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Executive Analysis of Fire Service Operations in Emergency Management

Examining Fire Department Response and Occupant Actions Within High-Rise Structures in Cincinnati, Ohio

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June 2007

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 or writings of another.

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Abstract

The research problem was the City of Cincinnati lacks an updated and coordinated fire department response procedure for high-rise fires. The purpose was to update the fire department response procedures. The action research method was used to research the following questions:

1. What high-rise standard operating procedures are in use by other fire departments?
2. What directions are given to occupants of high-rise structures?
3. What equipment is carried in the standpipe equipment of other fire departments?
4. What is the capability of the fire suppression systems of high-rise buildings in Cincinnati?

The procedure for this project included literature review, a national fire department survey, a high-rise building survey and a personal interview.

The research project resulted in updated high-rise fire fighting procedures for the Cincinnati Fire Department.

It was recommended the fire department adopt the new procedures, purchase new standpipe hose and equipment, train on high-rise fire fighting and investigate revising the building and fire codes to require automatic sprinklers.

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Examining Fire Department Response and Occupant Actions Within High-Rise Structures in Cincinnati, Ohio

The development of high-rise construction materials and techniques has formed the beautiful skyline of the City of Cincinnati. The high-rise structure has become an accepted and desirable result of improved construction technology maximizing a fixed amount of real estate within a thriving and expanding economy (Mendes, 1975). Inherent with high rise structure becomes the possibility of fires above the reach of ground based firefighting equipment which requires the firefighter to modify strategies and tactics to combat the fire and represent an extraordinary challenge (Klaene and Sanders, 2000) High rise building fires are inherently more difficult to manage for the fire service (United States Fire Administration [USFA], 2002).

The City of Cincinnati has many high-rise structures within the city limits. The research problem is the lack of updated and coordinated fire department response procedures in coordination with instructions given to occupants within a high-rise structure may place firefighters and occupants at greater risk in the event of a fire emergency. The purpose of this research is to identify and update fire department response procedures and high-rise occupant fire alarm instructions to the City of Cincinnati.

The action research method will be used to answer the following research questions.

1. What high-rise standard operating procedures are currently utilized by similar sized and larger career fire departments within the United States?
2. What directions/instructions are currently given by alarm systems and building owners of high-rise structures within the City of Cincinnati?

3. What equipment is included in the standpipe kit and carried into high-rise buildings within the United States?
4. What is the capability of the suppression systems currently in place in high-rise structures within the City of Cincinnati?

Background and Significance

Several infamous and devastating high-rise fires have occurred that should have had an impact on the operations, procedures and equipment of the fire service when responding to high-rise emergencies. The Meridian fire in Philadelphia, Pennsylvania occurred on February 23, 1991. The Meridian fire began on the twenty-second floor and burned for 19 hours and consumed eight floors of the building (McGrail, 2005). The Meridian fire required 12 alarms utilizing over 300 firefighters and resulted in twenty-four firefighter injuries and three fire fighter fatalities (Grimwood, 2003). The United States Fire Administration (USFA) summarized fourteen issues regarding the Meridian fire. Of the fourteen issues several key problems were the improper installation of pressure reducing valves for 1 ¾ inch hose, locked stairway doors and the lack of automatic sprinkler protection (Chubb, Jennings & Routley, n.d.).

On October 13, 2001 a Houston, Texas fire captain died on the fifth floor of a forty-one story residential high-rise. According to the National Institute for Occupational Safety and Health (NIOSH), the victim became disoriented, lost, and eventually asphyxiated while following a hose line stretched from a hose cabinet on the fire floor. The NIOSH report identified that Standard Operating Procedures were not followed, there was confusion regarding the location of the fire floor, and the firefighter's hose line did not lead to an area of refuge which all contributed to the death of the fire captain (NIOSH, 2002)

On October 17, 2003, a fire on the twelfth floor of the 37-story Cook County Administration Building in Chicago, Illinois, killed six people and seriously injured several others. The Cook County Commission report concluded that the deaths and injuries would not have occurred had the building been equipped with automatic sprinklers. The Commission also concluded that the stairwell doors did not automatically unlock and that the actions and/or inactions of the Chicago Fire Department contributed to the loss of life and serious injuries (Cook County Commission, 2004).

The City of Cincinnati has 191 buildings that meet the definition of a high-rise building. Forty-seven of these buildings are fifteen stories or greater. The current fire fighting and response procedures were developed in 1991 and have not been updated to reflect the lessons learned from any of the past high-rise fires from around the country. The current high-rise firefighting equipment was never evaluated prior to purchase or prior to being placed in-service to determine whether it would produce the required water flow with the standpipe pressure provided at high-rise occupancies.

The Cincinnati Fire Department (CFD) is comprised of 26 engine companies, 12 ladder companies, two heavy rescues, four advanced life support paramedic units, and six basic life support transport units. The operational daily strength is 186 firefighters staffing 40 fire suppression companies. The central downtown business district is clustered with high-rise structures of both residential and commercial occupancy including low income housing high-rises and upscale condominiums. The population of Cincinnati is 330,000.

Without coordinated and updated high-rise response procedures, the responding companies will not have the adequate number of resources and equipment to combat the fire and

perform rescue and evacuation. The fire department does not currently coordinate whether a building is conducting a full or partial evacuation during a fire emergency. Responding fire companies must make the determination upon arrival during chaotic conditions.

The lack of coordinated high-rise response procedures and insufficient equipment has been a continuing problem over many years. The high-rise response and necessary firefighting equipment has not been studied or evaluated and no previous attempts to address the problem have been made since the adoption of the current procedures in 1991. The current 1 ¾" high rise hose with automatic low-pressure break-apart nozzle was purchased in 1996 without any documented testing or evaluation. Recent flow testing of the current high-rise equipment by the Cincinnati Fire Training Bureau has identified the equipment does not provide an adequate water flow to support an interior fire attack. Additional study into historical high-rise fires and attendance at the Chicago Fire Department High-Rise Life Safety Conference in 2005 has led to concerns regarding the procedures and equipment.

Without efficient and effective procedures the ability of the CFD and other fire departments within the fire service to provide fire and life safety protection to the citizens who live and work in high-rise structures is left to chance. In the event of a high-rise fire within the City of Cincinnati, the current procedures and equipment may not be adequate to provide sufficient personnel and equipment to apply the required fire flow to control the fire and conduct search and rescue/evacuation tasks. The inadequate response procedures and high-rise equipment may lead to firefighter and civilian injuries and deaths.

The CFD has not experienced a significant high-rise fire, and as a result, the high-rise procedures and equipment have not been tested. The lack of practical use and testing has led to a

sense of complacency toward high-rise preparedness. Although future occurrences cannot be predicted, the potential of a significant high-rise fire is ever-present and may increase with the age of non-sprinkled structures.

The outdated procedures and inadequate equipment to effectively attack a high-rise fire has negatively affected the CFD's ability to safely respond to a high-rise emergency. The lack of equipment and procedures could lead to firefighter and/or civilian deaths or injuries in the event of a high-rise fire. The outdated procedures and inadequate equipment directly affects the mission of the United States Fire Administration (USFA) "to reduce life and economic losses due to fire and related emergencies ("About the U.S. Fire Administration", n.d.).

This research project directly relates to the Executive Analysis of Fire Service Operations in Emergency Management (EAFSOEM) curriculum of addressing the limiting factors of mitigation, preparedness and response as discussed on page 4-36 of the EAFSOEM student manual. The mitigation factor will include the role of the fire suppression systems and standpipes during high-rise fires. The preparedness factor will include all of the resources and equipment necessary to mount an offensive fire attack and the response factor will delineate the roles and responsibilities of the responding fire companies through operating procedures.

This research will identify and update the Cincinnati Fire Department response procedures to fire in high-rise structures. This investigation will use the action research method developing new standard operating procedures for operating at high-rise fires.

Literature Review

High-rise structures represent a thriving and expanding economy to communities operating on a fixed amount of real estate and have become accepted by communities and often

considered desirable (Mendez, 1975). The National Fire Protection Association defines a high-rise structure as "a building greater than seventy-five feet in height where the height is measured from the lowest level of fire department vehicle access" (National Fire Protection Association [NFPA], 2003). High-rise structures have also been defined as a structure more than seventy-five feet in height when the fire department aerial device will only reach seventy-five feet or a structure more than forty-feet high when the longest fire department ladder is a forty-foot extension ladder ("*High Rise Fires,"*n.d.). The City of Reno, Nevada, defines a high-rise as any building that is taller than fifty-five feet from its lowest part ("*High Rise Safety*", n.d.). A more broad definition of a high-rise is a building in which a complete evacuation is not practical and the fire must be fought internally (Orozco, 2005).

High-rise fires cause more injuries and damage than all structure fires and are inherently more difficult for the fire service (USFA, 2002). It is estimated that each year there will be 15,500 high-rise structure fires causing 60 civilian deaths, 930 civilian injuries and over $252 million in property loss (USFA, 2002). From 1977 to 1996, sixteen firefighters lost their lives due to traumatic injuries suffered in high-rise fires in the United States. Due to the small proportion of high-rise fires to other types of fires, the sixteen line-of-duty deaths in high-rise structures represents a significant number (Bush & Routley, 1996).

Seventy-five percent of the high-rise fires occur in residential occupancies with cooking representing the leading cause of fires, however residential high-rise fires only account for twenty-five percent of the total high-rise fire dollar loss. Residential high-rise fire death rates are less than half the death rate of fires in other residential type structures and ninety-five percent of the high-rise residential fires are contained to the room of origin. Compared to commercial high-

rise structures, the residential high-rise fire is smaller however the residential high-rise injures more people due to population density (USFA, 2002).

High-rise fires above the reach of aerial equipment represent an extraordinary challenge to fire departments and require firefighters to modify typical strategies and tactics (Klaene & Sanders, 2000). Fires that may appear from the street to be easily controlled with a 1 ¾" fire attack line will be doubling in size every thirty-seconds (McGrail & Tracy, 2000). The time required for the attack team to respond to and gain access to the building, report to the floor below the fire, connect to the standpipe and stretch a line to put water on the fire is defined as reflex time (McGrail & Tracy, 2000). Reflex time is much higher in high-rise structures than in smaller buildings (Bush & Routley, 1996).

High-rise structure characteristics that create additional challenges for firefighters are there are many floors beyond the reach of aerial apparatus, the buildings require unreasonable evacuation time and extended reflex time, firefighters are dependent on internal fire protection systems and the firefighters will be faced with extreme heat conditions (Orozco, 2005). Since the fire is beyond the reach of aerial apparatus access for firefighting is limited to the interior stairs where hundreds or possibly thousands of occupants may be exposed to the products of combustion while they are evacuating or will be unable to descend past the fire floor (Bush & Routley, 1996). Additional difficulties encountered by firefighters at high-rise structures are difficulty with accessibility and ventilation of smoke and heat (Fox, n.d.).

The two major priorities at a high-rise fire are fire suppression and occupant evacuation. The arriving firefighters must make the decision to suppress the fire or to help the occupants out of the building. The ability to contain and control the fire will greatly depend on the construction

of the building and the ability of the sprinkler system and standpipe system to deliver adequate water to the fire area (Bush & Routley, 1996). The design of the high-rise tends to allow smoke and gases to spread throughout the building and endanger occupants many floors away from the original fire (USFA, 2002). The key issues identified for firefighters for successful operations at a high-rise fire depend on high-rise standard operating procedures (SOPs), pre-fire planning, appropriate high-rise hose and nozzle combinations and timely evacuation of the occupants (Bush & Routley, 1996).

All fire departments with high-rise buildings should have SOPs to address command, water supply and evacuation (Bush & Routley, 1996). Developing and following standard operating procedures for high-rise fires will minimize the problems encountered by fire departments at high-rise fires (Greenwood, 2003). Many incident command system and SOPs for tall structures are based on out of date policies (Greenwood, 2003). There are a myriad of topics to cover in high-rise SOPs including level of response, duties of incoming apparatus, the incident command system, use of elevators and stairwells, evacuation and rescue, standpipe equipment and ventilation (Bush & Routley, 1996). A strategic operational plan must be developed to determine and verify the fire floor, control the movement of building occupants, secure the building systems and to locate, control and extinguish the fire (Orozco, 2005).

Each department must determine the appropriate level of response for high-rise structures. The Fire Department of New York (FDNY) dispatches one engine company for a fire alarm in a high-rise. When the FDNY receives the indication of smoke, the response is increased to three engines, two ladders, one heavy rescue and one battalion chief. If the FDNY receives a report of a working fire, the alarm receives a total of four engines, four ladders, two heavy

rescues, four battalion chiefs, one high-rise company, one division chief, one command post company, one field commander and one mask maintenance unit (Bush & Routley, 1996).

Fire departments must develop standard operating procedures that assign personnel to tasks and apparatus responsibility when operating in structures with standpipes (Shapiro, 2003). Priorities should be determined for first-in units to identify the fire floor, assign a minimum of three companies to conduct an attack on the fire, rescue persons in immediate danger, supply the fire department connection, establish lobby control, size up the fire floor and floor above, request additional resources and conduct ventilation. Usually two engines and one ladder should be assigned to each attack position, and the attack team should communicate which stairwell is used for attack. A company should also be assigned to the fire control room to monitor the building systems and to direct the evacuation using the public address system. The Philadelphia Fire Department designates the third due Ladder Company as lobby control immediately upon dispatch (Bush & Routley, 1996).

In addition to pre-assigning duties for fire companies, the responding chief officers also should have pre-assigned responsibilities. The first arriving battalion chief should establish a command post in the building lobby (Dunn, 1996). The second arriving chief officer should assume a forward command one to two floors below the fire floor, verify the fire floor, coordinate operations on the fire floor, monitor conditions and identify the stairs used for attack and evacuation (Orozco, 2005) The third arriving chief officer should be assigned the search and evacuation sector, should report to command and then be assigned two to three floors above the fire to coordinate the rescue and evacuation above the fire floor (Dunn, 1996).

The fire attack team should consist of at least six personnel. The six personnel will be the nozzle operator, the company officer, the back-up fire fighter, two corner fire fighters and a door fire fighter. A two-engine company attack team will permit a rapid advance (McGrail, 1999). Instead of utilizing a gated wye at the standpipe outlet to provide multiple low-flow hand lines, the best use of initial resources is to getting one powerful 2 ½" hand line in operation using two engine companies (McGrail & Tracy, 2000). One firefighter should remain at the stairwell door to monitor conditions and ensure the safety of the attack team and pull additional hose (McGrail, 1999). The first due truck or Squad Company should assist the fire attack team while the second due truck or squad performs search and rescue above the fire (Bush & Routley, 1996).

