Running head: EVACUATION PLANS FOR HIGH RISE BUILDINGS

Leading Community Risk Reduction

Evacuation Plans for High-Rise Buildings Related to Building Fire Codes

Leading Community Risk Reduction

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CERTIFICATION STATEMENT

I hereby 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 and writings of another.

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Abstract

The problem was there was nothing specifically identified in the 2003 International Fire Code that requires high-rise buildings evaluate their evacuation plans. This research's purpose was to identify systems to test evacuation plans in high-rise occupancies and make recommendations for amendments to City of Sugar Land codes. Descriptive research methods were used to answer questions regarding available testing systems, business concerns regarding drills, which test would be beneficial to both businesses and the city in regards to testing plans and code changes, and any type of enforcement criteria. Procedures included personal interviews with property managers and questionnaires to both managers and fire departments. Suggestions for amendments to the 2003 International Fire Code were proposed for the city's adoption based on information from research, interviews, and questionnaires. Recommendations were also made regarding additional funds and staffing necessary for proper implementation of proposals.

Table of Contents

Introduction

Building and property managers have a difficult task ahead of them. They must balance the legal requirements of protecting the occupants and visitors of the buildings with the concerns of their tenants regarding disruption of business. The National Fire Protection Association (NFPA), which is not a regulating body, makes certain recommendations for all buildings through NFPA 101®, Life Safety Code®. The Life Safety Code® says, "although not mandated for all buildings, NFPA 101®, Life Safety Code®, requires that workplaces, healthcare facilities, educational institutions and other occupancies provide evacuation/relocation plan information and routinely schedule and hold drills when practicable."

Property managers and building owners must also deal with any negative ramifications resulting from fire drills conducted in their occupancies.

The problem is that the City of Sugar Land currently has nothing in its fire or building codes that requires high-rise buildings evaluate the effectiveness of their emergency evacuation plans through some type of drill or testing process. The purpose of the research is to identify systems to test the effectiveness of evacuation plans in high-rise occupancies. A proposal for a change in the City of Sugar Land building and fire code will also be developed from the research.

Descriptive research methods will be used to answer the following questions:

1. What systems are available to test the effectiveness of evacuation plans for high-rise occupancies?
2. What reasons do businesses and management companies have for not wanting to conduct evacuation drills to test the effectiveness of their current evacuation plan?

3. Which types of tests would be most beneficial for both the businesses and city in regards to testing the effectiveness of an evacuation plan?
4. What type of enforcement criteria should be built into any code developed?
5. Which changes in building and fire codes regarding testing processes would be most advantageous to both the business community and the City of Sugar Land?

Background and Significance

The City of Sugar Land operates under the 2003 International Fire Code according to City Ordinance 1536. There are currently no amendments within the ordinance that requires buildings, other than those specifically identified in the 2003 International Fire Code, to conduct any type of evacuation drills. Because there are no specific requirements, there is also no specified method in which evacuations will be conducted.

One of the most illustrative examples of the significance of evacuation of high-rise buildings came on September 11, 2001. While this particular date is etched in everybody's memory, it is not the first time the World Trade Center buildings were evacuated. In 1993 during a terrorist bombing of the World Trade Center, fire drills were not common; but after this event, tenant emergency teams, training and more visible interior stairwells aided in a faster evacuation during September 11th according to Dr. Prouix (2003).

In the wake of the September 11th terrorist attacks, along with other recent deadly fires in high-rise buildings, many jurisdictions, large and small, are now requiring various types of evacuation drills. Chicago is probably one of the largest. Their ordinance specifies what a high-rise building is, that each identified high-rise have an evacuation plan and how it is filed with the City, and which high-rise occupancies require that evacuation drills are conducted. Other jurisdictions that have followed suit are Houston, TX; Pittsburg, PA; and Arlington County, VA.

Without specific mandates, building owners and managers may be reluctant to hold evacuation drills, primarily for fear of alienating or disturbing their tenants. As Azano (2003) identifies, drills remove employees from work, which causes lower productivity and revenue for tenants. Although various codes or recommendations suggest fire drills take place, owners and managers are more likely to do what is minimally required and not suggested.

Analysis of evacuees' reactions during the World Trade Center event has sparked new research into behavioral aspects during evacuations. Questioning of survivors has found that occupants did not behave in a manner that was previously predicted. Psychologists and other behavioral scientists are studying the World Trade Center disaster to determine how occupants behavavior during the event and the evacuation either helped or hindered the evacuation process (Winerman, 2004). Studies in individual behaviors are also prompting better computer modeling to simulate fire risk assessment. One such model is called CRISP, which incorporates a detailed behavior model (Fraser-Mitchell, 2004). While not always as reliable as evaluating the effectiveness of live drills, computer models can be used as an alternative in determining building and occupant reactions in an emergency.

Buildings becoming increasingly more populated with persons with disabilities, along with certain findings from the World Trade Center event is also opening considerations into alternative forms of evacuation. Elevators, which were once thought of as taboo, could become a viable means for evacuation and transporting fire fighters to upper levels of burning buildings. Another form of alternative vertical evacuation is single entry or multiple-entry escape chutes.

Leading Community Risk Reduction is a National Fire Academy course within the Executive Fire Officer Program. The course involves a comprehensive look at community risk reduction, instilling the concept that community risk reduction is a tool for reducing risk from

fire and other hazards in the community. Research in and recommendations from this project will correspond to all four phases of emergency management -- preparedness, mitigation, response and recovery -- by reviewing current codes and practices and identifying any areas change may be needed.

The United States Fire Administration (USFA) has five operational objectives. Research in this project can easily fall under all five objectives, dependent on the type of high-rise occupancy. Under typical high-rise occupancies within the City of Sugar Land, this research will primarily fall under objective three, reduce the loss of life from fire of fire fighters, and objective four, to promote within communities a comprehensive, multi-hazard risk-reduction plan led by the fire service organization.

