appendix D). At least two attempts were made to contact the companies that required messages to be left.

The feedback instrument assisted with answering the third research question regarding product availability. 75% of the companies queried stated their product is available today. This equated to six systems. 50% of those companies had systems or devices in service in the United States today (Appendix D).

Two CDD were available for purchase. The *Decenter* is available for purchase and is in use in the United States (S. Alberts, personal communications, April 6, 2006). Alberts went on to suggest these devices are mandated in Japan to be placed in all rooms, with and external exit, in high-rise structures. The *DoublExit* is available for purchase however, none are in use in the United States (J. Shimshoni, personal communications, April 3, 2006). ResQLine is not available for purchase according to a company spokesperson (personal communication, April 4, 2006) Overall discussions among this industry believes the automatic sprinkler lobbies are doing a great job in ensuring the focus stays on prevention of fires. This is not found to be the case in the Asian community and Japan (S. Alberts, personal communications, April 6, 2006).

Thirty-five Baker Life Chute Systems are in use by the United States Air Force for evacuation from the air traffic control towers. This system can be found in eight Countries including the United States. Thirteen systems are in use on Cokers in the oil rig industry (R. Baker, personal communications, April 6 2006). *AESOP* Chutes is not available for purchase. Once there is a demand for the product it can be placed into production (R. Catalan, personal communications, April 3, 2006).

The Kansas City, Kansas Fire Department had purchased EVAC Rescue Chutes and established an *EVAC Rescue Chute* Team under Fire Special Operations (Wyandotte County, 2005). These chutes have since been placed O.O.S. due to service life. Maintenance of such devices will need to be examined. No contact information could be found on the EVAC Systems, Inc., the manufacturer of the Evac Rescue Chute. This device was not admitted into the feedback survey.

Two Non-Structural Dependent devices are available and in use in the United States. These are the *EscapeChute* and the *Evac-U-Chute*. These can be best described as a parachute and the process for escape is similar to *base jumping*. Non-Structural Dependent devices have been sold to private citizens. There is no tracking of the end users with these devices (G. Galloway, personal communications. April 5, 2006). These devices are easily accessible by the general public. Neither building owners nor fire officials have any ability to police these devices. They can be easily stored undetected in an office.

Research on a third Non-Structural Dependent device, *Executive Chute*, lead the author to conclude this device is available for under $1,000 in the United States, however, attempts to contact the company via telephone and email proved unsuccessful (www.saferamerica.com). The availability of this product was not counted in the feedback instrument results due to lack of response to inquiries.

The term "chute" in the name of these devices was often referenced incorrectly in articles. The term in these cases refers to para*chute*, not the escape system category Chute.

Marcus Hirsh, General Manager for Emergency Evacuation Systems has requested the researcher to evaluate an Evac-U-Chute (Hirsh, personal communications, April 5, 2006). No such evaluation has taken place intentionally due to the chosen research method, Descriptive.

The *Escape Rescue System* is the only platform device that is currently available for purchase (Shimshoni, personal communication, April 6, 2006). This system is a suspended rescue platform (SRP) that deploys up to five enclosed platforms that have a capacity of thirty people each (escaperescuesystems.com). The device is also listed on the "Designation" list of the Support Anti-terrorism by Fostering Effective Technologies (SAFETY) Act of 2002 (Code of Federal Regulations [CFR], 2005). The *High-Rise-Rescue System* also known as the "*Eagle*" is still in engineering and design phase. It is expected to cost approximately five $500 thousand if it becomes available (Fainelli, 2001).

The Spider Rescue CDD, Verti Scape Chute, Advance Modular Evacuation System, Ingstrom Escape Chute all suggest the products are available overseas. These devices were not included in the feedback instrument results due to lack of response from the companies.

The fourth research question regarding potential challenges that are faced when trying to implement an escape system was answered by using information from the feedback instruments' third question. 75% of the companies that completed the feedback survey and stated they have encountered challenges trying to implement their device for the use of evacuation of high-rise structures (Appendix D). Specifically, the United States has been a difficult market for these companies. Israel and Japan have hundreds of thousands CDD units in place. Robert Smith, with Spidescape Product, Inc. suggested the Automatic Sprinkler System lobby has done a great job ensuring money is spent on sprinklers which already have a proven track record (R. V. Smith, personal communications, April 7, 2006).