The Incident Commander at a high-rise fire needs information regarding the fire location as soon as possible to effectively command and control the fire (Dunn, 1996). The first-in units must gather this information and communicate it to command (Wallington, 2006). Fire companies must keep their superiors informed of the conditions encountered within the area of responsibility so the information can be passed up the chain of command (Bush & Routley, 1996). The upward flow of information will assist the Incident Commander with making strategic decisions (Dunn, 1996).

SOPs should specify certain steps firefighters must take before utilizing elevators in a high-rise fire. Firefighters depend on elevator use for successful extinguishments of high-rise fires however elevators fail one-third of the time at major fires (High Rise Fires, n.d.). Elevator SOP's should determine who is responsible for taking control of the elevators (Bush & Routley, 1996). Immediately upon recognition of a fire in a high-rise structure the elevators should be recalled to the lobby (National Safety Council, n.d.). All elevators must be accounted for and

searched for potentially trapped victims (Dunn, 1996). After the elevators are recalled to the lobby they must be placed in bypass mode or manual mode. The SOP's should define when not to use an elevator as improper use can expose personnel to serious risk. The SOP's should establish the minimum equipment that must be carried when using an elevator such as full personal protective gear, self-contained breathing apparatus (SCBA), a radio and forcible entry tools (Bush & Routley, 1996). Elevators should not be used below the eighth floor and the elevator should be stopped every five floors to ensure the elevator is functioning properly. While ascending in the elevator the fire fighters should open the trap door to verify the shaft is clear of smoke and shall stop the car and exit at least two floors below the floor in alarm (Bush & Routley, 1996). A serious challenge for building designers has been to create elevators that could be reliable and safely utilized in an emergency (Lorenz, n.d.).

Lobby Control needs to be established and should secure the elevators and ensure they have been recalled. Lobby control is also responsible for assisting evacuation through the lobby, making public address announcements to direct evacuation and monitoring the alarm panel. The lobby control company should also perform accountability for incoming fire fighters, acquire building floor plans, locate building security and engineers and verify the status of the heating, ventilation and air conditioning (HVAC) system (Bush & Routley, 1996).

Depending on the height or overall size of the structure, standpipes will be required under the building and fire code (McGrail & Tracy, 2000). There are three classes of standpipe systems. Class one systems provide one 2 ½" outlet at designated locations designed for fire fighting for use by the fire department. Class two systems include 1.5" hose for use by building occupants. Class three systems include both the 1.5" outlet and hose for occupant use and a 2 ½"

outlet for use by the fire department (Shapiro, 2003). In high-rise structures, fire fighters must rely on the built-in fire protection systems and standpipes to help them control the fire and protect occupants however fire fighters must also be prepared for the failure of these systems and have a contingency plan in place (Bush & Routley, 1996). Standpipe issues can include the system being shut down for repair by the building maintenance staff, insufficient water pressure due to fire pumps not operating, aluminum outlets melting due to fire exposure and the presence of non-adjustable pressure reducing devices set at low pressures (High rise fires, n.d.). Fire control is virtually impossible when multiple systems fail (Bush & Routley, 1996).

High-rise standpipe systems are designed around the concept that the fire department will be using a specific combination of hose and nozzles. If different combinations are used than the combination for which the system is designed, serious problems can result. Prior to 1993, standpipe systems were required to provide 65 p.s.i at the required flow rate at the highest outlet in the system. These requirements assumed fire departments would be using 2 ½" hose with smooth bore tips. After 1993, the minimum flow pressure required at the highest discharge was 100 p.s.i. (Bush & Routley, 1996). The increase to the minimum required outlet pressure was to accommodate for the greater nozzle pressures required by fog nozzles (Shapiro, 2003). 100 p.s.i. may still not be enough pressure to adequately support standpipe operations using automatic nozzles that require 100 p.s.i. nozzle pressure (McGrail & Tracy, 2000). To overcome the friction loss of the hose and to deliver 100 p.s.i. at the nozzle, the outlet pressure at the standpipe must exceed 100 p.s.i. (Shapiro, 2003). Utilizing an automatic nozzle with a 65 p.s.i. standpipe outlet will produce an attractive stream but will deliver below 50 gallons per minute.(gpm) and at

100 p.s.i. the nozzle will flow below 100 gpm.. A flow of 100 gpm is not an acceptable flow for structural fire fighting, especially in large, open areas of high-rise buildings (McGrail, 2002).

In very tall high-rise structures head pressure on the lower floors can result in dangerously high outlet pressures requiring the installation of a pressure-regulating device (PRD) to be installed anytime the static pressure is above 175 p.s.i. or the outlet flowing pressure is exceeds 100 p.s.i. (McGrail, 2005). The installation of PRDs prevents dangerously high discharge pressures from standpipe outlets (Bush & Routley, 1996). There are three types of pressure regulating devices: pressure restricting devices, pressure reducing valves and pressure control valves (Shapiro, 2003). A pressure - regulating device contains separate external components or an internal component such as an orifice plate that is not integral to the valve and can be removed. A pressure-reducing valve contains internal parts that cannot be removed but may possibly be adjusted (McGrail 2005). Firefighters need to be aware that they may have to remove the pressure-restricting device or adjust the pressure-regulating valve (Shapiro, 2003). Some buildings place the tools necessary to adjust the valves in the fire control room and post a sign at the outlet indicating this fact. Although some valves are field-adjustable it does not necessarily mean that the valve can be adjusted quickly (McGrail, 2005). Pressure-regulating devices and particularly pressure-reducing valves have experienced high failure rates (Shapiro, 2003). The post fire investigation of the Meridian fire in Philadelphia revealed the pressure-reducing valves were improperly installed and adjusted resulting in an ineffective attack on the fire when it was still potentially manageable (McGrail, 2005). Fire departments must pay attention to buildings containing PRDs to ensure an adequate supply of water is provided (Bush & Routley, 1996).

Fire departments must be equipped to operate from standpipes with a low-pressure nozzle and high volume hose combination. Utilizing 2 ½" hose with a smooth bore nozzle will produce 250 gpm with 50 p.s.i. of inlet pressure and a 1 1/8" tip (McGrail, 2002). Andy Fredericks (1999) agrees stating that the use of smooth bore tips and 2 ½" hose is critical for firefighter safety. Using 1 ½", 1 ¾" or 2" hose and automatic fog nozzles violates the design of the standpipe system (Norman, 2005). Regardless of the facts, numerous fire departments are still utilizing 1 ¾" hose and automatic fog nozzles in their standpipe kit (McGrail, 2002). Additional equipment to be carried in a standpipe kit includes a pipe wrench, spanner wrenches, and an in-line pressure gauge (Fredericks, 1999).

The size and complexity of high-rise structures require a large force of fire fighters and well-coordinated operations (Bush & Routley, 1996). High-rise fires require significantly more personnel to extinguish than other types of fires (USFA, 2002). When the first-in companies encounter smoke and fire, additional alarms should be immediately requested (McGrail, 1999). In order to support the initial fire fighting effort, additional manpower must be readily available (Wallington, 2006). If insufficient resources are available, the priority should be total evacuation of the building without fighting the fire (Dunn, 2003).

The only fire attack strategy for buildings above the reach of aerial ladders is an interior attack (High Rise Fires, n.d.). Extinguishing the fire with the attack hose line at a high-rise fire is the single most important life safety action. The first attack hose team extinguishes ninety-five percent of all high-rise fires and ninety-five percent of the lives saved are the result of the attack line extinguishing the fire (Dunn, 1996). The ability of the attack hose team to contain and control the fire will be largely dependent on the construction of the fire building and the

performance of the standpipe and sprinkler system to deliver water to the fire area (Bush & Routley, 1996).

Smoke movement in high-rise structures is much different than in other structures (USFA, 2002). Smoke spread is the most significant hazard existing at the time of the fire (Orozco, 2005). Smoke movement in high-rise structures will be dependent on the interior and exterior temperatures. When the temperature is cold outside, the air will enter on the lower level and move toward the upper floors; the smoke will rise under these conditions. When the temperature is warm outside, the interior temperature will be lower than the exterior temperature and the air will enter on the upper floors and move downward; the smoke will tend to move downward from the fire floor under these conditions. The smoke movement under these conditions is called stack effect (Orozco, 2005).

The HVAC systems and other utilities service multiple levels within the building and provide avenues for the spread of smoke and fire (USFA, 2002). Dunn (1996) recommends shutting down the HVAC system as soon as possible in an attempt to control the spread of smoke beyond the fire floor. Bush and Routley (1996) also recommend shutting down the HVAC system and recommend establishing positive pressure ventilation (PPV) at the base of the stairwells. A preliminary test conducted by the National Institute of Standards and Technology (NIST) involving the use of PPV during high-rise fires indicates a reduced temperature and amount of smoke in the corridors and hallways outside the burn room (“Test Fans”, 2006).

Ventilation in high-rise structures is much more complicated than in other structures (Bush & Routley, 1996). Ventilation is limited to stairways and elevator shafts and both may be used for removal of occupants (Greenwood, 2003). A closed stairwell shaft will cause the smoke

to bank down in the stairwell exposing fleeing occupants therefore a company should verify the stairwell shaft is open (Bush & Routley, 1996). Horizontal ventilation by breaking windows is dangerous to those outside the structure creating falling shards ("High Rise Fires, n.d.).

Accounting for the life safety of occupants can take the form of a full or partial evacuation or a defend-in-place strategy. The defend-in-place strategy entails fighting the fire without evacuating the occupants. In order to employ the defend-in-place strategy, the building must be of fire resistive construction with smoke and fire confined to one floor, the fire is of a size that can be extinguished by fire fighters, and the people in the building must be willing to comply with the orders of the fire chief. In the aftermath of the World Trade Center fire and collapse, people may not choose to comply with the fire chief's order to remain in the building (Dunn, 2003).

The movement of occupants out of a building is difficult because exits are limited (USFA, 2002). High-rises have been designed to handle the evacuation of single floors and not the total evacuation of the building (Rospond, 2005). Partial evacuation priorities should include the fire floor and two floors immediately above and two floors immediately below (National Safety Council, n.d.). In the wake of the September 11, 2001, fire and collapse of the World Trade Center Towers some code officials are calling for total building evacuation in the event of an emergency (Lobash, 2005). If many floors attempt to evacuate at the same time the stairwells may quickly become overcrowded (Orozco, 2005). Kealy (n.d.) believes building management must plan for the simultaneous evacuation of the entire building. Uncontrolled evacuation will greatly complicate the emergency situation (National Safety Council, n.d.).

Fire department's must quickly divide the stairwells into attack stairs and evacuation stairs (Dunn, 1996). If both stairwells are utilized as attack stairwells they can both be contaminated with smoke exposing the occupants attempting to exit (McGrail & Tracy, 2000). If the building is equipped with a smoke-proof tower it should be used for evacuation (Fox, 2003). The fire attack stairwell will fill with smoke and the occupants need to be directed over the public address system to use the evacuation stairwell (Dunn, 1996). Some fire department SOPs require firefighters to search the stairwell prior to beginning an attack from the stairwell (Bush & Routley, 1996).

Self-evacuation of a building is a haphazard process and will be based upon the actions and decisions of the building's occupants (Fox, 2003). A successful evacuation is dependent on building occupant evacuation training prior to the emergency (Bush & Routley, 1996). A high-rise building will only be as safe as the building occupants; owners and managers want it to be (National Safety Council, n.d.). Training of the building occupants must include additional training for those individuals who may have to manage the evacuation (Wallington, 2006).

The modern building code takes a three-step approach to fire protection in high-rise structures: automatic sprinkler and fire alarm protection, fire fighting by fire fighters, and the fire resistance of the construction of the building (Wallington, 2006). Sprinkler systems have been proven to be the best method of successfully controlling a high-rise fire (Bush & Routley, 1996). Properly maintained sprinkler systems greatly increase the safety of the building (Quiter, 2006). The NFPA reports no more than two people have ever been killed as the result of a fire in a completely sprinkled building (Rospond, 2005). Most building codes require hard-wired smoke

detectors in high-rise buildings and they activate in sixty-nine percent of residential high-rise fires (USFA, 2002).

Fire code officials are considering additional changes to the fire code to address high-rise structure safety. Proposals have included increasing the size of stairwells to accommodate descending occupants and ascending fire fighters as well as full building evacuation. NIST has recommended that all stairwells be marked with consistent signage to facilitate an organized evacuation (Lorenz, n.d.). Additional proposals have included provision of dedicated fire fighting shafts to contain elevators and stairs in one protected shaft enabling the fire fighters to access the fire quickly without impeding the occupant escape (Kealy, n.d.). After the Cook County high-rise fire, the City of Chicago enacted an ordinance that requires all stairwell doors to be unlocked from the stairwell side permitting re-entry to floor (Rospond, 2005). Six occupants died as a result of not being able to re-enter due to locked doors from the stairwell (Quiter, 2006).

Procedures

The procedures utilized in this research proposal included two mailed surveys, a personal phone interview and an extensive literature review.

Two surveys were generated and conducted to obtain information for this research project. The first survey was distributed to fifty fire departments across the United States. Thirty-three fire departments responded.

The purpose of this survey was to determine the procedures utilized by other departments at high-rise structures, the number and type of resources dispatched and the type of equipment carried in the standpipe kit. The fire departments were selected by searching for the largest

metropolitan areas in the United States from the website www.mongabay.com ("Largest Metropolitan Areas, n.d.). The cities identified were then referenced to the United States Fire Administration website – Fire department census information section to obtain mailing address information ("*National fire department census,* n.d.). The survey was conducted between December 20, 2006 and January 30, 2007. A self-addressed-stamped envelope was enclosed to return the survey; a detailed list of the departments surveyed is contained in Appendix A. The survey distributed to the departments is contained in Appendix B.

The second survey was distributed to all high-rise buildings, fifteen stories and greater within the City of Cincinnati. Forty-seven surveys were distributed. Twenty-two surveys were returned. The high-rise building information was obtained from the Cincinnati Fire Department – Fire Prevention Bureau. The purpose of the survey was to determine the directions and instructions building owners are providing to the occupants of their high-rise buildings and to determine the built-in fire suppression and protection limitations and capabilities. The survey was conducted between January 30, 2007, and March 2, 2007. A self-addressed stamped envelope was enclosed to return the survey; a detailed list of the buildings surveyed is contained in Appendix C. The survey distributed is contained in Appendix D.