Literature Review

Evacuation plans for high-rise buildings has always been a controversial issue. Taking into account legal considerations and studies of recent events involving high-rise occupancies, the issue becomes even more complex. Governing and regulatory bodies are now taking a harder look at both the planning and evaluation phases for certain occupancies.

Most of the controversy regarding evacuation plans, and more importantly evacuation drills, in high-rise buildings revolves around the losses tenants may incur by having to vacate their place of business for any period of time. Butler (1987) discusses that evacuation drills held in the middle of the day, with pre-warning, typically have three phases. Butler identifies these phases as the “winding down” period in anticipation of the drill, the actual drill itself, then a “winding up” period where employees get back into their work. Time is placed in relevancy with business cost, or in this case business loss. According to Azano (2003), a ten-story building may take up to 20 minutes to fully evacuate.

Most building owners and management companies are fully aware of their legal requirements. In particular, the City of Sugar Land adopted the 2003 International Fire Code on December 6, 2005, under Ordinance 1536. Chapter 4 of the 2003 International Fire Code discusses Emergency Planning and Preparedness. More specifically, Section 404 discusses Fire Safety and Evacuation Plans. High-rise buildings are identified as occupancies that need a fire safety and evacuation plan. Referring to Section 405, Emergency Evacuation Drills, there is no specific mention of high-rise buildings requiring evacuation drills performed, although there is reference to "when required by the fire code official." While Ordinance 1536 contains certain amendments to the 2003 International Fire Code, there is no amendment relating to evacuation drills in high-rise occupancies. There is also no clear definition identifying what qualifies as a high-rise occupancy.

There are a number of private and governmental agencies that make certain requirements and recommendations. The NFPA has the Life Safety Code® (NFPA 101®). The Life Safety Code® does identify fire drills in Section 4.7; however, the NFPA is not a regulatory entity. According to the National Safety Council, fire prevention, fire protection, adequate evacuation programming and planning and complete rehearsal for survival are needed to make sure losses will be minimal in the event of fire. Additionally, an article on the National Safety Council's web page (Griffith and Vulpitta, 1999) discusses how the Occupational Safety & Health Administration (OSHA) requires facilities with over ten employees to have emergency response plans. Referring to a U.S. Department of Labor web page, it identifies employers in high-rise buildings should conduct emergency evacuation drills periodically.

The events of September 11, 2001, as well as other recent incidents in high-rises, have initiated new research and analyses of high-rise building evacuations. Behaviors of both the

building and its occupants did not react as previously expected, causing additional alternatives for evacuation to be considered. Additionally, fire fighters are evaluating their tactics and strategy based on what happened at the World Trade Center.

The Columbia University Mailman School of Public Health report (2004) noted "because full-scale evacuations of high-rise buildings are rare, very little is known about how readily and rapidly these types of structures can be fully evacuated and, importantly, what factors serve as facilitators or barriers to this process." Cited as environmental factors affecting evacuation in the World Trade Center's evacuation attempt was structural damage blocking egress routes, heavy congestion on certain stairways, and lack of back-up communication systems, according to a (Center for Disease Control and Prevention [CDC], 2004) report titled "Preliminary Results from the World Trade Center Evacuation Study --- New York City, 2003." Reviews of more recent high-rise fires, such as The James Lee Witt Associates, LLC, review of the Cook County Administration Building fire in Chicago, Illinois (2004) on October 17, 2003, noted inconsistencies in building codes as one of its findings which contributed to the fire and loss of life.

The response of evacuees during the World Trade Center disaster has prompted further interest in and research of the psychological aspects of evacuations in high-rise structures. According to Winerman (2004), assumptions by fire safety engineers failed to consider behaviors of people during emergencies. People's behavior and reactions are dependent on many factors, including the initial fire cues; the information content of the cues; the person's activities at the time of the cues; the clarity of the cue; and how the group people are with, if any, react to the cues, according to Fraser-Mitchell (2004). Natacha Thomas, assistant professor of civil

engineering at the University of Rhode Island, is quoted by Page (2004) as indicating, “research into pedestrian flows in and around buildings has been neglected.”

The standard recommendation regarding elevator use during high-rise fires, fire fighting and evacuations is to not use them. Recognized agencies, such as the NFPA, specifically identify that elevators are never appropriate to use during a fire or similar emergency. Deaths have occurred to both occupants and fire fighters using elevators during fires in high-rise buildings. According to Favro (1997), five guests were killed in a New Orleans hotel; and fire fighters in New York were killed when attempting to use an elevator to take them two floors below the fire floor when the elevator inadvertently went to the fire floor. Newer technology, research, and building designs are now bringing into question earlier thinking regarding the use of elevators in evacuations and firefighting activity. Research conducted by the National Institute for Standards and Technology (NIST), on behalf of the Federal Aviation Administration (FAA), concluded elevator evacuation in air traffic control towers is feasible (Favro). Other considerations, such as an updated understanding of human behavior and a more diversified disabled workforce, also support the idea of elevators enhancing evacuation of high-rise buildings.

Concepts regarding evacuation of high-rise buildings vary somewhat; however, there are some inherent consistencies in most of them. The three primary evacuation concepts are a complete evacuation, phased evacuation and shelter-in-place (Harper and Greene, 2005). According to Harper and Greene, a complete evacuation is where the entire building is evacuated, a phased evacuation is only a portion of the building and shelter-in-place is where the occupants stay where they are. Because of the varying concepts, there are also varying recommendations in how to evacuate buildings in an actual emergency. The City of Houston Fire

Department recommends that evacuation plans identify that all personnel go to the nearest stairs and stand by the stairway for instructions. It even specifies further that the occupants are not to go into the stairs. The Singapore Civil Defense Force offers more specific instructions. Their recommendations divide buildings into three categories; low-rise, medium-rise, and high-rise. They identify low-rise buildings as anything below 8 stories, medium-rise buildings from 8 to 30 stories, and high-rise buildings as anything above 30 stories. In their recommendations they indicate that in evacuations of low-rise buildings a total evacuation should occur, while in medium-rise buildings total evacuation is contingent on a two-stage alarm system. In high-rise buildings they recommend a phased evacuation.