The NFPA states that “escape chutes and controlled descent devices are not permitted nor recommended by U.S. based codes for commercial and public buildings” (NFPA, 2006). The researcher did find evidence this may not be the Association’s stance forever. The phrase *escape system or device* can be found in the *Master Index* to the National Fire Codes for 2006. Specifically, Chapter 3 of the NFPA 5000 *Building Construction and Safety Code* reserved Section 3.608.7 for escape devices or systems (National Fire Protection Association [NFPA], 2006, p. 241). There is currently no wording in this Section.

All of the representatives contacted agreed these devices should be used as a last resort. “The intent of these devices is to give an alternative means of escape, not a primary one” (M. Hirsh, personal communications, April 6, 2006).

Discussion

SCCIMS manual’s operational definition of a high-rise structure, 4 stories or 75 feet, is supported by the rarity of fires in such buildings within Seminole County . Specifically, lack of experience by personnel in dealing with emergencies in high-rise buildings supports the minimum height of four stories. This ensures safe practices when crews are working in a high risk low frequency incident. Additionally, the research showed buildings over four stories present different challenges than that of three or less. Aerial apparatus reach, secondary means of egress, and fatigue factors must be considered when calculating high-rise risk. The definition also falls within the NFPA 101 *Life Safety Code®, 2006 edition* definition of 75 feet from the lowest place an apparatus can make access to the highest occupied floor (NFPA, 2006).

Number of floors and linear height should always be considered when responding to a high rise emergency (Brannigan). One example of this importance would be a high angle rescue. If linear height of the Altamonte Springs Majesty building is calculated by number of floors using 10 feet as an average, rescuers would be approximately 70 feet short getting from the roof to the ground.

The Risk Rating of injury or death due to an emergency in a high-rise structure was given a value of two under normal circumstances (Appendix F). Simply, the fire protection systems are operable and able to perform as designed. In an event of terrorism or arson the Risk Rating doubled to four (Appendix F). This rating should be evaluated as the number of high-rise structures in Seminole County increases. Risk Ratings change as the community changes (NFA, 2004). Fire Departments can not solely depend on the fire protection systems of buildings to prevent injuries and death in high-rise emergencies. The Fire Service must incorporate a terrorism and arson hazard when calculations regarding risk and life safety are made.

The results of the research showed there are escape systems available for evacuation of high-rise buildings during emergencies. Three are in use today in the United States (Appendix A). Many more appear to be available across the world. It is hard to state that other Countries are ahead of the United States because they allow such systems (APF, 2004). More so, there may be two reasons for this difference. The first is terrorism is not new to Israel, one of the largest users of these devices. Secondly, these Countries do not have the aggressive fire protection codes like that of the United States.

Most companies that were contacted agreed these devices should be considered as a last means of egress (Appendix E). The researcher also agrees. A push for these devices to be used as primary means of egress from high-rise buildings is not applicable. A benefit analysis must be performed when determining escape system use. This leads to the question regarding the Human Factor. Will people use the device simply because it is available? This is yet to be seen. The research leads the researcher to believe this will not be the case. Any of these devices are not for the *faint of heart*. It would take a life threatening situation for most individuals to even consider parachuting off a high-rise building.

Even without certification or approval in the Fire Service, it should be noted these devices are being tested by Fire Departments. Several articles listed in the reference section document firefighters being participants in evaluating these devices (Zicherman, 2003). This practice should stop due to safety concerns. These devices due not have secondary safety lines in place in the event of a failure.

NFPA, ASTM, and the Fire Service need to agree these devices are an alternative means of egress, when there is no other way out (Industrial Fire World, 1993). The "Human Factor" must be considered prior to any approval or certification of these products. It is well known in the Fire Service people react differently in an emergency situation than that of a planned drill.

Recommendations

The first recommendation is for the SCFD to support this researcher in participating in the ASTM E06.77 Subcommittee on High-rise Building External Evacuation Devices. An invitation from the Subcommittee's Secretary, W. Christensen, has already been received.

The second is for the researcher to seek membership and participation on the NFPA Committee regarding building evacuation and egress.