A phone interview was conducted with Fire Prevention Specialist Darryl Meadows of the Cincinnati Fire Department Fire Prevention Bureau on March 21, 2007, at 4:00 P.M. Specialist Meadows was selected to be interviewed because he is assigned the high-rise buildings in the downtown business district. The following questions were asked of Specialist Meadows:

1. What is the most current edition of the Cincinnati Fire Protection Systems Testing Guidelines?

2. What performance standards are high-rise standpipe systems currently required to meet?

Research question one regarding the standard operating procedures currently in place in other fire departments was answered by the responses received from the survey sent to the 50 similar sized fire departments. Research question two regarding instructions given to building occupants of high-rise buildings during fire alarms was answered by the responses to the survey distributed to the high-rise buildings fifteen stories and greater within the City of Cincinnati. The third research question regarding the standpipe equipment carried by similar sized fire departments was answered by the responses to the fire department survey. The fourth research question regarding the capability of the suppression systems in high-rise buildings was answered using the responses from the building survey.

The research was limited by the fire departments not using a standard definition of a high-rise structure. The definition varied from building height, to number of stories, to the length of the department's aerial apparatus. The different number and type of resources available to the fire departments surveyed also limited the research. The resources immediately available within the department determine the alarm assignment size and actions. The respondents not returning both the fire department survey and the high-rise building survey or returning a partially completed survey also limited the research.

Results

The first research question was what high-rise standard operating procedures are currently utilized by similar sized and larger career fire departments within the United States? A survey was distributed by mail to 50 career fire departments similar in size to the Cincinnati Fire

Department. Of the 50 departments contacted, 34 responded to the survey. The survey requested information regarding the number of resources assigned to high-rise structures, the assignment of those resources and information regarding fire ground operations.

The first question of the fire department survey asked how the department defined a high-rise structure. Of the thirty-four fire departments that responded, eight defined high-rise structures as buildings 75 feet or greater in height above the lowest fire department access. Four fire departments defined a high-rise as any structure four floors or higher. Four departments defined a high-rise as any structure five floors or greater and four departments defined a high-rise as seven stories or greater. Three departments defined a high-rise as a structure six floors or greater. Two departments defined a high-rise structure as any structure beyond the reach of the department's aerial apparatus. Two departments defined a high-rise as any building six stories or greater and at least 75 feet in height and two departments defined a high rise as a building greater than 75 feet tall and where evacuation would not be practical. One department defined a high-rise as a building over 55 feet in height; one department defined a high rise as any building over 80 feet in height and one department defined a high-rise as any multi-storied building. Two departments did not supply an answer to the question.

Fire department survey question number two asked what resources were dispatched to a reported fire in a high-rise occupancy? Nineteen departments dispatch four engines on the initial alarm, eight departments dispatch three engines, four department dispatch five engines, two departments dispatch two engines and one department dispatches seven engines on the initial alarm. Twenty-five departments dispatch two truck companies on the initial dispatch for fire in high-rise structures. Four departments dispatch three trucks, three departments dispatch one truck

and two departments dispatch four trucks on the initial alarm. Eighteen fire departments surveyed dispatch one heavy-rescue on the first alarm in a high-rise structure. Thirteen departments do not dispatch a heavy rescue on the initial alarm and three departments dispatch two heavy rescues an the initial alarm. Fourteen departments dispatch two chief officers on the first alarm, eleven departments dispatch one chief, six departments dispatch three chiefs and three departments dispatch four chief officers on the initial alarm. Seventeen departments dispatch advanced life support (ALS) medical units on the initial dispatch, eleven departments do not provide an ALS unit on dispatch and six departments provide two ALS units. Thirty-one departments do not provide basic life support (BLS) medical units on the first alarm and three departments provide one BLS unit. Five departments dispatch a light and air unit on the first alarm. Four departments dispatch a safety officer. Four departments dispatch an Emergency Medical Services (EMS) supervisor. Three departments dispatch a command vehicle. One department dispatches a customer service unit.

Table 1: Number and type of resources dispatched on the first-alarm in a high-rise building by department S.O.P

Type of Resource	0	1	2	3	4	5	6	7
Engines	0	0	2	8	19	4	0	1
Trucks	0	1	25	4	2	0	0	0
Heavy Rescue	13	18	3	0	0	0	0	0
Chief Officers	0	11	14	6	3	0	0	0
ALS Units	11	17	6	0	0	0	0	0
BLS Units	31	3	0	0	0	0	0	0

Table 1 Continued:

Type of Resource	0	1	2	3	4	5	6	7
Light/Air Unit	28	5	0	0	0	0	0	0
Safety Officer	29	4	0	0	0	0	0	0
EMS Supervisor	29	4	0	0	0	0	0	0
Command Vehicle	30	3	0	0	0	0	0	0
Customer Service	32	1	0	0	0	0	0	0

The third fire department survey question asked if additional units were dispatched automatically if first arriving units confirmed a working fire and if units are dispatched automatically, how many are dispatched and of what type? Twenty-four departments responded that additional units were automatically dispatched upon confirmation of a working fire in a high-rise structure. Ten departments do not dispatch additional units automatically upon confirmation of a working fire. Eight departments dispatch four additional engines, five departments dispatch one additional engine, four departments dispatch two additional engines, two departments dispatch five additional engines and one department dispatches three additional engines. Eight of the departments dispatch one additional truck companies, seven departments dispatch two additional truck companies and three departments dispatch three additional truck companies. Nine of the departments dispatch one heavy rescue automatically on the confirmation of a working fire in a high-rise structure. Seven departments dispatch two additional chiefs, seven departments dispatch one additional chief, two departments dispatch three additional chiefs and one department dispatches five additional chief officers. Other units dispatched included an air unit – ten departments, and EMS supervisor – five departments, a command van

– two departments, a safety officer – two departments, and one department dispatched an aerial platform upon confirmation of a working fire.

Table 2: Resources dispatched automatically upon confirmation of a working fire by number of department.

	Number of Resources Dispatched					
Type of resource	0	1	2	3	4	5
Engines	4	5	4	1	8	2
Trucks	6	8	7	3	0	0
Heavy Rescue	15	9	0	0	0	0
Chief Officers	7	7	7	2	0	1
EMS Supervisor	18	6	0	0	0	0
Air Unit	14	10	0	0	0	0
Safety Officer	22	2	0	0	0	0
Command Van	22	2	0	0	0	0
Aerial Platform	23	1	0	0	0	0
Rehab Unit	23	1	0	0	0	0

Fire Department survey question four inquired if department procedures define pre-assigned duties for fire companies at high-rise fires and if so what are the assignments. Thirty-three fire department's pre-assign duties for high-rise structure fires. One department does not pre-assign duties. Twenty-four departments assign the first arriving engine to attack the fire. Three departments assign the first arriving engine to attack the fire and connect to the fire department connection (FDC). Three departments assign the first arriving engine to Lobby

Control. One department assigns the first engine to fire attack and lobby control. One department assigns the first engine to supply the FDC and lobby control. One department assigns the first engine to supply the FDC and one department assigns the first engine to supply the FDC and to secure the elevators.

Table 3: First Arriving Engine Company Assignments

Assignment	Number of Departments
Fire Attack	24
Fire Attack/FDC	3
Lobby Control	3
Fire Attack/Lobby Control	1
Lobby Control/FDC	1
Supply FDC	1
FDC/Secure elevators	1

Ten departments assign the second arriving engine to assist with the initial fire attack. Six departments assign the second engine to establish lobby control. Three departments rely on the second engine to provide the initial fire attack. Three departments assign the second engine to supply the FDC. Two departments require the second engine to establish a water supply. Two departments require the second engine to stage. Other single departments assign the second engine to tasks of the Rapid Intervention Team (RIT); to assist the initial attack and secure a water supply; assist the fire attack – secure a water supply and supply the FDC; provide a back-up line; supply the FDC, assume command and provide RIT functions; supply the FDC and establish lobby control; and to supply the FDC and establish a water supply.

Table 4: Second Arriving Engine Assignments

Assignment	Number of Departments
Assist Fire Attack	10
Lobby Control	6
Initial Fire Attack	3
FDC	3
Water Supply	2
Staging	2
RIT	1
Assist Fire Attack/Secure water supply	1
Assist Fire Attack/Secure Water Supply/FDC	1
Back-up Fire Line	1
FDC/Assume Command/RIT	1
FDC/Lobby Control	1
FDC/Water Supply	1

Six fire departments surveyed place the third responding engine into staging. Five departments utilize the third engine as part of the fire attack group. Five fire departments utilize the third engine to provide a back-up line to the fire floor. Three fire departments utilize the third engine to secure a water supply while three other departments require the third engine to report to command for assignment. Two departments utilize the third engine to establish lobby control. Two departments utilize the third engine for lobby control as well as supplying the FDC. One

department assigns the third engine to establish a water supply and to provide a back-up line on the fire floor. One department requires the third engine to establish Base.

Table 5: Third Arriving Engine Company Assignment

Assignment	Number of Departments
Staging	6
Back-up Fire Line	5
Water Supply	3
Report to command	3
Lobby Control	2
Lobby Control/FDC	2
Water Supply/Back-up line	1
Base	1

The fourth engine responding was assigned to report to the incident commander by six fire departments. Five departments SOPs assign the fourth engine to staging. Three departments assign the fourth engine to establish a water supply, to establish base or to assist with the fire attack. Two departments assign the fourth engine to provide back-up on the fire floor. Establishing base and lobby control, assisting with fire attack and securing a water supply, taking a hose line to the floor above the fire and assisting with evacuation and ventilation are all tasks assigned to the fourth engine by single departments responding to the survey.

Table 6: Fourth Arriving Engine Assignments

Assignment	Number of Departments
Report to Command	6
Staging	5
Water Supply	3
Base	3
Assist Fire Attack	3
Back-up line	2
Base/Lobby Control	1
Assist Fire Attack/Water Supply	1
Hose to floor above	1
Ventilation/Evacuation	1

The fifth arriving engine was assigned to form a task force by three departments. Two departments assigned the fifth engine to staging or to report to the Incident Commander. The remainder of the departments that pre-assigned the fifth engine assigned them to base, Safety – Stairwell support – Staging, supply the FDC, Stairwell support, back up for the fire line or as an ascent team.

Table 7: Fifth Arriving Engine Assignments

Assignment	Number of Departments
Form Task Force	3
Staging	2
Report to Command	2
Base	1
Safety/Stairwell Support/Staging	1
FDC	1
Stairwell Support	1
Back-up Fire Line	1
Ascent Team	1

The sixth arriving engine was assigned to staging by three departments. The remainder of the departments who pre-assigned the sixth utilized the engine for base, to form a task force, RIT, stairwell support or to report to the Incident Commander.

Table 8: Sixth Arriving Engine Assignment

Assignment	Number of Departments
Staging	3
Base	1
Task Force	1
RIT	1
Stairwell Support	1
Report to Command	1

Seven departments pre-assign the seventh engine company. Three departments assign the seventh engine to staging. One department each assigns the seventh engine to base, to form a task force, RIT, or to report to the Incident Commander.

Table 9: Seventh Arriving Engine Assignment

Assignment	Number of Departments
Staging	3
Base	1
Task Force	1
RIT	1
Report to Command	1

Only two departments pre-assign the eighth responding engine company. One department assigns the eighth company to form a task force and the other department assigns the engine to report to command.

Thirty departments responded to the survey pre-assigned the first arriving truck duties. Fifteen departments assigned the first arriving truck to assist with the fire attack. Four departments directed the first arriving truck to perform search and rescue activities. Three departments assigned the truck to lobby control and three departments assigned the truck to the fire investigation team (FIT). Two departments assigned the first truck to assist with fire attack and perform search and rescue and two departments assigned the first truck to perform search and rescue and to ventilate. One department assigned the first truck to control the HVAC and assume stairwell support functions.

Table 10: First Arriving Truck Company Assignments

Assignment	Number of Departments
Assist Fire Attack	15
Search and Rescue	4
Lobby Control	3
Fire Investigation Team	3
Assist Fire Attack/Search and Rescue	2
Search and Rescue/Ventilation	2
HVAC/Stairwell Support	1

Twenty-four departments responded to pre-assigning the second arriving truck company. Four departments assign the second arriving truck to assist with fire attack, to provide back-up on the fire floor or to search the floor above the fire. Three departments assign the second truck to conduct search and rescue or to perform search and rescue and ventilation. The second arriving truck in two departments reports to the Incident Commander for assignment. One department assigns the second truck to staging, ventilation, to protect the elevator or to serve as the RIT.

Table 11: Second Arriving Truck Assignments

Assignment	Number of Departments
Assist Fire Attack	4
Back-Up	4
Search Floor Above	4
Search and Rescue	3

Table 11 continued:

Assignment	Number of Departments
Search and Rescue/Ventilation	3
Report to Command	2
Staging	1
Ventilation	1
Protect Elevator	1
RIT	1

Fourteen departments surveyed pre-assign the duties of the third arriving truck company. Three departments assign the third truck to ascend the interior stairs checking for victims. Two departments assign the third truck to lobby control, and two departments assign the third truck to a task force. The remaining departments assign the third truck to base, RIT, Stairwell ascent and search of the floor above the fire, Self-Contained Breathing Apparatus (SCBA) logistics, Search and rescue of the floor above the fire; report to command or to ventilation.

Table 12: Third Arriving Truck Company Assignment

Assignment	Number of Departments
Stairwell Ascent Team	3
Lobby Control	2
Task Force	2
Base	1
RIT	1
Stairwell Ascent/Search Floor Above	1

Table 12 continued:

Assignment	Number of Departments
SCBA Logistics	1
Search and Rescue Floor Above	1
Report to Command	1
Ventilation	1

The fourth arriving truck company was pre-assigned by nine departments. Two departments form a task force using the fourth arriving truck. Two departments assign the fourth truck to search the upper floors of the building. Other responding departments assign the fourth truck to: base, ascent team, RIT, report to command, and search and rescue.

Five departments pre-assign the fifth arriving truck. Two departments stage the fifth arriving truck while the other departments assign the truck to base, form a task force or perform RIT functions.

The first heavy rescue was pre-assigned by nineteen departments responding to the survey. The first arriving heavy rescue was assigned to RIT activities by eight departments. Four departments assigned the heavy rescue to search and rescue of the fire floor, and two departments assigned the heavy rescue to search the floor above the fire. The other departments assigned the heavy rescue to search the fire floor and the floor above the fire, to control the HVAC, lobby control, ventilation and to report to command.