For years firefighting tactics have relied on the assumption that the building would never collapse. According to Berry (2004), previous assumptions are being replaced with the idea that buildings can now topple due to damage and fire. Berry further identifies that fire fighters will become better trained in regards to building design and construction to help recognize the signs of imminent collapse.

There are a number of computer models available to test and simulate various aspects of fires, alarm systems, smoke travel and evacuation of high-rise buildings. NIST's Building and Fire Research Laboratory lists CFAST – Consolidated Fire and Smoke Transport Model; ASET-B – Available Safe Egress Time – Basic; ASCOS – Analysis of Smoke Control Systems; and ELECAC – Elevator Evacuation, to name a few. Additionally, new simulators are being developed to account for behavioral aspect during evacuations. One such model is called FIRESCAP: A Computer Simulation Model Of Reaction To A Fire Alarm. FIRESCAP incorporates past research on fire emergencies, as well as research on crowd behavior (Feinberg and Johnson, 1995). Most simulator programs are used during the initial building design process.

Procedures

Several occupancies classified as high-rise within the City of Sugar Land were contacted. Personal interviews were conducted with representatives from most of the occupancies contacted. These buildings included Fluor Coproration, The Marriott Town Center, One Sugar Creek Place, and Granite Towers. The same five questions (Appendix A) were asked during all interviews; however, follow-up questions were also asked based on some of the answers given or the direction of the general conversation. Two of the initial questions involved the perceived complexities in conducting full-scale evacuation drills in their occupancies and if they believed having drills would help eliminate some of those complexities. Another question involved any reasoning for not wanting to participate in full-scale evacuation drills. The fourth question was primarily involving occupancies that did participate in evacuation drills and questioned who dictated that participation. The final question asked for any suggestions on organization of evacuation drills to minimize negative impact of their tenants.

In addition to the personal interviews, questionnaires (Appendix B) were left with the representatives interviewed to obtain further information. The questionnaire consisted of eight questions, with several of the questions having multiple parts. The first question simply identified the height of their building. The next question asked if their occupancy had an emergency evacuation plan and, if so, when was the last time it was updated. The third question had several parts, if answered yes. The first part asked if they had ever practiced their emergency evacuation plan. If they had, the next two parts asked them to identify how often and in what manner the drills were conducted. The next question asked for some of the reasons their occupancy has not ever had an evacuation drill, if that were the case. The last four questions involved motivators and assistance to help promote participation in conducting evacuation drills.

In order to see how Sugar Land's current code, along with the idea of changing the code to require evacuations drills, compared with other jurisdictions a questionnaire (Appendix C) was sent out to various cities. The cities who returned the questionnaires were Peoria, AZ; Rialto, CA; St. Petersburg, FL; Naperville IL; Peoria, IL; Grand Rapids, MI; Broken Arrow, OK; Cincinnati, OH; Miami Township, OH; and Bedford, TX. This questionnaire consisted of six questions, several of which had multiple parts, dependent on certain answers. The first question asked if their jurisdiction required occupancies to have evacuation plans. The next question delved further into their codes, asking if they required buildings with evacuation plans to conduct drills. If they answered yes to that question, there were follow-up questions asking how often and in what manner these drills were conducted. The third question inquired if their jurisdiction offered any type of incentives encouraging businesses to conduct evacuation drills and, if so, what those incentives may be. Question four asked what type of enforcement procedures their jurisdictions had regarding evacuation drills. The next question was to find out what they considered a high-rise occupancy. Finally, they were asked if any other types of occupancies were considered a high-rise, in conjunction with how their codes were written and enforced.

Limitations

This paper has several limitations. These limitations include jurisdictional interpretations of codes and occupancy types, interviews and questionnaire sampling to building managers and other cities, and the number of high-rise buildings within the City of Sugar Land.

The 2003 International Fire Code references evacuation plans and requirements for evacuation drills. Some of the terminology is specific and some is ambiguous. Most jurisdictions and occupancies are pretty consistent with regards to the specifically identified criteria. There are

variances in interpretations regarding areas of the code that are not so specific. Another area where terminology differs is regarding the classification of what a high-rise is.

Interviews and subsequent questionnaire sampling was limited to occupancies within the City of Sugar Land that were considered a high-rise by the Prevention Division. There were further limits imposed by the actual number of those building managers who made themselves available for an interview.

The selection of cities for questionnaires was non-scientific; however, cities selected to send questionnaires to were spread throughout the United States for a broad perspective. Limitations to these questions were based on the responses to the questionnaires sent out.

Definitions

ADA – American with Disabilities Act

Complete Evacuation – evacuation whereby the entire building is evacuated

CRISP – a computer simulation model that incorporates a risk assessment of the building in conjunction with detailed human behavior.

Escape Chute – an escape chute system installed inside a protected vertical shaft enclosure that is constructed in accordance to local fire codes and provides protection from fire effects for evacuees.

Evacuation Drill – an exercise performed to train staff and occupants and to evaluate their efficiency and effectiveness in carrying out emergency evacuation procedures.

Evacuation Plan – a predetermined system by which occupants safely and orderly exit a building.

Fire Code Official – the fire chief or other designated authority charged with administration and enforcement of the code, or a duly authorized representative.

Floor Warden – Assist with training occupants and leading drills on their assigned floor in the building. In the event of an emergency, the floor warden is responsible for assisting with evacuation and assuring all personnel are accounted for.

High-rise Building – as defined by the NFPA, a building greater than 75 feet in height where the building height is measured from the lowest level of fire department vehicle access to the floor of the highest occupiable story.

HSE – Health, Safety & Environmental. Fluor Corporations terminology for the division of their company over property and employee health and safety.

NFPA – National Fire Protection Association. An international nonprofit organization dedicated to reduce the worldwide burden of fire and other hazards by providing and advocating consensus codes and standards, research, training and education.

NIST – National Institute for Standards and Technology

Phased Evacuation – evacuation whereby only a portion of the building is evacuated

Shelter-in-place – occupants of a building or area remain where they are

Two-stage alarm – a system by which two different alarms sound. The first alarm last not less than one minute and is used as an alert signal for occupants to stand by for evacuation. The second continuous alarm is sounded and immediate evacuation should be effected.