The third recommendation is for the SCFD to obtain available devices for evaluation and comparison. This will give the SCFD a first hand understanding of each system's benefits and limitations. Any action oriented research including testing should include the ability to have a secondary safety line attached to any live demonstrations.

The fourth recommendation is for SCFD to initiate high-rise company and officer drills. Although this is not a new idea, it has been some time since the SCCIMS procedures regarding high-rise structures have been exercised.

Finally, any future researcher should consider using the contacts in this ARP as a starting point when conducting further research in the area of escape systems.

References

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Appendix A

List of Rescue Escape Devices

Table 1B

Device	Company	Category	Contact Information
Advance Modular Evacuation System	Advance Evacuation Systems	Chute	www.AES-Systems.com . info@ames-1.com
AESOP	Skyscraper Evacuation Systems	Chutes	www.SkyscraperEvac.com Robert@skyscrapperevac.com Roberto Catalan 301-728-7676
Baker Life Chutes	Baker Safety Equipment Incorporated.	Chutes	www.lifechute.com info@lifechute.com Ralph Baker 1-88-LifeChute
Best Rescue System	unknown	CDD	No contact information listed
DescendrMax300	Spidescape Product, Inc.	CDD	www.spidescape.com Robert V. Smith 480-236-4825
Descenter Evac-Pac	Matsumoto Kiko Company /ORIRO	CDD	www.evacuation.net scott@evacuation.net Scott Alberts 323-849-1711 exit 21
DoublExit	DoublExit	CDD	www.doubleexit.com Dr. Jonathan Shimshoni 212-292-5669
EscapeChute	Precision Aerodynamics	Non-structural dependent	www.precision.aero.com infor@precision.net George Galloway 423-949-9499
Escape Rescue System "Lifeboat"	Escape Rescue Systems	Platform Rescue System	www.eswcaperescue.com info@escaperescue.com Dr. Jonathan Shimshoni 212-292-5669
EVAC Rescue Chute	EVAC Systems, Inc.	Chutes	No contact information
Evac-U-Chute	Emergency Evacuation Systems	Non-structural dependent	www.evacuchute.com Marcus Hirsch 866-E-Chutes

Executive-Chute High-Rise Kit	Safer America	Non-structural dependent	www.saferamerica.com info@saferamerica.com 269-273-3183 – disconnected
High-Rise-Rescue or Eagle	DM Aerosafe	Platform Rescue System	metrevel@internet-zahav.net
Ingstrom Escape Chute	Escape Consult Mobilex	Chutes	www.escapeconsult.com/ ingstrom@algonet.se
Rescuer Cone	Babakin Space Technologies Centre	Non-structural Dependent	No contact information.
Safir-Rosetti ResQline.	Safir-Rosetti	Controlled Descent Device	www.SafirRosetti.com asafir@safirrosetti.com Adam Safir 212-817-6700
Spider Rescue	OmniTop International Trade and Marketing, Ltd.	CDD	www.omnitop.org
Verti Scape or Slide Scape	Escape Chute Systems	Chute	www.escape-chute-systems.com
Unknown	Wahlefield Safety Corp.	Platform	No contact information.

Appendix B

Escape System Companies Contacted by Email
April 3-6, 2006

Advance Evacuation Systems
Advance Modular Evacuation System
info@ames-1.com

Baker Safety Equipment Inc.
Baker Life Chutes
info@lifechute.com

DM Aero Safe
High-rise Rescue or Eagle
metrevel@internet-zahav.net

DoublExit
DoublExit
info@doublexit.com

Emergency Evacuation Systems
Evac-u-Chute
info@evacuchute.com

Escape Chute Systems
VertiSlide or SlideScape
sales@escape-chute-systems.com

Escape Rescue Systems, Ltd.
Escape Rescue System
info@escaperescue.com

MobilTex
Ingstrom Escape Chute
ingstrom@algonet.se

Matsumoto Kiko Company
Decenter
scott@evacuation.net

Precision Aerodynamics
Escape Chute
info@precision.net

OmniTop International Trade and Marketing, Ltd.
Spider Rescue
info@omnitop.co.il

Safer America
Executive-Chute
info@saferamerica.com

Safir Rosetti
ResQline
arosetti@safirrosetti.com

Spidescape Product, Inc.
DecndrMax300
info@spidescape.com

Skyscraper Evacuation Systems
AESOP
robert@skyscraperevac.com

Appendix C

Feedback Instrument

Battalion Chief Michael Johansmeyer
Seminole County Fire Department
150 Bush Blvd.
Sanford, Fl
mjohansmeyer@cfl.rr.com