Table 13: First Arriving Heavy Rescue Assignment

Assignment	Number of Departments
RIT	8

Table 13 continued:

Assignment	Number of Departments
Search and Rescue – Fire Floor	4
Search and Rescue – Floor Above	2
Search and Rescue – Fire Floor & Floor Above	1
HVAC	1
Lobby Control	1
Ventilation	1
Report to Command	1

The second arriving heavy rescue was assigned by five fire departments. Two departments have the second heavy rescue report to command and two departments assign the heavy rescue to perform search and rescue. One department assigns the second heavy rescue as SCBA logistics.

Twenty-eight departments pre-determine the role of the first arriving chief officer. Twenty-four departments assign the first arriving chief to assume command. Three departments assign the first arriving chief officer to a forward command position within several floors of the fire floor, and one department assigns the first arriving chief officer to the Operations Section.

Table 14: First Arriving Chief Officer Assignment

Assignment	Number of Departments
Command	24
Forward Command	3
Operations Section	1

Twenty-one departments responding to the survey pre-assign the role of the second arriving chief officer. Eight departments assign the second arriving chief to a forward command in close proximity to the fire floor. Five departments assign the second chief to assume the Operation Section Chief position. Three departments require the second chief to assume command. Two departments assign the second chief to a division supervisor position within the building. Other departments assign the second chief to the Planning Section, to assist command or as RIT command.

Table 15: Second Arriving Chief Officer Assignment

Assignment	Number of Departments
Forward Command	8
Operations Section	5
Command	3
Division Supervisor	2
RIT Command	1
Planning Section	1
Assist Command	1

Twelve departments pre-assign the third chief officer responsibilities. Two departments assign the third chief as a command aide and two others have the third chief report to command for assignment. Other assignments for the third chief included: Division supervisor, staging, Safety officer, EMS supervisor, lobby control, Logistics Section Chief, forward command and Operations Section Chief.

Ten departments pre-assign the fourth arriving chief officer. Three departments have the chief officer report to command for assignment. Two departments assign the fourth chief to a forward command position. Other assignments for the fourth chief include command, Command aide, staging, accountability and a division supervisor.

Twenty-one departments pre-assign the first arriving emergency medical services (EMS) unit. Five departments assign the first arriving EMS unit to establish the EMS Group. Four departments assign the first arriving EMS unit to establish rehabilitation for the fire fighters. Three departments assign the first arriving EMS unit to staging, triage or to a forward EMS position within the building. Two departments have the EMS unit report to command for assignment. One department assigns the first EMS unit to establish the EMS Group, set up rehabilitation and to perform triage.

Table 16: First Arriving EMS Unit Assignment

Assignment	Number of Departments
EMS Group	5
Rehabilitation	4
Staging	3
Triage	3
Forward EMS	3
Report to Command	2
EMS Group/Rehab/Triage	1

Eleven departments pre-assign the second arriving EMS unit. Three departments assign the second EMS unit to rehabilitation for firefighters. Two departments assign the second EMS

unit to the lobby, to transport or to report to command. The other departments assign the second EMS unit to base or to the EMS Group.

The fire department survey requested information regarding elevator and standpipe use by the fire companies. The departments were asked when using the elevators during a high-rise fire attack at what floor do the SOPs state to exit the elevator and use the stairs? Thirty-three departments responded to this question. Twenty-five departments require the fire fighters to stop the elevator two floors below the reported fire floor. Four fire departments require firefighters to exit the elevator four floors below the fire floor. Three departments require the fire fighters to exit the elevator one floor below and one department required the firefighters to exit three floors below.

Table 17: Elevator Use During High-Rise Fire

Floor to Exit the Elevator	Number of Departments
One Floor Below Reported Fire Floor	3
Two Floors Below Reported Fire Floor	25
Three Floors Below Reported Fire Floor	1
Four Floors Below Reported Fire Floor	4

The departments were asked when the standpipes are located in the stairwell, what floor do the procedures state to make the initial standpipe connection? Thirty-four departments responded to this question. Twenty-one departments procedures require the initial standpipe connection to be made on the floor below the fire. Eight departments require the standpipe connection to be made in the stairwell on the fire floor. Four departments responded that the

standpipe connection would be dependent on the location of the fire. One department requires the standpipe connection to be made two floors below the fire floor.

Table 18: Location of Initial Standpipe Connection – Standpipe Outlet in Stairwells

Stairwell Standpipe Connection Location in Relation to Fire Floor	Number of Departments
Floor Below	21
Fire Floor	8
Fire Dependent	4
Two Floors Below	1

The survey asked the department when the standpipe outlet is in the hallway where do the procedures state to make the initial standpipe connection? Thirty-one departments responded to the question. Nineteen department procedures require the initial standpipe connection when the standpipe outlet is in the hallway to be connected on the floor below the fire. Four departments permit the connection to be made on the fire floor. Two departments stated the standpipe connection in the hallway was not applicable to their fire department. Two departments stated the location would be dependent on the fire conditions. Two departments stated the situation was not addressed in the procedures. One department requires the connection to be made two floors below and one department stated the procedures call for the use of hallway standpipe outlets as a last resort.

Table 19: Location of Initial Standpipe Connections – Standpipe Outlet in Hallway

Hallway Standpipe Connection Location in Relation to Fire Floor	Number of Departments
Floor Below	19
Fire Floor	4
Not Applicable	2
Dependent on Fire Conditions	2
Not Addressed	2
Two Floors Below	1
Last Resort	1

The second research question asked what directions and instructions are currently given by alarm systems and building owners of high-rise structures within the City of Cincinnati? A survey was distributed by mail to the managers and building owners of high-rise buildings fifteen stories and greater within the City. Forty-seven surveys were distributed and twenty-two surveys were returned.

The first high-rise building survey question asked when the fire alarm sounds does the building fully evacuate? Twenty-two responses were received. Six buildings require a full evacuation and sixteen do not fully evacuate the building.

The second question asked how the building management communicated the alarm to the occupants? Sixteen buildings responded to this question. Two buildings notified all occupants with verbal instructions given to the floor affected. Fourteen buildings only notified the floors affected.

The third question was directed to the buildings that only notify the floors affected. Question three asked if only the floors affected are notified what direction is given? Thirteen of the buildings direct the occupants of the affected floors to evacuate the building via the stairs. One building directs the occupants of the affected floors to evacuate to a designated location within the building.

The fourth question asked whether the stairwells within building use an identification system and if the doors are labeled on each floor? Sixteen buildings responded the stairwells have an identification system, and six buildings stated the stairwell do not have an identification system. Seventeen buildings label each stairwell door on every floor is labeled, and five buildings do not label every stairwell door.

The fifth question asked whether the building, have a designated fire command center. Twenty-two surveys answered this question. Nineteen buildings surveyed have designated fire command centers and three buildings do not have a designated fire command center.

The third research question was what equipment is included in the standpipe kit carried into the high-rise building by similar sized and larger fire departments within the United States? The survey sent to the fifty fire departments referenced in research question one included questions regarding the standpipe equipment carried by the department.

The departments were asked what equipment is carried in the standpipe kit? The departments were asked to provide the size and length of hose and the type of nozzle utilized. Thirty-four departments responded to this question. Twenty departments utilize 1 ¾” hose, seven departments utilize 2 ½” hose and seven departments use both 1 ¾” hose and 2 ½” hose. Eight departments utilize a smooth bore nozzle with the high-rise hose. Seven departments utilize a

break-apart combination nozzle, which provides a fog stream/straight stream, and the tip can be removed to provide a smooth bore tip. Six departments use a fixed gallon - combination nozzle that will provide the designed gallon per minute flow if the nozzle is supplied with the required nozzle pressure. Five departments utilize automatic adjustable fog nozzles in the high-rise kit. Eight departments did not provide an answer in the nozzle section of the question.

Table 20: Size and Length of Hose Carried in Standpipe Kit

1 ¾" Hose Length	Number of Departments
100 Feet	6
150 Feet	7
200 Feet	7
2 ½" Hose Length	
100 Feet	1
150 Feet	4
200 Feet	2
1 ¾" Length & 2 ½" Length	
100 Feet 1 ¾" and 100 Feet 2 ½" Hose	4
150 Feet 1 ¾" and 100 Feet 2 ½" Hose	1
150 Feet 1 ¾" and 150 Feet 2 ½" Hose	2

Table 21: Nozzle Type Carried in Standpipe Kit

Type of Nozzle	Number of Departments
Smooth Bore	8
Break-Apart Combination	7

Table 21 continued:

Type of Nozzle	Number of Departments
Fixed Gallon Combination	6
Automatic Adjustable	5
No Answer	8

The survey question also requested information as to whether the standpipe kits contained a pipe wrench, in-line pressure gauge, spanner wrenches and adapters. The survey question also provided an option to include any other standpipe equipment not previously requested. Fifteen of the departments surveyed carry a pipe wrench in the standpipe kit. Thirty departments carry spanner wrenches and eight carry an in-line pressure gauge. Seventeen departments carry a set of adapters in the standpipe kit. Fifteen departments carry a gated wye and five departments carry wood door wedges.

The fourth research question was what is the capability of the suppression systems currently in place in high-rise structures within the City of Cincinnati? The survey sent to the building owners and managers cited in research question two contained additional questions in reference to the building's fire suppression capability. The survey asked whether the building contained standpipes in all stairwells and whether the standpipe system was designed with pressure reducing devices (PRDs) or pressure reducing valves (PRVs)? Nineteen buildings replied that all of the stairwells in the building contained standpipes while three buildings only have standpipes in designated stairwells. Ten buildings replied that the standpipes in the building contained PRDs or PRVs. Ten buildings replied that the standpipes in the buildings do not contain PRDs or PRVs. Two buildings were not sure if the standpipe system contained PRDs or

PRVs. The buildings were asked the capacity of the fire pump within the building. Six buildings contain 750 gallon per minute (GPM) fire pumps. Five buildings contain 1000 GPM fire pumps. Two buildings contain 500 GPM fire pumps and two contain 1500 GPM pumps. One building contained a 2250 GPM and a 750 GPM fire pump. Six buildings did not provide an answer to the fire pump question.

The final building survey question asked if the building was fully protected by a sprinkler system. Twenty-two buildings responded to the question. Nineteen buildings of the twenty-two buildings completing the survey are fully protected by a sprinkler system. Four buildings are not fully protected by a sprinkler system.

A phone interview was conducted with Fire Prevention Specialist Darryl Meadows of the Cincinnati Fire Prevention Bureau on March 21, 2007. Specialist Meadows was asked what was the most recent edition of the Cincinnati Fire Department – Fire Protection Systems Testing Guidelines. Specialist Meadows replied the most recent edition was revised and adopted in 1988. Specialist Meadows was then asked which standard the standpipe systems were required to perform. Specialist Meadows stated that the 1988 edition of the Testing Guidelines were still in use for standpipe performance tests. The standpipes were required to produce 65 p.s.i. at the highest discharge. Specialist Meadows also stated a new edition of the testing guidelines was currently in draft form.

The new high-rise firefighting procedure generated from this research is included in Appendix F. The new procedures increase the first alarm assignment for reported fires in high-rise structures and require an automatic second alarm upon the confirmation of the fire. The new procedure also assigns specific tasks to fire companies based on arrival order. The new

procedure establishes new standpipe equipment with greater water flow capability and procedures for connecting to the standpipe. The new procedure outlines the parameters for elevator use within a high-rise fire.

The procedures will need to be approved by the Operations Bureau Chief and the Fire Chief. The new equipment required will need to be approved by the Administration Bureau Chief and the Fire Chief, put out for bid and purchased. Upon approval of the procedures and purchase of the equipment, all fire companies will need to receive high-rise fire training. The Incident Commanders and Company Officers will evaluate the procedure during training exercises and active incidents to determine whether sufficient resources have been allotted for assignment to the required tasks. The new equipment will be evaluated by water flow test to determine if it is flowing at least 200 G.P.M. for a safe and effective fire attack.

Discussion

The study revealed that the fire departments surveyed do not agree on the definition of a high-rise structure. The CFD defines a high-rise as a building greater than six stories or more than seventy-five feet in height from the lowest point of fire department access. The NFPA bases the definition of a high-rise on the height of the structure alone (NFPA, 2003) while other definitions are based on the length of the fire department's aerial apparatus (*"High Rise Fires", n.d.).* A consistent definition of a high-rise structure within the fire service would assist with making comparisons of procedures, resources and equipment.

This study also revealed the current high-rise firefighting procedures within the CFD have not been updated to reflect lessons learned from the high-rise fires, which have occurred

throughout the United States. The study also revealed that Cincinnati is not the only fire department that has not updated the high-rise procedures and equipment as a result of these fires.

The study revealed the current hose and nozzle combination carried by the Cincinnati Fire Department might not provide the necessary water flow to extinguish a fire within a high-rise building. Standpipe systems have been designed with the intention that the fire department would be utilizing 2 ½" attack hose with smooth bore tips (Bush & Routley, 1996). During the phone interview with Specialist Meadows it was revealed that the CFD Fire Protection Systems Testing Guideline has not been updated since 1988. As a result, the systems tested are only required to provide 65 p.s.i. at the standpipe outlet. The CFD currently carries 1 ¾" standpipe hose with a break apart combination nozzle in the standpipe kit. Twenty of the thirty-four departments responding to the survey still carry 1 ¾" hose exclusively for standpipe operations and nineteen departments still carry combination nozzles. McGrail (2002) has also found that many departments throughout the country are still utilizing 1 ¾" hose and combination nozzles in the standpipe kits. Utilizing 1 ¾' hose and automatic nozzles at 65 p.s.i. outlet pressure will produce less than 100 G.P.M. which is not an acceptable flow for structural firefighting (McGrail, 2002).

The study revealed that departments have very different procedures and response levels to fires within high-rise structures. A compilation of the results of the survey distributed revealed that the resources dispatched on a reported fire are four engine companies, two truck companies, one heavy rescue company, two chief officers and one ALS medical unit. The majority of departments surveyed automatically dispatch additional companies upon confirmation of a working fire. McGrail (1999) agrees with automatically dispatching additional units. Although

none of the literature reviewed stipulated the ideal response level, most authors agreed the high-rise fire requires a large force of firefighters and well-coordinated operations (Bush & Routley). Dunn (2003) stipulates the availability of resources will determine whether a fire attack will be attempted or the total evacuation of the building without a fire attack should be conducted. The CFD dispatches three engines, two trucks, one Rapid Assistance Team (RAT), two District Chiefs and one ALS medical unit on the initial alarm. The CFD does not automatically dispatch additional units upon confirmation of a working fire.