Results

Interviews

Interviews were set up with managers of various high-rise occupancies throughout the City of Sugar Land. Five standard questions were asked of each manager, with subsequent questions posed based on information provided.

One of the larger high-rise and office complexes in the City of Sugar Land is Fluor Corporation. The discussion included Mr. James B. Hart, Senior Manager of Office Services and Mr. C.H. Shayne Carter, Director of Facility HSE and Security.

1. "What would you consider some of the complexities in conducting a full-scale evacuation drill in your company?"

One complexity is coordinating the drill to bring about the least amount of disruption. Another complexity identified was the floor warden system, in particular trying to maintain a current list of occupants and keep up with the constant changes in personnel. Also identified

were the concerns presented by tenants who are working for a specific client at the time, with their time being billable to that client. In such situations neither the tenant nor the client wish to pay for the time being spent on the fire drill. A final complexity identified was including people with impairments. These individuals are typically evacuated to stairwells during drills.

2. "Do you think holding drills to practice the evacuation plan for your building eliminates some of the complexities discussed?"

Mr. Hart identified that it is extremely important to keep doing the drills. He indicated that pre-drill preparations with the floor wardens also help eliminate some of the complexities that could be encountered during drills. Finally, he indicated that scheduling the drills plays a vital role in eliminating the drill complexities. Mr. Hart added that scheduling was with the floor wardens but stressed that it was also important that none of the general population was apprised of the drill in advance.

3. "What are some of the reasons you would not want to participate in full-scale evacuation drills of your building?"

Mr. Hart and Mr. Carter both indicated they did not typically hold full-scale evacuation drills in their buildings. Participants in a typical drill included occupants from the identified fire floor, one floor above the fire floor and one floor below the fire floor. Later in the interview Mr. Carter noted that they have evacuated the entire building during some previous drills. In those situations they were able to evacuate the entire building in less than 12 minutes. He believed this was pretty good, considering their occupancy population ranges from 3,500 to 5,000.

4. If your company conducts evacuation drills (of any type), who dictates they be accomplished?"

Mr. Carter identified that Fluor Corporation was very safety conscientious. He said that Fluor gives the Health, Safety and Environmental (HSE) section flexibility to do what they believe is needed for each specific occupancy. He continued that there are specific policies established by Flour, then subsequent site-specific procedures. Mr. Hart added that for locations without specific needs, nor a need for a HSE Division, Fluor has generic plans available.

5. "Do you have any suggestions on how evacuation drills could be organized to lessen the negative impact on your business?"

A suggestion offered by Mr. Hart was to exempt certain people from the drills, adding that it is important that most businesses remain available for their customers. In those situations, Mr. Hart also indicated that people exempt from drills should be documented and rotated so that it is not the same individuals every time. Mr. Hart continued, that different businesses have different processes and these variances should be incorporated in the drills when and where possible. Finally, Mr. Hart identified he believed it was important to have the fire department there so that the participants believed the drill was being taken seriously by all involved.

Mr. Hart and Mr. Carter offered some additional information during the interview. Fluor's drills and process was based on NFPA 101®, Life Safety Code®. They understood that the drills were not mandated by city codes, but believed they should be. Regarding their drills, Mr. Hart added that they also conduct "warden only" drills several times a year.

Mr. Jack Van Demark, with Uniley Management Corporation, Real Estate Management at One Sugar Creek Place, 14141 Southwest Freeway, was also interviewed. The following questions were asked:

1. "What would you consider some of the complexities in conducting a full-scale evacuation drill in your company?"

Mr. Van Demark discussed that trying to time the drills to be as least intrusive as possible was one of the primary complexities. He included that individuals identified as ADA could pose specific issues during evacuation drills.

2. "Do you think holding drills to practice the evacuation plan for your building eliminates some of the complexities discussed?"

Previous drills at his building were coordinated through Unocal, the primary tenant. Mr. Van Demark would act as a building liaison, working within the specific responsibilities in that role during drills. He also included that he believed it important to have an identified muster area and a way to confirm everyone was out of the building. Regarding individuals identified as ADA, he offered that it was important to specify the location of said individuals and have two attendants identified to assist these people.

3. "What are some of the reasons you would not want to participate in full-scale evacuation drills of your building?"

He added that it was much easier to get tenant participation when it was the primary tenant that was urging and coordinating the evacuation drills. He also noted that Unocal had changed its drill schedule to one per year, when in the past it was typically conducting two.

4. If your company conducts evacuation drills (of any type), who dictates they be accomplished?"

The desire of Unocal, the primary tenant, to hold annual evacuation drills was the primary motivating factor in holding evacuation drills.

5. "Do you have any suggestions on how evacuation drills could be organized to lessen the negative impact on your business?"

Mr. Van Demark offered that in his experiences, at this building and previous buildings, he believed that showing movies that instilled a small amount of fear and showed occupants what conditions may really be like during an actual emergency would help promote better participation. He also added that stress during drills and actual emergencies was typically high and people in charge of evacuation plans should anticipate all questions, having prepared answers. He concluded that education of occupants and tenants was another key factor. He stressed specific information on the environment and evacuation should be included, saying "the little stuff that hits home."

A representative with Granite Properties, Inc., one of the newer high-rise buildings in Sugar Land, was interviewed. Ms. Zeva S. White, Property Administrator with Granite Properties, is located at 363 N. Sam Houston Parkway in Houston. Having worked at several high-rise properties throughout the area, including Sugar Land and Houston locations, she offered interesting insight to the interview questions, from multiple perspectives.

1. "What would you consider some of the complexities in conducting a full-scale evacuation drill in your company?"

Ms. White indicated that getting tenant participation was one of the primary complexities in conducting evacuation drills. With her current location operating under the City of Houston ordinances, tenants are just required to stand by the nearest stairwell and await instructions from fire department personnel prior to exiting the building.