Sir or Madam, I am looking for information regarding escape systems for use in high-rise buildings. The information gathered will be used for an Applied Research Project as required by the National Fire Academy' Executive Fire Officer Program. Please include your company contact information, as it will be placed in the appendix section of this project for the sharing of information with other fire departments.

1. Is your escape system currently in use for high-rise building evacuation of civilians?

2. If so, is there any in use in the United States?

3. Has your company encountered challenges regarding implementing your escape system for use in evacuation of high-rise buildings (i.e. approval, certification)?

Appendix D

Feedback Instrument Results

Table 1D	Question	Question	Question	
Company	1	2	3	
AESOP	no		yes	acceptance and certification
Baker Life Chutes	yes	yes	no	U.S. Military, NASA
DescendrMax300	no		no	no demand
Descenter	yes	no	yes	politics, prototype available, acceptance and certification.
DoublExit	yes	no	yes	acceptance and certification
EscapeChute	yes	yes	yes	acceptance
Escape Rescue System	yes	no	yes	Israel, Fire Service, NFPA, acceptance and certification
Evac-U-Chute	yes	yes	yes	acceptance
Percent of yes	75%	50%	75%	
15 feedback instruments - email		0 returned	0%.	
10 feedback instruments - telephone		8 returned	80%	

Appendix E

Escape System Companies Contacted by Telephone, April 3-6, 2006

Baker Safety Equipment Inc.
Baker Life Chutes
Ralph Baker
1888-LifeChute

Double Exit
DoublExit
Jonathan (Yoni) Shimshoni, PhD.
212-292-5669

Emergency Evacuation Systems
Evac-U-Chute
Marcus Hirsh
866-E-Chutes

Escape Rescue Systems, Ltd.
Escape Rescue System
Jonathan (Yoni) Shimshoni, PhD.
212-292-5669

Matsumoto Kiko Company
Decenter
323-849-1711 ext.21

Precision Aerodynamics
Escape Chute
George Galloway
423-949-9499

Safer America
Executive-Chute
269-273-3183

Safir Rosetti
ResQline
212-817-6700

Skyscraper Evacuation Systems
AESOP
Roberto S. Catalan
301-728-7676

SpideScape Products, Inc.
DecndrMax300
Robert V. Smith
303-524-1069

Appendix F

Matrix 1F - Hazard Identification		
Hazards	What is the probability an event will occur at this hazard?	What is your best estimate of total population that could be affected seriously by this hazard?
Event at a high-rise building requiring emergency evacuation.	1. ☐ unlikely 2. ☒ possible 3. ☐ likely	1000
Terrorist event at a high-rise building.	1. ☐ unlikely 2. ☒ possible 3. ☐ likely	1000

Matrix 2F– Vulnerability Assessment		
Hazards	Event at a high-rise building requiring emergency evacuation	Terrorist event at a high-rise building
Impact Rating		
Danger/Destruction (High=3, Moderate=2, Low=1)	1	3
Economic (Permanent=3, Temporary=2, Immediate Short Term=1)	1	2
Environmental (High=3, Moderate=2, Low=1)	1	1
Social (High=3, Moderate=2, Low=1)	1	2
Political Planning Level (Federal=3, Regional=2, Local=1)	1	1
Total Vulnerability Rating (Sum of all factors)	5	9
Rank (High 12-15, Moderate 9-11, 5-8-Low)	Low	Moderate

Matrix 3F-Risk Rating							
	Probability of Occurrence			Vulnerability			
Hazard	Likely (3)	Possible (2)	Unlikely (3)	High (3)	Moderate (2)	Low (1)	Rating (Probability x vulnerability
Event at a high-rise building requiring emergency evacuation.		x				x	2
Terrorist event at a high-rise building		x			x		4