The study revealed the departments surveyed have very different procedures regarding the tasks that need to be accomplished and what companies should complete the tasks. The authors reviewed discuss many tasks that need to be accomplished during a high-rise fire however do not specify what company should be assigned to carry out the tasks. Bush and Routley (1996) agree that departments must have SOPs to address the challenges of a high-rise building and that developing and following the SOPs will minimize the problems encountered when faced with a high-rise fire (Greenwood, 2003). Shapiro (2003) agrees that the fire department's SOPs must assign personnel to specific tasks. The large number of tasks to be accomplished quickly overwhelms the number of resources currently dispatched by the CFD.

The survey revealed that twenty-five of the thirty-three departments who responded to the survey have SOPs that require the fire fighters to exit the elevator two floors below the fire floor. Bush and Routley (1996) agree that fire fighters should exit the car two floors below the lowest floor in alarm and suggest fire fighters should continue to monitor conditions in the elevator shaft through the trap door in the ceiling. Elevator operations during high rise fires are a calculated risk and use must be constantly evaluated for safety throughout the incident. Current

CFD elevator procedure only requires companies to exit the car one floor below the fire floor and does not provide the additional floor as a safety margin.

The CFD's current standpipe procedure permits connecting into the standpipe on the fire floor if the standpipe connection is within the stairwell. The survey revealed that twenty-one of the thirty-four responding departments require the initial standpipe connection to be made on the floor below the fire. Connecting below the fire provides a margin of safety for the initial attack team to make the connection and a larger area to stretch out the hose line. McGrail (2005,May) also recommends connecting to the floor below the fire and suggests using the floor below the fire to stretch the hose and remove kinks.

The high-rise survey asked if the buildings required a full or partial evacuation when the fire alarm sounded and how the alarm was communicated to occupants. The high-rise survey revealed that sixteen of the twenty-two buildings returning the survey conduct partial evacuations of the building utilizing a defend-in-place strategy. Only six buildings require a full building evacuation. Fourteen buildings only notify the floors affected by the partial evacuation and two notified the entire building. Cincinnati Fire Fighters will encounter occupants of buildings during a high-rise fire that may not be aware of the fire within the building since not everyone will be notified. Thirteen buildings that partially evacuate the building use the stairwell to exit the building. Only one building relocates the occupants to another floor within the building. The occupants of the floors in alarm should be evacuated from the building however floors above the fire and floors below the fire may still have many occupants unaware of the fire danger. The National Safety Council (n.d.) recommends the partial evacuation priorities include the fire floor and two floors above the fire and two floors below the fire. Vincent Dunn (2003)

questions the validity of the defend-in-place strategy and advises the building must be of fire resistive construction with the fire and smoke contained to one floor and capable of being extinguished by firefighters. Dunn (2003) also suggests the occupants must be willing to stay in the building, and in the aftermath of the World Trade Center collapse in 2001 the occupants may not comply with the Fire Chief's orders. As a result of occupants not complying with the defend-in-place strategy the stairwells may become quickly overcrowded delaying the evacuation and preventing fire fighters from reaching the fire floor (Orozco, 2005).

The building survey revealed that nineteen of the twenty-two buildings contain standpipe systems in all of the stairwells, and ten of the standpipe systems contain pressure-reducing devices. Three buildings were unsure if the standpipe system contained pressure-reducing devices. Due to the potential for low outlet pressures and resultant low water flow firefighters must be aware of the presence of PRDs and need to be trained in the procedures to overcome these devices when possible. Bush and Routley (1996) and Shapiro (2003) agree that firefighters must be aware of the PRDs and recommend that the firefighter may have to remove or adjust the valve to obtain the desired flow.

The study revealed nineteen of the twenty-two buildings responding to the survey are completely protected by an automatic sprinkler system. Quiter (2006) states a properly maintained sprinkler system greatly increases the occupant safety within a high-rise. The NFPA statistics agree. The NFPA reports that no more than two people have ever been killed in a building as the result of a fire in a fully sprinkled building (Rospond, 2005). A high-rise building containing a fully automatic, properly maintained sprinkler system is safer for the occupants and for the responding fire fighter.

The implication of the results of this research identifies the needed updates to the current high-rise procedures and resource response assignment. Another implication is the fire department will need to commit significant resources to a high-rise alarm and will need to purchase new equipment specific to high-rise firefighting. An additional implication is to dispel the premise that the building will be conducting a full evacuation upon fire department arrival and that many of the building occupants may be unaware of the fire emergency.

Recommendations

The City of Cincinnati and the CFD need to pursue the following recommendations:

- Approve and implement the procedures developed as a result of this research.
- Train all fire fighters on the new procedures including the hose evolutions and search operations.
- Replace current high-rise equipment with 2 ½" hose and smooth bore tip and additional standpipe equipment as outlined in the procedure.
- Train all fire fighters in recognizing and adjusting or defeating pressure-reducing devices.
- Amend the Building and Fire codes to require fully automatic sprinklers in all high-rise buildings.
- Update and adopt the Cincinnati Fire Department Fire Protection System Testing Guidelines to current standards.

Adopting the new procedures will provide additional resources to handle the numerous tasks present at a high-rise fire. The pre-determined operational procedures define each company's role and responsibility and will get the incident off to a predictable start ensuring the basic incident priorities have been assigned.

The recommended changes such as new equipment purchases and additional training will have a significant budgetary impact and will need to be incorporated into the budget. The implementation of the recommendations will require the following:

1. Purchasing the equipment.
2. Publishing the procedures in draft form for fire fighters to become familiar with the procedures.
3. Conduct department-wide training on procedures and high-rise equipment to include hose evolution, search tactics, and each pre-designated incident assignment.
4. Distribute the final approved procedures and establish an implementation date.

Additional research needs to be conducted into the economic impact of amending the building and fire codes to require fully automatic sprinklers in all high-rise buildings retroactively. Research should also be conducted regarding the feasibility of providing fire-hardened stairwells and elevators for fire department use and increasing the capacity of occupant stairwells to accommodate total evacuation of the building. Ventilation tactics and methods need to be researched to determine the capability of the internal HVAC systems and the efficacy of positive pressure ventilation.

References

About the U.S. Fire Administration. (n.d.) Retrieved January 8, 2007 from the U.S.F.A. website: http://www.usfa.fema.gov/about/

Bush, R. & Routley, J.G. (1996). *Operational considerations for high-rise firefighting* (Rep. No. USFA-TR-082). Emmitsburg, MD: United States Fire Administration.

Chubb, M., Jennings, C., & Routley, J.G. (n.d.) *High-rise office building fire – One Meridian Plaza* (United States Fire Administration contract number EMW-90-C-3338) Emmitsburg, MD: National Fire Data Center

Cook County Commission (2004). *Report of the Cook County Commission investigating the 69 West Washington building fire of October 17, 2003.* Retrieved on January 8, 2007 from http:// www.co.**cook**.il.us/**Fire**_Commission/**...**/07.07.04 **County** Report Final.pdf

Dunn, V. (1996, October). Information the key to successful firefighting. *Fire Engineering, 140.*

Dunn, V. (2003). Evacuating people from burning buildings. Retrieved March 1, 2007 from http://vincentdunn.com/dunn/newsletters/jan-feb-mar-2003/FDNYHP_21.htm

Fox, B. (2003, August). The operational aspect of high-rise fire fighting. Retrieved on March 1, 2007 from http://64.233.167.104/search?q=cache:1WkT40_75xwJ:www.emich.edu/cerns/downloads/papers/FireStaff/Unsorted/High%2520Rise%2520Fires%2520-%2520The%2520Operational%2520Aspect%2520of%2520High%2520Rise%2520Fire%2520Fighting.pdf+high+rise+firefighting&hl=en&ct=clnk&cd=20&gl=us

Fredericks, A. (1999, February). Standpipe system operations: The standpipe kit [Electronic version]. *Fire Engineering* 152

Grimwood, P. (2003, March). Operational aspects of high-rise firefighting – A review of major incidents and S.O.P.s. Retrieved March 1, 2007 from http://www.firetactics.com/HIGH-RISE1.pdf

High Rise Fires. (n.d.) Retrieved March 1, 2007 from http://www.iklimnet.com/hotelfires/highrisefire.html

High Rise Safety, (n.d.). Retrieved March 1, 2007 from http://www.cityofreno.com/res/fire/risk_reduc/home/high_rise/

Kealy, M. (n.d.). CIBSE Technical conference: Fire in high-rise. Paper presented at the CIBSE National Technical Conference. Retrieved on March 1, 2007 from www.cibse.org/pdfs/Martin%20Kealy.pdf

Klaene, B.J. & Sanders R.E. (2000). *Structural Firefighting.* Quincy, Massachusetts: National Fire Protection Association, Inc.

Largest Metropolitan Areas in the United States (n.d.). Retrieved December 28, 2006 from http://www.mongabay.com/igapo/cities.htm

Lobash, M. (2005). Speaking in code. *Building operating management.* Retrieved March 1, 2007 from http://www.facilitiesnet.com/BOM/article.asp?id=2426

Lorenz,B. (n.d.). Evacuation 911. Retrieved on March 1, 2007 from http://www.facilitiesnet.com/BOM/article.asp?id=2426

McGrail, D.M.(1999, March). High-rise fire fighting and standpipe training. *Fire Engineering, 152,* 68-88.

McGrail, D.M. (2002, December).High-rise fire fighting and standpipe operations: Proper nozzle selection. *Fire Nuggets*. Retrieved January 7, 2007 from http://www.firenuggets.com//xARDS/dec2002index.htm

McGrail, D.M. (2005, February). Engine company standpipe operations: Pressure regulating devices. *Fire Engineering, 158,No.2* 63-76.

McGrail, D.M. (2005, May). Engine Company Standpipe Operations: Tactical use of the 2 ½" handlines, Part 1. *Fire Engineering, 158 No. 5* 79-100.

McGrail, D.M. & Tracy, G. (2000, August). Standpipe Operations: Facts and fiction. *Fire Engineering*, 153, 97-115.

Mendes, R.F. (1975). *Fighting High-Rise Building Fires: Tactics and Logistics.* Boston, Massachusetts: National Fire Protection Association

National Fire Department Database. (n.d.). Retrieved March 1, 2007 from the U.S.F.A. website: http://www.usfa.fema.gov/applications/census

National Fire Protection Association (2003) *Life Safety Code 101.* [CD Rom] Quincy, Massachusetts: Author

National Institute for Occupational Safety and Health (NIOSH) (2002, October 21). *High-rise apartment fire claims the life of one career fire fighter (Captain) and injures another career fire fighter (Captain) – Texas.* Retrieved March 1, 2007 from http:// www.cdc.gov/niosh/fire/pdfs/face200133.pdf

National Safety Council. (n.d.). *Evacuation systems for high-rise buildings* (Data sheet 1-656-Reaf. 85) Retrieved March 1, 2007 from http://www.nsc.org/public/library/evacsys.doc

Norman, J. (2005). *Fire officer's handbook of tactic* (3rd ed.). Tulsa, Oklahoma: Penn Well Corporation

Orozco, R. (2005, August/September). High rise buildings. *Fire Nuggets.* Retrieved January 7, 2007 from http://firenuggets.com//x_ARDS/orozco32.htm

Quiter, J. (2006, Summer). High-rise buildings – What should we do about them? [Electronic Version] *Fire Protection Engineering.* Retrieved on March 1, 2007 from http://www.fpemag.com/articles/article.asp?issue_id37&I=228

Rospond, K.M. (2005). New high-rise building codes are stricter on fire safety. *Building Operating Management*. Retrieved on March 1, 2007 from http://www.facilitiesnet.com/BOM/article.asp?id=2426

Science Daily (2006, November). *Test Fans For High-Rise Fire Safety.* Retrieved on March 1, 2007 from http://www.sciencedaily.com/releases/2006/11/061123115309.htm

Shapiro, J. (2003). Standpipe and hose systems. *Fire Protection Handbook:* Vol. II. (19th ed., pp. 10-351-10-367, National Fire Protection Association Inc., Quincy, Mass.

US Fire Administration. (2002, January). *Topical Fire Research Studies – Highrise Fires.* Retrieved on March 1, 2007 from http://www.usfa.dhs.gov/downloads/pdf/tfrs/v2i18-508.pdf

Wallington, N. (2006). A tall order [Electronic version]. *Security Middle East Magazine,* 30. Retrieved on March 1, 2007 from http://www.securitymiddleeastmagazine.com/Pages/issue_30_2.aspx

Appendix A

National Fire Department Survey Respondents

The following thirty-four fire departments responded to the national survey:

Clark County Fire Department	Clark County, Nevada
Memphis Fire Department	Memphis, Tennessee
Sacramento Metro Fire Department	Sacramento, California
San Diego Fire Department	San Diego, California
Minneapolis Fire Department	Minneapolis, Minnesota
Providence Fire Department	Providence, Rhode Island
Houston Fire Department	Houston, Texas
Atlanta Fire Department	Atlanta, Georgia
Chicago Fire Department	Chicago, Illinois
St. Petersburg Fire Department	St. Petersburg, Florida
San Antonio Fire Department	San Antonio, Texas
Jacksonville Fire Department	Jacksonville, Florida
Miami Dade Fire Department	Miami, Florida
Cleveland Fire Department	Cleveland, Ohio
Nashville Fire Department	Nashville, Tennessee
Las Vegas Fire Department	Las Vegas, Nevada
Portland Fire Department	Portland, Oregon
Fairfax County Fire Department	Fairfax County, Virginia
Milwaukee Fire Department	Milwaukee, Wisconsin
Philadelphia Fire Department	Philadelphia, Pennsylvania
Kansas City Fire Department	Kansas City, Missouri

Orlando Fire Department	Orlando, Florida
Baltimore City Fire Department	Baltimore, Maryland
Columbus Fire Department	Columbus, Ohio
Seattle Fire Department	Seattle, Washington
San Bernardino Fire Department	San Bernardino, California
San Francisco Fire Department	San Francisco, California
Jersey City Fire Department	Jersey City, New Jersey
Sacramento City Fire Department	Sacramento, California
Los Angeles City Fire Department	Los Angeles, California
Honolulu Fire Department	Honolulu, Hawai
Virginia Beach Fire Department	Virginia Beach, Virginia
Unknown 1	No demographic provided
Unknown 2	No demographic provided

Appendix B

National Fire Department Survey

December 20, 2006

My name is Thomas Lakamp and I am a District Chief with the Cincinnati Fire Department. I am currently enrolled in the Executive Fire Officer Program at the National Fire Academy. As a requirement to complete the Executive Analysis of Fire Service Operations in Emergency Management Course I must complete an Applied Research project. My project topic is to examine fire department response and occupant actions within high rise structures within the City of Cincinnati. I would greatly appreciate if you would complete the attached survey and return it in the enclosed addressed stamped envelope by January 31, 2007.