2. "Do you think holding drills to practice the evacuation plan for your building eliminates some of the complexities discussed?"

Ms. White believed that additional training has made tenants more aware of their surroundings. She said that it was also important to stay current on floor wardens, identifying

that she communicates frequently with her tenants to assure her list of floor wardens is updated. She also keeps track of their certifications and notifies them when their certification is about to lapse and where they may attend training to be recertified. Ms. White also indicated that having drills and including security personnel help them better understand their roles and responsibilities during an emergency. She added that they even changed their drills to include some in the afternoon so the second shift of security personnel could participate.

3. "What are some of the reasons you would not want to participate in full-scale evacuation drills of your building?"

She identified that Granite Properties did not like their buildings to participate in full-scale evacuation drills. She added that the primary reason was liability, in that occupants may get injured walking down stairs and such. She also identified interruption in business as another reason, stating that companies usually don't have time to conduct a full-scale evacuation.

4. If your company conducts evacuation drills (of any type), who dictates they be accomplished?"

Her current property location was mandated by City of Houston ordinances under their Fire Codes in how and how often they conducted fire evacuation drills.

5. "Do you have any suggestions on how evacuation drills could be organized to lessen the negative impact on your business?"

Ms. White believed it was important to get the fire department involved in the evacuation drills. She thought it helped to develop closer relationships, in particular with the nearest fire stations. She also believed building management should heed advice from those specific fire fighters, since they would be the ones responding to and working within their building. Ms. White added that seminars and training were also important, specifically for information sharing

and preparedness. She identified that they schedule all drills and announce the drill in advance of sounding the alarm. She also sends a letter in advance of the drill. Ms. White indicated they have a mobility impaired list, which was she keeps updated and would supply to fire department officials on their arrival.

A representative with one of the newest and the highest hotel occupancy in Sugar Land was also interviewed. Mr. Larry Bundy, General Manager at Sugar Land Marriott Town Square, had a wealth of information, serving as manager of numerous high-rise hotels throughout the country.

1. "What would you consider some of the complexities in conducting a full-scale evacuation drill in your company?"

The primary complexity identified by Mr. Bundy involved the numerous and different patrons involved. He added that in dealing with hotel residents, another issue is not recalling the guests quick enough after the drill was over.

2. "Do you think holding drills to practice the evacuation plan for your building eliminates some of the complexities discussed?"

Mr. Bundy indicated that conducting quarterly drills had a positive effect on the aftermath of actual evacuations or emergencies. He identified that as an example they found that there was a time delay in the enunciator for their speakers whereby they needed to hold the button down for a short time prior to speaking to assure guests could hear the entire message.

3. "What are some of the reasons you would not want to participate in full-scale evacuation drills of your building?"

He indicated that there was no reasoning behind not wanting to participate in full-scale evacuation drills because they were required to do so.

4. If your company conducts evacuation drills (of any type), who dictates they be accomplished?"

Mr. Bundy identified that the Marriott Corporation was the primary authority requiring them to conduct evacuation drills. He added that the first priority for Marriott and himself was the lives of everyone in this hotel. Marriott's requirements also included monthly testing of emergency generators. Additional requirements included local codes.

5. "Do you have any suggestions on how evacuation drills could be organized to lessen the negative impact on your business?"

Mr. Bundy suggested one area that could help lessen the negative impact of evacuation drills was a quick critique afterwards. This critique would include all available hotel staff. He also identified that review of plans to eliminate any redundancies could aid in a more organized evacuation while also eliminating wasted time during a drill or actual emergency.

Questionnaires

In addition to interviews with occupancy managers, a questionnaire was also developed and left with the managers interviewed. The purpose of the questionnaire was to assist in further answering the research questions involving the reason for not wanting to conduct evacuation drills, which types of tests would be most beneficial for the businesses, what type of enforcement criteria should be built into any code developed, and what type of tests would be most advantageous to businesses regarding building and fire codes.

The questionnaire consisted of eight total questions, with three of the questions having multiple parts.

1. Type of Occupancy (Check One)

The answers were either building height of six stories or less or building height of seven stories or more. All managers interviewed replied in their questionnaire that their building was above seven stories.

2. Does your building have an emergency evacuation plan?

The answers to the question were limited to yes or no. All managers identified they did have an evacuation plan in place.

An additional part to this question pertained to if their answer was yes. If yes, when was the last time your plan was updated?

The dates from the last updated varied. The oldest update was January of 2004 with the latest update being December 2005.

3. Has your building ever practiced your emergency evacuation plan?

The answers to the question were limited to yes or no. All respondents answered yes.

If the respondent answered yes, there were two additional questions asked. First, if yes, please identify how often the plan is practiced below using the best answer. The choices were once, after the plan was created; annually; twice a year; or other. Seventy-five percent of the respondents identified they conducted drills twice per year. Twenty-five percent of the responses were other, which happened to be the Marriott Hotel. They are required, according to the 2003 International Fire Code, to conduct quarterly evacuation drills. In addition, the Marriott Corporation requires quarterly evacuation drills as well.

Secondly, if yes, please identify below how your emergency evacuation plan is practiced using the best answer. The choices for this part were tabletop or simulated exercise; drills utilizing management, security and maintenance personnel only; drills utilizing partial evacuation of the building; drills utilizing the emergency evacuation plan to evacuate the entire

building; or other. Half the respondents indicated they evacuated the entire building during their drills. One identified they did partial evacuations. The other respondent indicated they only conducted drills to the extent that occupants went to their nearest stairwell and awaited orders.

4. If your building has never had a drill to evaluate the effectiveness of your emergency evacuation plan, what are some of the reasons you have not done so (check all that apply)?

The answers available to the respondent were too costly for tenants to participate; concern over upsetting tenants; have not considered it necessary; unsure how to conduct an evacuation drill; not enough time for management staff to conduct a drill; and no budget to conduct a drill. This question was not applicable to all respondents; due to identifying they had an emergency evacuation plan in question two.

5. If assistance from the local fire department were provided to aid in facilitating an evacuation drill, would this assistance increase the likelihood of your building conducting evacuation drills?