Thank you for your time completing this survey.

Sincerely,

Thomas C. Lakamp – District Chief
Cincinnati Fire Department
7982 Countfleet Ct.
North Bend, Ohio 45052

513-357-7503
513-368-1384

1. How does your department define a high rise structure?

2. What resources are dispatched to a reported fire in a high rise occupancy? (Caller states there is a fire – Not a system alarm only)

____ Engines ____ Trucks ____ Heavy Rescue ____ Chief Officers

____ Medical Units (ALS ____ BLS ____)

Other: _____

_____

3. Upon confirmation of a working fire by fire units arriving on the scene are additional resources dispatched automatically?

YES NO

If YES please specify

____ Engines ____ Trucks ____ Heavy Rescue ____ Chief Officers

____ Medical Units (ALS ____ BLS ____)

Other: _____

_____

4. Do the high rise procedures define pre-assigned duties for arriving fire companies? (IE. 1st in engine investigate on reported fire floor, 2nd engine – Lobby Control, 1st truck – investigate fire floor with 1st engine, etc.)

YES NO

If Yes, please specify

Company	Assignment
Engine 1	_____
Engine 2	_____

Engine 3 _____

Engine 4 _____

Engine 5 _____

Engine 6 _____

Engine 7 _____

Truck 1 _____

Truck 2 _____

Truck 3 _____

Truck 4 _____

Truck 5 _____

Heavy Rescue 1 _____

Heavy Rescue 2 _____

Chief 1 _____

Chief 2 _____

Chief 3 _____

Chief 4 _____

Medical Unit 1 _____

Medical Unit 2 _____

5. What equipment is carried in your standpipe kit? (Mark all that apply)

2 ½” hose _____ Length _____

1 ¾” hose _____ Length _____

Nozzle _____

Pipe Wrench _____

Pressure gauge at discharge _____

Spanner _____

Adapters/fittings _____

Other Equipment _____

---

6. When utilizing the elevators during a high rise fire attack at what floor below the fire do your procedures state to exit the elevator and use the stairs?

One floor below reported fire floor _____

Two floors below the reported fire floor _____

Three floors below the reported fire floor _____

Four or more floors below the reported fire floor _____

7. When the standpipe outlets are located in the stairwell, what floor do your procedures state to make the initial standpipe connection?

Fire floor ____ Floor below _____

8. When standpipe outlets are located in the hallways of the building, where do your procedures state to make the initial standpipe connection?

Fire floor _____ Floor below _____

If possible, please send a copy of your current high rise firefighting procedures to thomas.lakamp@cincinnati-oh.gov

Department:
Number of firefighters in department:
Population served:
Would you like a copy of this ARP? (Include e-mail address please)

YES NO

Appendix C

High Rise Building Survey Respondents

The following twenty-two buildings responded to the high-rise building survey:

Atrium II

Fifth Third Tower

Hammond North Condominiums

Highland Tower

Westin Hotel

Ingalls Building

Kroger Building

U.S. Bank Tower

Chiquita Center

URS Center

Garfield Suites Hotel

Center at 600 Vine

One Lytle Place

Page Towers

Regency Condominiums

Edgecliff Point Condominiums

525 Vine Street Building

Scripps Center

Millenium Hotel

Atlas Building

Hyatt Regency Hotel

Federated Building

Appendix D

High Rise Building Survey

January 30, 2007

My name is Thomas Lakamp and I am a District Chief with the Cincinnati Fire Department. I am currently enrolled in the Executive Fire Officer Program at the National Fire Academy. As a requirement to complete the Executive Analysis of Fire Service Operations in Emergency Management Course I must complete an Applied Research project. My project topic is to examine fire department response and occupant actions within high rise structures within the City of Cincinnati. My goal is to update current fire department response procedure so that the fire tactics employed match the occupant actions. I would greatly appreciate if you would complete the attached survey and return it in the enclosed addressed stamped envelope by March 2, 2007.

Thank you for your time completing this survey.

Sincerely,

Thomas C. Lakamp – District Chief
Cincinnati Fire Department
700 W. Pete Rose Way
Longworth Hall, 5th Floor
Cincinnati, Ohio 45203

Thomas.lakamp@cincinnati-oh.gov

513-357-7503
513-368-1384

1. When the fire alarm sounds do you require a full evacuation of the building?

YES NO

If yes – Go to Question #4.

2. If no, how do you communicate the alarm to the occupants?

_____ All occupants within the building are notified of the alarm with verbal instructions given to the floors and/or occupants affected.

_____ Only the floors affected by the alarm are notified. (Floor of alarm, floor(s) above and receiving floor(s).

3. If only the floors affected are notified what direction is given? (I.E. If the fire alarm is on the 13th floor the voice alarm would direct the occupants of Floors 12-15 to evacuate to the 11th floor. What does your alarm instruct the occupants to do and who does it instruct?)

4. Do the stairwells within the building use an identification system? (I.E. “Stairwell A”, “Stairwell 1”, “East Stairwell” etc.)

YES NO

If yes, are the doors labeled on every floor?

YES NO

5. Does the building have a designated fire command center?

YES NO

6. Please answer the following questions regarding the fire suppression equipment within the building:

Are there standpipes in all stairwells? Yes No

Do the standpipes contain pressure reducing valves or pressure restricting devices?

YES NO UNSURE

Fire Pump Rating _____ g.p.m.

7. Is the building fully protected by an automatic sprinkler system?

YES NO

Building Name:

Building Address:

Number of Stories:

Thank you for your time completing this survey. If you have any questions regarding this survey please contact me.

Thomas C. Lakamp
District Chief
Cincinnati Fire Department

Office: (513) 357-7503

Appendix E

Current Cincinnati Fire Department High-Rise Procedures

March, 1991

CHAPTER II Operations

SUBJECT 3 Emergency Operations

TOPIC 10 High Rise Buildings

A. PURPOSE

This topic is intended to adapt normal operating procedures to a high-rise mode of operation. Also to establish a standard approach and general guidelines for use at High Rise Buildings. High Rise Buildings are defined as buildings more than six stories or more than 75' above the lowest level of Fire Division access. It must be recognized that the six story building does not present problems of the same magnitude as a forty story building. Logistics and access problems increase with height. The more stories above the fire, the more people are endangered, and the more there is to burn.

B. PRIORITIES

1. Priorities for a High Rise incident will be:

   Rescue

   Fire Control

   Property Conservation

C. SAFETY

1. Full protective clothing including SCBA shall be worn at the scene of all high rise fires until the incident Commander directs otherwise. However, members involved in external activities are not mandated to use respiratory protective equipment as long as they are in a clear atmosphere.
2. All units will work under the direction of "Command", no free-lancing.

D. PRE-PLANNING

Will identify major problems and prescribe what is needed to meet them, without going too deeply into step by step actions. Pre-plans may also include apparatus placement for first alarm companies. Pre-plans may modify this topic, but should not otherwise address procedures. Pre-plans are required for high rise buildings. Also, see 202.02 Pre-Planning.

E. WATER SUPPLY

Water supply requirements shall be the same as for any structure fire, namely a source of water supply shall be secured by the first in Engine company unless the pre-plan preempts this requirement. Most properties protected by fire suppression systems require a 5" supply line or soft suction connection. The first in engine company shall connect to the Fire Department Siamese intakes (unless other arrangements are made on the pre-plan for that property). Also see 203.02 Suppression Systems.

F. RESCUE

Units must evaluate and report on the conditions in each area of the structure and the tenability or need for evacuation. Large numbers of occupants are usually involved in these decisions.

Rescue of occupants is limited mainly to using the interior stairs. Fire fighting efforts must control the stairs, and prevent extension. Compounding the problem is core construction methods used in new high rise buildings, where all the stairways are located in the center of the building. Occupants are trapped if the fire occurs near the core, or anywhere between them and the core. Core construction also limits fire attack positions. It may be difficult to reach the fire from the stairways. If the fire is between the core and victims, fire streams may push the fire toward the victims, creating a no win situation.

Applying the incident Command System to a serious High Rise fire is using the system to advantage, and a challenge to the Incident Commander. Not many firefighters relish lobby control or stairway support assignments. Proper utilization of this procedure is a test of department discipline.

F. Rescue (continued)

Some of the key positions, specific to a High Rise incident are:

Base

Staging (interior)

Stairway Support

Lobby Control

BASE (Exterior)

Base for High Rise fires identifies a location where support equipment and personnel are kept on the exterior of the building. The reason for this distinction is that the Staging Area is moved inside the structure in a High Rise fire. Unless there is a possibility of moving to an exterior operation, or the fire is involving other structures, it would be unusual to amass a large force outside at a High Rise fire.

STAGING (Interior) or REHAB

In a high rise situation, most of the reserve force is moved through the lobby, and then to the interior staging area. This area is normally two or more floors below the fire. A rehabilitation area may be set up at the staging area, or on another floor. The idea here is the same as with the normal exterior staging, having a reserve force close at hand.

The duties of the Interior Staging Area Officer are enumerated as follows:

1. Record companies in staging and rehabilitation.
2. Request additional reserves.
3. Maintain a minimum reserve of Engine and Ladder companies as determined by Command or The Division Commander.
4. Maintain an adequate supply of air cylinders.
5. Supply first aid equipment and medical services for units involved in rescue and suppression.

   Supply special equipment (and not so special equipment, hose, nozzles, adaptors).

F. Rescue (continued)

This idea of an interior staging area should not be reserved for High Rise fires only. Effective staging areas can be utilized in four and five story structures. Anytime an extensive interior attack is in progress, where firefighters expend more than one tank of air, interior staging and rehabilitation can be implemented. Depending on interior conditions, an exterior manpower staging area is often located near the fire perimeter. In weather extremes, firefighters need rehabilitation. Rested crews should be ready to relieve forward crews when they need to be moved to Rehabilitation. In extremely hot weather, or when an extended operation is expected, it may be necessary to have three firefighters for each interior attack position.

STAIRWAY SUPPORT

Moving equipment up stairways is a necessity. Many items elevators are unsafe to use, damaged by the fire, or electrical power to the elevator is disrupted. Moving supplies and manpower up 10, 20, 30 or more stories is an arduous task. If not properly managed, no one will reach the fire floor in condition to fight the fire.

A method has been developed for moving supplies to the fire area, in the absence of, or limited, elevator availability, by placing a firefighter on every other floor. Using this method, firefighters ascend two stories with air cylinders and other equipment, handling it off to the next firefighter. This firefighter then descends two stories, empty handed, providing a break. During extended operations, involving many companies in rescue and suppression activities, it may be necessary to place two firefighters on every floor, or even move air cylinders down for refill. Moving equipment up through the building, without the use of elevators, is a mammoth undertaking, but this method provides a reasonable approach. If the fire is located above the twentieth floor, without any elevator service, it may be advisable to let the suppression forces ascend the stairs empty handed (possibly without fire clothes and air mask for part of the way), thereby, saving them for the battle. Stairway Support will need to be one of the first assignments made in such a case.

The minimum manpower requirement for Stairway Support is one firefighter for every 2 stories.

F. Rescue (continued)

Lobby Control

A company should be assigned to Lobby Control regardless of whether the elevators are operating or not. The duties of Lobby Control are:

1. Control, operate, and account for elevators.
2. Assist in Incident Command Post operations.
3. Locate all interior stairs.
4. Direct incoming companies to the proper elevator or stairway.
5. Consult with the building engineer.
6. Control the Heating Ventilating and Air Conditioning (HVAC) system after consultation with the Incident Commander.

Controlling the elevators and stairs is the only way to gain access to a High Rise building. The (HVAC) Heating, Ventilation, and Air Conditioning System can be a valuable asset, if operated properly, and a complete disaster, if handled poorly. This system can prevent smoke and toxic gases from reaching uninvolved areas, or be the vehicle that spreads the products of combustion well beyond the fire area. Few buildings engineers are completely knowledgeable about the operation of the HVAC. In some buildings, it is virtually impossible to know what is going to happen when the HVAC is operated because of the following variables:

Heat of the fire

The intensity and size of the fire will determine how much combustion gases are heated, and how high they will rise inside the building. In lower structures, there is generally enough heat energy to cause the heated fire gases to rise to the highest level in the structure. In High Rise buildings, the smoke and toxic gases will tend to rise until they reach temperature equilibrium, then they will stratify. It is not unusual to have heavy smoke on a mid-level floor, and smoke free floors above. This stratification can endanger occupants who enter a smoke free stairway, discovering smoke several stories below. Many times, doors leading back into a floor area are locked, forcing the fleeing occupant to wait it out in the stairway or proceed through the smoke.

F. Rescue (continued)

Stack Effect

On a cold day, the stack effect will be positive, or cause the products of combustion to rise in the building. Tightness of the structure has much to do with stack effect. The unpredictable behavior of smoke within a High Rise is due, in large part, to stack effect. In some buildings, the stack effect is so great that it interferes with the proper operation of the HVAC. The colder it is outside, and the warmer inside, the greater the stack effect. Conversely, the stack effect can be negative on a warm day, within air conditioned building. Actually, the heat of the fire and stack effect are interdependent. On a cold day, the chances of smoke stratification are less than on a warm day.

Wind

There is a point within a High Rise structure of sufficient height, called the Neutral Pressure Plane. Below the Neutral Pressure Plane (NPP), air is moving into the building, at the NPP, forces are neutral (air is not moving in or out) and above the NPP, air moves out of the building. The NPP is affected by the heat of the fire and stack effect. Wind also plays a major role. Ground level winds are not always a good indication of wind direction and speed high above the ground. Downtown areas of large cities, containing large numbers of High Rise buildings, are like giant canyons. Wind entering the High Rise canyon is redirected and becomes very turbulent. This gustiness also prevails high above the ground, but possibly in another direction at a higher velocity. Wind passing over a roof opening has a pulling effect. In addition, the wind will push smoke back into the budding on the leeward side, and tend to help on the windward side. Therefore, the wind will effect ventilation in three ways, moving the NPP, pulling smoke through a roof opening, and pushing or pulling smoke from a window. In reality, it is impossible to predict the wind factor accurately. Wind direction and velocity can change dramatically, even when atmospheric conditions are not changing significantly.

F. Rescue (continued)

Ventilation and control of the HVAC should be done in terms of reversible methods. Opening a window is much preferred to breaking a window. If a window is opened and the effect is contrary to what we expected, it can be closed (reversible). The HVAC should be operated under the same principle. If the effect is negative, try something else.

When large numbers of people are attempting to exit through the lobby, and firefighters are gathering in an effort to ascend toward the fire, the lobby is a poor place for the Incident Commander. Newer High Rise buildings are sometimes equipped with a command center that is not always near the lobby. An Incident Commander would be foolish not to take advantage of such an area, providing good communications and the needed work space for command activities. The location of a primary and secondary command post shall be included in the building pre-plan.

G. THE HIGH RISE INCIDENT COMMAND SYSTEM

Looking at logistical requirements and multiply staging areas, it is apparent that the span of command can be quickly exceeded at a High Rise fire. Incident Commanders tend to retain the Operations Section as part of their function during most incidents, even fairly large situations. In the case of the high rise fire, the Incident Commander is well advised to hand off the Operations and/or Planning Section early, so other problems can be adequately addressed. Record keeping is essential. Units operating on the fire floor and staging area can be controlled by an Operations Section Chief.

The value of an Operations Section aide is clear. The Operations Section Chief needs to know who is operating where, but does not have time to keep the worksheet up to date.

G. The High Rise Incident Command System (continued)

COMMUNICATIONS

Communication is simplified using the Incident Command System as companies working on the fire floor change, but whoever is in that area at any given time will be Division # (fire floor). Communications can be very complicated within a High Rise building. If separate radio or hard wire communi-cations are not provided at the incident scene chaos could prevail as:

* The rescue and evacuation group would be communicating among companies in their group as to status of various floors.

* Division # (fire floor) would be communicating with Operations and each other.

* Division # (floor above fire floor) would be doing much the same.

* Stair support would be communicating with each other and Logistics.

* Staging would be communicating with Divisions, Operations, and Logistics.

* Radio discipline must be maintained and alternative methods arranged (messenger, telephones, face to face, etc.). Complicating the communications problem is the fact that it is difficult to use radios within many structures, and nearly impossible to transmit from inside to dispatch from a steel skeleton building.

The average office building has one person for every 100 square feet. For example, multiplying out a building that is 200' X 100', 17 stories high, yields 200 people per floor, 3400 people in all. The maximum occupant load for the building should be noted in the pre-plan.

G. The High Rise Incident Command System (continued)

The occupants of an office building are generally mobile and able to escape on their own, provided stairways are available for their use. Firefighters trying to advance up stairways, while everyone else is attempting to evacuate, results in delays to both the occupants and fire fighters. Many High Rise building managers, and fire departments recognize that it is not always the best policy to have all of the building's occupants in the stairways at the same time. The people on the fire floor and floor immediately above are in the greatest danger, having the stairway full of people, hinders their escape. Quite simply, the people who really need to leave cannot, while others who are relatively safe jamb their exit. Firefighters complicate the self rescue effort by swimming upstream in the stairway full of evacuees. Further complicating the evacuation process, occupants above the fire must pass by the fire floor to reach safety. Firefighters tend to exacerbate this problem, violating the stairway enclosure by blocking doors open with fire lines, or in their ventilation attempts. There is no easy, or for that matter, best way to deal with this dilemma.

First, search efforts must be systematic and include a complete primary search of the fire floor and floors above the fire. When searching above the fire, it is important to check the status of all stairways. Are people in the stairway? Are any stairways filled with smoke? Smoke may stratify. Don't assume that the stairway is clear, because it was clear on another floor level. It is not necessary to check every stairway on every floor, but it will be necessary to check regularly, perhaps every three floors. One way to accomplish this is to enter the floor using one stairway and exit using another, thus cris crossing floor areas. Forcible entry will be a necessity, and proper tools must be carried by the search and invaluable in gaining access to rooms and thus, reducing the damage. It is necessary to check individual rooms to assure the occupants have escaped on any floor endangered by the fire or smoke. Occupants may display what is now called "convergence cluster" behavior. They gather in certain rooms, thought to be safe and for the feeling of safety gained when others are present. Searching firefighters may not find anyone in several rooms or on an entire floor area, while one room may contain far more victims than anticipated.

G. The High Rise Incident Command System - Communications (continued)

As search and rescue team proceed with a systematic search, they must provide status reports to their division commander and mark areas searched. Using the chalk marking system as described in 203.01G.

Many High Rise buildings lock the doors from the stairs to the hallway further complicating search and rescue efforts. Power saws may not operate due to heavy smoke conditions. Other forcible entry tools should be available to rescue and fire control teams.

Blocking the doors open will most certainly allow smoke to enter the hallway from the stairs and should be avoided. Elevators should be grounded and checked by lobby control. If elevators are stalled or otherwise located above the ground floor, they must be checked for victims.

A relatively new system called a Vocal Alarm System (VAS) is not being used in a few High Rise buildings. The VAS system uses prerecorded messages to notify occupants of a fire and gives specific directions to places of safe refuge within the building. Using the VAS, people above the fire are directed to floors higher within the structure, avoiding the need to pass the fire floor. People on the fire floor, and floor below, are directed to an area two or three floors below the fire. Occupants of the receiving floors are also notified of the evacuation, and people on elevators are told that the elevator is responding to the ground floor, where they are to exit. The VAS seems to solve many of the evacuation problems. Whenever occupants are left in the structure, a calculated risk, with their lives. In such cases, we are depending on the structure, fire suppression systems and our efforts to confine the fire.

Helicopter rescues are extremely dangerous and in most cases unnecessary. Few cases warrant the use of a helicopter in removing occupants from a roof. There is no agreement in place for helicopter rescues.

THE PRIMARY RESCUE TACTIC IS A WELL PLACED, AGGRESSIVE INTERIOR ATTACK.

G. The High Rise Incident Command System - Communications (continued)

In a High Rise, more than any other building, confining and extinguishing the fire will do more to save lives than any other single factor. Once the fire is extinguished, the toxic products of combustion are no longer being produced, and the whole operation becomes more manageable.

H. FIRE CONTROL

Large structures can contain a substantial fire without displaying any outside manifestation. Occupants will report smoke or smells, but these are often many floors above the fire. Even internal alarms are sometimes misleading, as smoke detectors sense smoke above the fire floor or in other areas where the HVAC is depositing smoke. Finding the fire may involve a search and rescue type effort, assigning units to different floors and compartments.

The floor area of a fire resistive building should be thought of as an enclosed system, until successfully ventilated. Lines operated on the fire floor will push the fire. Like all other energy and matter, the fire will follow a path of least resistance. If it cannot proceed upward or outward, it will follow hallways or false spaces. This can be extremely dangerous in a closed high rise. The fire can wrap around or follow the ceiling false space, getting between firefighters and their way out. For this reason, backup lines protecting "the way out" are needed and the use of fog streams is discouraged.

As soon as the fire floor is reached and identified the officer will give Command a report of conditions on the fire floor, immediate needs, and a confirmation of the actual fire floor. Command should then establish the fire floor as a Division (Floor 16 = Division 16).

H. Fire Control (continued)

Also upon reaching the fire floor, ceiling tiles must be removed to assure the fire is not getting behind the engine company crew. Ventilation can be extremely valuable, although very difficult to perform. The fire line is used as the life line to safety. Members should stay within range of this protective line, not only for the protection it can provide, but as a means of finding the stairway. It is also good practice to place a firefighter at the stairway opening to the floor. This firefighter will be needed to help stretch hose and can talk firefighters to the exit if things go wrong.

REFER TO "WORKING IN A BUILDING EQUIPPED WITH A STANDPIPE" 203.02

All floors above the fire are exposures. Companies need to check above the fire floor for extension and be equipped to fight the fire. Companies would rather be actively involved in fighting the fire, but the Incident Commander must insist that units placed on fire watch, maintain their positions. In modern buildings with curtain walls, fire can extend near the exterior wall. Stairways, and to a lesser degree elevator shafts are vertical openings through which fire can spread. Additionally, pipe chases, utilities, wiring etc. penetrate floors. Fires can extend via the exterior of the building by lapping form floor to floor. While upward extension is the main concern, the fire can spread downward through melting expansion joints, plastic materials dropping down, the HVAC etc.. Areas below the fire need to be checked. If sufficient numbers of firefighters are available, the search and rescue team can check floors above the fire, as they proceed and, firefighters assigned to property conservation should check below the fire.

I. PROPERTY CONSERVATION

High Rise buildings are high value buildings with high value contents. Rescue and fire control problems in a high rise are of such magnitude, and so manpower intensive, that property conservation is often overlooked. The first priorities are rescue and fire control, but property conservation must be considered early.

I. Property Conservation (continued)

The height of the building comes into play in an opposite way when we consider property conservation. The greatest property conservation exposure is downward as water flows through curtain walls and electrical fixtures, damaging valuable property beneath the fire. Outside of moving and covering operations, there is a need to give the water a place to go. Property conservation does deserve our attention, with all floors below the fire possibly exposed to water damage.

Incident Commanders tend to be impatient. They give an order and expect to see immediate results. Ordering a portable master stream appliance to the tenth floor could take a considerable amount of time, especially if the elevators are not available for our use. It is not uncommon for lead time to be 10 to 25 minutes in a High Rise fire situation.

J. FIREFIGHTER SAFETY

Already mentioned were the needs to provide backup lines, rehabilitation, communications and a viable Incident Command System. All of these increase firefighter safety. Here the discussion is limited to the use of elevators by firefighters and finding a way out. As mentioned under fire control, fire lines are used as life lines on the fire floor and above.

Additionally, firefighters must orientate themselves to the building. Where am I in relation to the stairways and elevators? It is good practice for firefighters to look at a typical floor plan, before reaching the fire floor. This can be done by getting out of the elevator or stairway long enough to pick out landmarks. How far away is the alternate exit? Is the floor laid out in an "L" or "T" formation? The first and second floors are generally not typical floor layouts. It is better to look at another floor that will be very similar to the fire floor. Many High Rise buildings have floor layouts that resemble a maze, making it very likely for a firefighter to become disoriented and lost.

K. ELEVATOR SAFETY

Lobby control should control, operate, and account for all elevators.

K. Elevator Safety (continued)

The use of elevators under fire conditions is a calculated risk. Elevators often stall or act erratically under fire conditions.

Elevators are equipped with redundant safety systems to prevent their falling. An elevator shaft is fire enclosed, but a fire of sufficient intensity will invade the shaft, most certainly smoke and toxic gases will enter elevators stalled above the fire floor. As bad as this situation is for firefighters, who should be fully equipped with personal protective clothing and an air mask think of the civilian without protective gear. Maintenance and security people should not be taken into the elevator until it has been verified that the elevator is completely safe for use. See Topic 203.05 Elevator/Escalator Emergencies.

Appendix F

Proposed Cincinnati Fire Department High-Rise Fire Procedures

June, 2007

CHAPTER II Operations

SUBJECT 3 Emergency Operations

TOPIC 10 High Rise Operations

A. PURPOSE

This topic is intended to establish a standard approach and general guidelines for use at high-rise buildings. High-rise buildings are defined as buildings more than six stories or more than 75' above the lowest level of Fire Department access. It must be recognized that the six-story building does not present problems of the same magnitude as a forty-story building. Logistics and access problems increase with height. The more stories above the fire, the more people are endangered, and the more there is to burn.

B. PRIORITIES

Priorities for a High Rise incident will be:

Rescue

Fire Control

Property Conservation

C. SAFETY

1. Full protective clothing including SCBA shall be worn at the scene of all high rise fires until the incident Commander directs otherwise. However, members involved in external activities are not mandated to use respiratory protective equipment as long as they are in a clear atmosphere.

2. All units will work under the direction of "Command", no free-lancing.

3. All accountability Passports shall be delivered to the Lobby Control Officer until the Accountability Officer is established.

D. PRE-PLANNING

1. Building specific pre-plans will identify major concerns and prescribe what is needed to meet them, without going too deeply into step-by-step actions.
2. Pre-plans may also include apparatus placement for first alarm companies.
3. Pre-plans may modify this topic, but should not otherwise address procedures.
4. Pre-plans are required for high-rise buildings. Also, see 202.02 Pre-Planning.

E. RESPONSE

Response to structures meeting the definition of a high-rise shall be:

First Alarm

Five (5) Engines Companies

Three (3) Truck Companies

Two (2) Squad Companies

One (1) Rapid Assistance Team (RAT)

Three (3) District Chiefs

One (1) Advanced Life Support (ALS) Rescue Unit

One (1) EMS Supervisor (Rescue 2)

Upon confirmation of a working fire the Fire Tower shall automatically dispatch the second alarm. The second alarm shall consist of the following:

Second Alarm

Five (5) Engine Companies

Three (3) Truck Companies

One (1) RAT Assist Engine

One (1) Assistant Chief

One (1) Basic Life Support Transport Unit

F. Actions

The following actions shall be taken by the arriving fire companies:

First Alarm

Fire Attack Team (FAT) – First and second arriving Engines, first arriving Truck Company and First Arriving Squad Company.

- The FAT shall determine the fire floor and immediately communicate this information to command.
- Determine which stairwell will be utilized for fire attack and which stairwell will be used for occupant evacuation and communicate this information to command.
- Report Conditions, Actions and Needs (CAN) to Command upon reaching the fire floor.

First Arriving Engine;

- Shall form the Fire Attack Team (FAT) with second engine, first truck, and first squad.
- Shall secure a water supply and connect to the Fire Department Connection (FDC)
- Officer and two (2) fire fighters shall report to the lobby with standpipe equipment and spare SCBA cylinders. Spare SCBA cylinders shall be placed in the lobby in proximity to the elevator.
- Shall check the alarm panel to determine location of alarm.
- Shall work with second Engine to advance one hose line to the seat of the fire

Second Arriving Engine;

- Shall form the FAT with the first arriving engine, first truck and first squad.
- Shall secure a water supply and Fire Apparatus Operator (FAO) shall assist FAO of first engine with water supply and FDC.
- Officer and two (2) fire fighters shall report to the lobby with standpipe equipment and spare SCBA cylinders. Spare SCBA cylinders shall be placed in the lobby in proximity to the elevator.
- Shall work with first engine to advance one hose line to the seat of the fire.

First Arriving Truck Company;

- Shall form the FAT with the first and second arriving engines and first squad.
- Officer, FAO and two (2) firefighters shall report to the lobby with forcible entry equipment including a Rabbit Tool and with spare SCBA cylinders. The spare SCBA cylinders shall be placed in the lobby in proximity to the elevator.
- Shall perform forcible entry for the FAT.