The answers were yes, no and wouldn't matter. Fifty percent identified yes and the other fifty percent indicated it wouldn't matter.

6. Would your company support ordinances requiring evaluation of the emergency evacuation plan through annual drills?

The answers were limited to yes or no. All responses were yes.

7. If there were insurance incentives for conducting evacuation drills, how likely would your company be to conduct annual evacuation drills?

The answers were yes, no and wouldn't matter. Fifty percent identified yes and the other fifty percent indicated it wouldn't matter.

8. If there were economic incentives from local government for conducting evacuation drills, how likely would your company be to conduct annual evacuation drills?

The answers were yes, no and wouldn't matter. Fifty percent identified yes and the other fifty percent indicated it wouldn't matter.

An additional questionnaire was developed and sent to a sampling of various fire departments throughout the United States. The purpose of this particular questionnaire was to help answer specific research questions from the perspective of the jurisdiction having authority. The questions were designed to help answer the first, third, fourth and fifth research questions. There was no definitive methodology in the departments chosen; however, many of the departments were similar in size and makeup to the City of Sugar Land. A total of six questions were asked, with five of the questions having multiple parts.

1. Does your jurisdiction require high-rise occupancies to have evacuation plans?

The answer to this question was limited to yes or no. Of the questionnaires returned, 90% answered yes, indicating that most jurisdictions did require high-rise occupancies to have evacuation plans.

2. Does your jurisdiction require occupancies with evacuation plans to conduct drills to evaluate the effectiveness of their plan?

The answer to this question was limited to yes or no. Eighty percent of the respondents answered yes, indicating they required evacuation drills.

There were two subsequent portions to this question if the respondent answered yes to the question. The first portion asked if yes, how often do they have to conduct drill(s)? The available answers were once, after the plan was created; annually; twice a year; or other. Of those who

answered yes, six indicated they required annual drills, with one identifying twice a year and another one indicating other. In the notes for other this, particular respondent identified their drills were those required per the 2003 International Fire Code, which was based on use group, but also noted they were not able to follow up on enforcement of the drills being conducted.

The second portion, if the respondent answered yes, was if yes, please identify below how the emergency evacuation plans are practiced and evaluated according to the code, using the best answer. The answers were limited to tabletop or simulated exercise; drills utilizing management, security and maintenance personnel only; drills utilizing partial evacuation of the building; drills utilizing the emergency evacuation plan to evacuate the entire building; or other. Five of the affirmative responses indicated their drills were conducted using management, security and maintenance personnel only. Three respondents identified they utilized drills evacuating the entire building. The final affirmative respondent indicated other and noted the drills were conducted by the 2003 International Fire Code, based on use group.

3. Does your jurisdiction offer any type of incentives for occupancies to conduct evacuation plans?

The answer to this question was limited to yes or no. Only thirty percent of the respondents answered yes in regards to any incentives being offered, with seventy percent answering no.

A second portion to the question asked if yes, what type (check all that apply)?

The answers available were assistance with developing evacuation drills; assistance with conducting evacuation drills; assistance with evaluation of evacuation drills after they are conducted; tax breaks to occupancies who comply with codes regarding evacuation drills; discounts or rebates on alarm permits; other economic incentives (identify); and other (identify).

Of the three affirmative responses all, indicated they offered assistance with developing, conducting and evaluating the evacuation plans and drills.

4. If your jurisdiction has codes requiring evacuation drills, in conjunction with evacuation plans, how do you enforce these codes (check all that apply)?

The answers available were warnings, citations, fines, revocation of permits, and other. Several of the respondents indicated multiple responses. Six responses indicated warnings as an enforcement tool. Four identified citations while three marked fines. Two indicated revocation of permits and two noted other. One of the two respondents for other included notes, which identified "fire inspectors follow up with letters". Of the respondents with multiple responses, two marked warnings, citations, fines, and revocation of permits. One response was warnings, citations, and fines. Another response was warnings and citations.

5. What size building does your jurisdiction consider a high-rise building?

The answers available were five-stories and higher, six-stories and higher, seven-stories and higher, above seven stories, or other. Four responses identified five-stories and higher as a high-rise. One response indicated six-stories and higher as a high-rise. Four of the respondents identified other for what their jurisdiction considered a high-rise. The notes provided for these other responses varied with one identifying three-stories and higher, one indicating "55 feet above lowest level of fire department access" and the other two noting 75 feet above the lowest fire department access.

6. Are any other size or type of occupancies considered a high-rise in regards to your jurisdictions codes?

The choices were limited to yes or no. Only one respondent identified their jurisdiction included any other type of occupancies in the high-rise classification.

A second portion to the question asked the respondent if yes, please describe. The note from the one respondent identified "very large structures that can not access with aerial."

Discussion

The City of Sugar Land has adopted the 2003 International Fire Code as its governing regulatory format for fire codes through Ordinance 1536. In the adoption of this ordinance, certain amendments were identified; however, none of the amendments were relative to evacuation plans or drills. The 2003 International Fire Code does require that all high-rise buildings, along with other specifically categorized occupancies, have fire safety and evacuation plans. The code also requires fire safety and evacuation plans be reviewed or updated annually or as needed based on changes in staff or the occupancy. The code does call for required evacuation drills in specifically identified groupings, along with their frequency. The code also notes that all identified occupancies shall have evacuation drills conducted; however, it does not indicate the frequency of said drills. Additionally, the 2003 International Fire Code indicates that drills shall be conducted "when required by the fire code official." There is no clear definition in the code as to what size or height of building constitutes a high-rise occupancy. Considering there are also variations in different documents as to what constitutes a high-rise, a clear definition must be made by the jurisdiction having authority. Since Ordinance 1536 does not indicate the definition of a high-rise in its amendments, it would be difficult to enforce the stipulations set regarding evacuation drills in high-rise occupancies.

The value of evacuation drills has been long understood within the fire service. Unfortunately, it has taken events such as the terrorist attack of the World Trade Center and other fatal incidents to overcome obstacles hindering mandatory evacuation drills, particularly in high-rise buildings. The difference in noted evacuation times between the 1993 bombing and the

2001 terrorist attack at the World Trade Center highlighted the importance of evacuation planning and drills. Some caution is emphasized when considering the identified evacuation times in the two events. For one, only about a quarter of the occupants were inside the two buildings at the time of the disaster (Dr. Prouix, 2003). Another differing factor was the visibility of the two incidents. All occupants did not initially know the 1991 bombing had occurred and evacuation was conducted differently than the highly visible events of 2001, with fire and debris seen falling from above and many people self-evacuated. Fortunately, many corporations are now taking the lead, like Marriott and Fluor, in having specific procedures in place identifying where evacuation plans are required and how and when drills will be conducted.

Studies of other recent fatal events in high-rise occupancies have also brought to light deficiencies in previous thinking. An independent review of the fire at the Cook County Administration Building fire in Chicago, IL, (James Lee Witt Associates, LLC, 2004) identified several issues in its findings. For one, there were inconsistencies in their building codes. As an example, it was found that this particular building was not equipped with a fire sprinkler system. In addition to no fire sprinklers, there were also locked stairway access doors. Additionally, the report identified that the local fire department gave a higher priority to mitigation efforts than for search and rescue activities. As part of the overall review, the Guylene Human Behavior Study was conducted. Three primary contributing factors were identified including evacuation messages, locked doors inside the stairwells and firefighting efforts combined to cause the fatalities. This study also indicated that eighty percent of the occupants surveyed were not aware of the building's evacuation plans and that even the building staff did not have a clear understanding of the emergency plan.

Another aspect of building evacuations revealed during more recent incident analyses includes behavioral tendencies not previously considered. Evacuating an entire high-rise building was not considered likely in the past but due to the events of September 11, 2001, consideration must be given to this occurring, either as part of the plan or as a result of the emergency. Behavioral scientists and psychologists have debunked some previously held assumptions during their research (Winerman, 2004). For one, when faced with a true emergency, people generally do not panic. They also found that people have a tendency to help strangers in an emergency, more so than everyday life. Additionally, they found that people would travel through smoke if they believe it will lead to their rescue. Their research also reinforced an old assumption that people typically try to exit through the door they entered the occupancy. Finally, they found that people do not like to stop what they are doing, particularly if the fire alarm does not strike them as an immediate risk to their safety. Other studies have shown that people will panic and be less likely to help others when situations deteriorate and they feel in more imminent peril.

These new findings and dispelled myths reinforce the need for evacuation plans to be practiced by all occupants in a building. During such drills, actual plans can be evaluated against the behaviors of the occupants in that particular building and adjusted accordingly. Conducting drills will also get occupants acquainted with alternative exits, fire alarm systems and evacuation routes so they are less likely to panic when they are able to adjust their actions to changing conditions in their environment.

New research and studies, coupled with improving technology and building construction, is opening alternatives to evacuating people from high-rise occupancies. Previously dismissed, elevators are being further studied as a viable alternative to move people out of and fire fighters into a burning building. Studies have proven this strategy to the point where recommendations

are being considered among various government and private agencies to include this alternative in future codes for certain situations. Other alternatives, such as vertical escape chutes are now being considered as well. Viable products have been produced and tested, and developers are pushing various agencies to consider these alternatives in future codes.

In the past, the only system by which to evaluate the effectiveness of an evacuation plan is to have an evacuation drill. While this is still one of the most ideal methods of testing evacuation plans, modern technology and computer modeling are allowing researchers to design simulators. These simulators can predict things such as fire movement, building structural integrity, smoke travel and evacuation patterns. Some models even allow specific occupancy patterns entered to generally predict how people would react during the emergency. Variations in evacuation drills, such as partial evacuation of a building, are consider viable alternatives to a total evacuation under proper training and monitoring conditions. Considering the variations in how an evacuation drill's effectiveness can now be evaluated, the previous excuse that an evacuation drill will disrupt my tenants' business too much is no longer viable or justifiable.

Various fire events in the first few years of the 21st Century have prompted more jurisdictions to take a closer look at their fire codes. Many larger cities, such as Houston, Chicago, Cincinnati, and Pittsburg have updated their codes to require evacuation drills of some type be conducted. Other cities, like New York and Los Angeles, are also considering more stringent codes on high-rise occupancies. The same is true for smaller cities such as Rialto, CA; Grand Rapids, MI; Peoria, IL; and Peoria, AZ, who also require evacuation drills in high-rise buildings. During research conducted and questionnaires reviewed, it is also evident that, while taking a proactive approach in requiring evacuation drills, many jurisdictions are having problems in the enforcement side. Whether it is the strength of the code, the reluctance of the

leadership of the jurisdiction in enforcement, or the availability of resources to adequately enforce codes, nothing written will matter if the perception of the community is that the fire department and jurisdiction does not believe it is important (Azano, 2003).

Recommendations

The research resulted in several areas whereby the Sugar Land Fire Department (SLFD) could make recommendations to the City of Sugar Land involving requirements for evacuation drills in high-rise buildings. The recommendations by SLFD should include amendments to the 2003 International Fire Code, resources necessary to enact and enforce the amendments, and internal policies and procedures needed to effectively carry out the recommendations.

As identified in the research, the 2003 International Fire Code is not very clear in several areas regarding high-rise occupancies and evacuation drills. Amendments to this Code should be introduced to clarify any discrepancies or omissions. The amendments should specifically identify the definition of a high-rise building within the City of Sugar Land. Utilizing the research, building setbacks already in the existing code, and the fact that Sugar Land's highest aerial device is 105 feet, to help set this benchmark a logical definition would be "75 feet as measured from the lowest level of fire department vehicle access." This definition would put the typical height at about seven stories but would also counter floor height variances that sometimes occur in buildings.

An additional amendment to the 2003 International Fire Code should be added to require any identified high-rise building within the City of Sugar Land conduct two evacuation drills annually. Keeping in mind the disruption to business possible in this requirement, wording in the amendment could note that at least one of the drills shall be an entire building evacuation. Further clarification would identify that the second drill could be a partial or phased evacuation;

although, it should also be clearly noted that within a certain time frame everyone in the building would need to participate in the partial evacuation drill. An exemption to the fire drills could be included as long as it identifies the occupancy conduct a detailed analysis of both building and occupant reactions during an emergency and evacuation, to assure their evacuation plan is adequate.

To adequately enact and enforce the new amendments to the 2003 International Fire Code, SLFD should make budgetary recommendations to the City of Sugar Land identifying necessary resources and staffing. Dependent on the timetable for total implementation, additional staffing would be necessary to assist in educating all qualified occupancies on the new amendments and their requirements therein. There would also need to be personnel available to assist in training and coordination of required evacuation drills. This same staff could also enforce the new ordinance amendments through standard enforcement processes with the City of Sugar Land. Other funding, resources or personnel time would be needed for typical management of the overall issue.

Finally, internal policies and procedures need to be created to conform to the new amendments. Certainly, management procedures would be necessary for the SLFD Prevention Division to cover the implementation, follow-up, and enforcement of the new codes. Additionally, policies and procedures would be necessary for the SLFD Suppression Division. These new policies and procedures would identify specific capacities that Suppression supports the evacuation planning, drills, and emergency process. Research and interviews have identified that having a visible presence from the fire department during evacuation drills helps promote the importance and seriousness of the drill, as well as get responding personnel familiar with the occupants and how their particular occupancy reacts in an emergency.

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Appendix A

Sugar Land Management Company
Interview Questions

1. What would you consider some of the complexities in conducting a full-scale evacuation drill in your occupancy?

2. Do you think holding drills to practice the evacuation plan for your building eliminate some of the complexities discussed?

3. What are some of the reasons you would not want to participate in full-scale evacuation drills of you're your building?

4. Do you have any suggestions on how evacuation drills could be organized to lessen the negative impact on your businesses?

Appendix B

Sugar Land Management Company Questionnaire

Company Name: _____

Occupancy Location Address: _____

Contact Name: _____

Contact Telephone Number: _____

1. Type of Occupancy (Check One)

   □ Building height of 6 stories or less

   □ Building height of 7 stories or more

2. Does your building have an emergency evacuation plan?

   □ Yes □ No

   If yes, when was the last time your plan was updated?

   _____

3. Has your building ever practiced your emergency evacuation plan?

   □ Yes □ No

   If yes, please identify how often the plan is practiced below using the best answer:

   □ Once, after the plan was created

   □ Annually

   □ Twice a year

   □ Other _____

   If yes, please identify below how your emergency evacuation plan is practiced using the best answer:

   □ Tabletop or simulated exercise

   □ Drills utilizing management, security and maintenance personnel only

   □ Drills utilizing partial evacuation of the building

   □ Drills utilizing the emergency evacuation plan to evacuate the entire building

□ Other _____

4. If your building has never had a drill to evaluate the effectiveness of your emergency evacuation plan, what are some reasons you have not done so (check all that apply)?
   - □ Too costly for tenants to participate
   - □ Concern over upsetting tenants
   - □ Have not considered it necessary
   - □ Unsure how to conduct an evacuation drill
   - □ Not enough time for management staff to conduct a drill
   - □ No budget to conduct a drill

5. If assistance from the local fire department were provided to aid in facilitating an evacuation drill, would this assistance increase the likelihood of your building conducting evacuation drills?
   □ Yes □ No □ Wouldn't Matter

6. Would your company support ordinances requiring evaluation of the emergency evacuation plan through annual drills?
   □ Yes □ No

7. If there were insurance incentives for conducting evacuation drills, how likely would your company be to conduct annual evacuation drills?
   □ More Likely □ Less Likely □ Wouldn't Matter

8. If there were economic incentives from local government for conducting evacuation drills, how likely would your company be to conduct annual evacuation drills?
   □ More Likely □ Less Likely □ Wouldn't Matter

Appendix C

Fire Code Questionnaire

Department Name: _____

City / Jurisdiction: _____

Contact Name: _____

Contact Telephone Number: _____

1. Does your jurisdiction require high-rise occupancies to have evacuation plans?
   [ ] Yes [ ] No

2. Does your jurisdiction require occupancies with evacuation plans to conduct drills to evaluate the effectiveness of their plan?
   [ ] Yes [ ] No

   If yes, how often do they have to conduct the drill(s)

   [ ] Once, after the plan was created

   [ ] Annually

   [ ] Twice a year

   [ ] Other _____

   If yes, please identify below how the emergency evacuation plans are practiced and evaluated according to the code, using the best answer:

   [ ] Tabletop or simulated exercise

   [ ] Drills utilizing management, security and maintenance personnel only

   [ ] Drills utilizing partial evacuation of the building

   [ ] Drills utilizing the emergency evacuation plan to evacuate the entire building

   [ ] Other _____

3. Does your jurisdiction offer any type of incentives for occupancies to conduct evacuation drills?
   [ ] Yes [ ] No

   If yes, what type (check all that apply)?

[ ] Assistance with developing evacuation plans

[ ] Assistance with conducting evacuation drills

[ ] Assistance with evaluating evacuation drills after they are conducted

[ ] Tax breaks to occupancies who comply with codes regarding evacuation drills

[ ] Discounts or rebates on alarm permits

[ ] Other economic incentives _____

[ ] Other _____

4. If your jurisdiction has codes requiring evacuation drills, in conjunction with evacuation plans, how do you enforce these codes (check all that apply)?

[ ] Warnings

[ ] Citations

[ ] Fines

[ ] Revocation of permits

[ ] Other _____

5. What size building does your jurisdiction consider a high-rise building?

[ ] 5-stories and higher

[ ] 6-stories and higher

[ ] 7-stories and higher

[ ] Above 7 stories

[ ] Other _____

6. Are any other size or types of occupancies consider a high-rise in regards to your jurisdictions codes?

[ ] Yes [ ] No

If yes, please describe.

_____