- Shall perform search and rescue operations on the fire floor.

First Arriving Squad Company;

- Shall form FAT with the first and second arriving engines and first truck.
- Shall proceed up the designated fire attack stairwell beginning at the fire floor all the way to the roof. Shall ventilate the fire attack stairs at roof using scuttle or door if possible. If possible, ventilate elevator shaft.
- Shall direct and/or assist occupants found in fire attack stairs to the designated evacuation stairwell.
- Shall advise Command when fire attack stairs are clear of occupants.
- Shall continue to sweep fire attack stairs for occupants from the top floor to the level of exit.

Third Arriving Engine:

- Shall stage apparatus
- Shall assume the role of Lobby Control and report to the lobby
- Officer shall become Lobby Control Officer, determine the location of the stairwells and shall be advised by the FAT which stairwell shall be used for fire attack and which stairwell will be used for building evacuation.
- Officer shall be the Lobby Control Officer and perform fire fighter accountability until the arrival of the Accountability Officer.
- The two fire fighters shall ensure the elevators have been recalled to the lobby and placed on fire department service. The firefighters shall each man an elevator and transport fire companies and equipment to the staging area below the fire floor.

- The FAO shall report to the fire alarm annunciator panel and determine the floors in alarm. The FAO will stand by at this location and will be prepared to make evacuation announcements as directed by the Incident Commander.
- Lobby Control Officer shall locate building engineer and shut down HVAC system.

Fourth and Fifth Arriving Engines;

- Shall secure a water supply and be prepared to augment the fire suppression system
- Officer and two firefighters from each company shall report to the lobby with standpipe equipment and spare SCBA cylinders. Spare SCBA bottles shall be staged in lobby in close proximity to elevators.
- Both companies shall proceed to the fire floor and work together to deploy a back-up line behind the initial attack line.
- FAO's shall verify fire pump is activated and operating properly.

Second Arriving Truck Company;

- Officer, FAO, and two (2) fire fighters shall proceed to the lobby with forcible entry tools and spare SCBA cylinders. Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Shall proceed to the floor above the fire and conduct search and rescue operations
- Shall utilize a search rope secured to a place of refuge within the fire attack stairwell.

Third Arriving Truck Company;

- Officer, FAO, and two (2) fire fighters shall proceed to the lobby with forcible entry tools and spare SCBA cylinders. Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Shall proceed to the evacuation stairwell and conduct a search of the stairwell above the fire floor to the roof.
- Shall ventilate the stairwell utilizing the scuttle or door to roof if necessary.
- Shall continue to sweep the evacuation stairwell to ensure safety of occupants evacuating.
- Shall ensure door to fire floor remains in the closed position unless utilized by occupants to exit the fire floor.

Second Arriving Squad Company

- Officer, FAO, and two fire fighters shall report to the lobby with standpipe equipment and spare SCBA cylinders.
- Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Shall proceed to the floor above the fire and assist the second truck with search and rescue above the fire.
- Shall connect to the standpipe above the fire floor and advance the fire line for protection of the search.

Rapid Assistance Team

- Shall obtain accountability board from District vehicle and deliver it to the Lobby Control Officer

- All four members shall proceed to the floor below the fire with all RAT equipment.
- Shall evaluate floor layout on the floor below the fire noting location of stairs and elevator shafts in relation to floor layout.
- Shall report to the forward division supervisor.

First Arriving District Chief;

- Shall assume Command of the incident
- Shall utilize the fire command center within the building if equipped.
- Upon notification of the fire floor by the FAT shall immediately communicate information to all responding companies and the Fire Tower.
- Upon notification by the FAT shall immediately communicate the location of the attack stairs and evacuation stairs to all responding companies, the Lobby Control officer, and fire dispatch.

Second Arriving District Chief;

- Shall establish a forward command position in the fire attack stairwell or one to two floors below depending on fire conditions.
- Shall immediately confirm fire floor and notify command of verification.
- Shall assume the Division Supervisor of the fire floor. Radio designation shall be “Division (Fire Floor Number)”.
- Shall supervise and account for all companies working on the fire floor, the RAT Team, and the fire attack stairwell ascent team (First Squad).
- Shall evaluate conditions and occupant presence within the fire attack stairwell and advise command.

- Shall assess the evacuation procedure within the building in relation to the fire conditions. Based on the current fire conditions, the Division Supervisor must consider recommending to the Incident Commander a systematic full evacuation of the building if the building has only partially evacuated. (Most buildings only partially evacuate).

Third Arriving District Chief;

- Shall report to command and serve as a command aide
- Shall serve as the accountability officer assuming the accountability board from the Lobby Control Officer.

First Arriving ALS Rescue Unit;

- Shall establish Rehabilitation and Medical treatment for fire fighters two floors below the fire floor.
- Shall report with all ALS equipment including oxygen.

EMS Supervisor (Rescue 2)

- Shall report to the Lobby and establish the EMS Group.
- Shall evaluate the need for additional EMS units and call for multiple EMS strike teams to staging when appropriate

Second Alarm (Incident Commander may stage second alarm depending on severity of fire)

Sixth and Seventh Arriving Engines;

- Officer and two fire fighters shall report to the lobby with standpipe equipment and spare SCBA cylinders.

- Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Both companies shall work together to advance a hose line to the floor above the fire.

Eighth and Ninth arriving Engine Companies;

- Officer, FAO, and two (2) firefighters shall report to the lobby with standpipe equipment and spare SCBA cylinders.
- Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Both companies shall report to the Division Supervisor for relief of the initial FAT.

Tenth Arriving Engine Company;

- Shall begin to shuttle extra SCBA cylinders and equipment to the staging area two floors below the fire floor utilizing the elevator.
- Officer shall become the staging manager
- If elevators are not in-service shall establish stairwell support.

Fourth Arriving Truck;

- Officer, FAO, and two (2) firefighters shall report to the lobby with standpipe equipment and spare SCBA cylinders.
- Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Shall proceed to the top floor of the structure and conduct search and rescue. (Do not take the elevator past the fire floor)

- Shall proceed downward as floors are cleared.
- Shall advise command or division/group supervisor of conditions found and location changes.

Fifth Arriving Truck Company;

- Officer, FAO, and two (2) firefighters shall report to the lobby with standpipe equipment and spare SCBA cylinders.
- Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Shall perform ventilation as needed and set up positive pressure ventilation of the stairwells.

Sixth Arriving Truck Company;

- Officer, FAO, and two (2) firefighters shall report to the lobby with standpipe equipment and spare SCBA cylinders.
- Spare SCBA cylinders shall be carried to two floors below the fire floor and staged.
- Report to forward Division Supervisor for relief of first arriving truck.

BLS Transport Unit;

- Shall report to the EMS Group Supervisor

G. High-Rise Elevator Procedures

1. Never use an elevator for fires below the eighth floor, use stairs.
2. Never take an elevator to the fire floor.

3. Never pass the fire floor, use stairs.

4. Don't return in an up elevator except on Fire Department service.

5. Place all elevators in hoistway on Fire Department service.

6. Activate stop switch when escaping.

7. Wear complete PPE and bring forcible entry tools and S.C.B.A.'s

8. Do not overcrowd elevator.

9. Use elevators whose hoistway terminates below fire floor whenever possible.

10. Use elevator in another area of building away from the fire if possible, preferably in an area separated by firewalls and fire doors.

11. Never take the word of building occupants as to the fire floor. Make every attempt to determine exact fire location before ascending. This can be accomplished by:

    Counting floors from the exterior (there may be a mezzanine or no 13th floor) or, opening the top escape door and looking up the elevator shaft.

12. The elevator shall be stopped at an intermediate floor, to check floor layout (stair locations, etc.) and verify that the elevator can be stopped.

13. Exit the elevator at least two floors below the reported fire floor or two floors below the lowest level of fire alarm on the fire alarm panel.

H. Standpipe Procedures for High-Rise Structures

1. Standpipe equipment shall include:
   a. 150’ of 2.5” lightweight standpipe hose
   b. Vindicator Heavy Attack Nozzle
   c. 60° Elbow
   d. In-line pressure gauge
   e. Spare valve wheel
   f. 18” Pipe wrench
   g. Wood door wedges
   h. 1 set lightweight spanners
   i. 1.5” smooth bore tip

(The Vindicator and the smooth bore tips are the only nozzles to be used when operating from a standpipe system)

2. The initial standpipe connection shall be made to the outlet one floor below the fire floor and stretched up the stairs to the fire floor.
3. The standpipe shall be flushed prior to connecting the hose to remove debris.
4. The hose shall be stretched into position using two engine companies.
5. The nozzle fire fighter and the back-up firefighter will advance the hose line
6. The Company Officer should be in the third position to get an overview of the conditions on the fire floor.

7. The additional fire fighters should be located at friction points along the hose line assisting with its advance. (Doors and corners)
8. One firefighter shall remain at the standpipe valve.

I. High-Rise Building Fire Responsibilities and Definitions

BASE (Exterior)

Base for High Rise fires identifies a location where support equipment and personnel are kept on the exterior of the building. The reason for this distinction is that the Staging Area is moved inside the structure in a High Rise fire. Unless there is a possibility of moving to an exterior operation, or the fire is involving other structures, it would be unusual to amass a large force outside at a High Rise fire.

STAGING (Interior) or REHAB

In a high-rise situation, most of the reserve force is moved through the lobby, and then to the interior staging area. This area is normally two or more floors below the fire. A rehabilitation area may be set up at the staging area, or on another floor. The intent here is to have a reserve force close to the fire floor for replacement of operating companies.

The duties of the Interior Staging Area Officer are enumerated as follows:

1. Record companies in staging and rehabilitation.
2. Request additional reserves.
3. Maintain a minimum reserve of Engine and Ladder companies as determined by Command or The Division Commander. It may be necessary to maintain three firefighters for each interior position.
4. Maintain an adequate supply of air cylinders.

5. Supply first aid equipment and medical services for units involved in rescue and suppression.

Supply special equipment (and not so special equipment, hose, nozzles, adaptors).

STAIRWAY SUPPORT

Moving equipment up stairways is a necessity in high-rise fires. Elevators may become unsafe to use, damaged by the fire, or electrical power to the elevator may be disrupted. Moving supplies and manpower up 10, 20, 30 or more stories is an arduous task.

A method has been developed for moving supplies to the fire area, in the absence of, or limited, elevator availability, by placing a firefighter on every other floor. Using this method, firefighters ascend two stories with air cylinders and other equipment, handling it off to the next firefighter. This firefighter then descends two stories, empty handed, providing a period of rest. During extended operations, involving many companies in rescue and suppression activities, it may be necessary to place two firefighters on every floor, or even move air cylinders down for refill.

The minimum manpower requirement for Stairway Support is one firefighter for every 2 stories.

Lobby Control

The third arriving engine company should be assigned to Lobby Control regardless of whether the elevators are operating or not. The duties of Lobby Control are:

1. Control, operate, and account for elevators.

2. Provide Accountability until the arrival of the third District Chief

3. Locate all interior stairs.

4. Direct incoming companies to the proper elevator or stairway.

5. Consult with the building engineer.

6. Shut down the HVAC system

Fire Attack Team (FAT)

1. Shall be formed by the first and second arriving engine companies, first arriving truck company and first arriving squad company.

2. Shall assemble in the lobby and ascend to the fire floor as a task force

3. Shall initiate fire attack on fire floor, primary search of fire floor and primary search and continual search of the fire attack stairwell.

4. Shall confirm the fire floor.

5. Shall determine the fire attack and evacuation stairwell

Division/Group Supervisor

1. Shall be assigned to a forward position to supervise fire companies operating on floors of the structure.

2. Second arriving District Chief shall assume a Division Supervisor position assuming command of the fire floor.

3. Division radio designation shall be “Division + floor number” of responsibility. Example – Second arriving District Chief proceeds to the twelfth floor which is the

fire floor. The second arriving District Chief becomes Division 12 and is responsible for the actions occurring within the twelfth floor, the fire attack stairwell ascent team, and the RAT.

4. There may be several division supervisors assigned depending on the magnitude of the incident.

5. Group Supervisors will be responsible for functional areas with the fire operations. Examples may include Search and Rescue Group, Evacuation Group, and Stairwell Support Group.

J. High-Rise Fire Information

Heat of the fire

The intensity and size of the fire will determine how much combustion gases are heated, and how high they will rise inside the building. In lower structures, there is generally enough heat energy to cause the heated fire gases to rise to the highest level in the structure. In high-rise buildings, the smoke and toxic gases will tend to rise until they reach temperature equilibrium, then they will stratify. It is not unusual to have heavy smoke on a mid-level floor, and smoke free floors above. This stratification can endanger occupants who enter a smoke free stairway, discovering smoke several stories below. Many times, doors leading back into a floor area are locked, forcing the fleeing occupant to wait it out in the stairway or proceed through the smoke.

Stack Effect

On a cold day, the stack effect will be positive, or cause the products of combustion to rise in the building. Tightness of the structure has much to do with stack effect. The

unpredictable behavior of smoke within a High Rise is due, in large part, to stack effect. In some buildings, the stack effect is so great that it interferes with the proper operation of the HVAC. The colder it is outside, and the warmer inside, the greater the stack effect. Conversely, the stack effect can be negative on a warm day, within air-conditioned building. Actually, the heat of the fire and stack effect is interdependent. On a cold day, the chances of smoke stratification are less than on a warm day.

Wind

There is a point within a high-rise structure of sufficient height, called the Neutral Pressure Plane. Below the Neutral Pressure Plane (NPP), air is moving into the building, at the NPP, forces are neutral (air is not moving in or out) and above the NPP, air moves out of the building. The heat of the fire and stack effect affects the NPP. Wind also plays a major role. Ground level winds are not always a good indication of wind direction and speed high above the ground. Downtown areas of large cities, containing large numbers of High Rise buildings, are like giant canyons. Wind entering the high-rise canyon is redirected and becomes very turbulent. This gustiness also prevails high above the ground, but possibly in another direction at a higher velocity. Wind passing over a roof opening has a pulling effect. In addition, the wind will push smoke back into the budding on the leeward side, and tend to help on the windward side. Therefore, the wind will effect ventilation in three ways, moving the NPP, pulling smoke through a roof opening, and pushing or pulling smoke from a window. In reality, it is impossible to predict the wind factor accurately. Wind direction and velocity can change dramatically, even when atmospheric conditions are not changing significantly.

Search and Rescue

The Incident Commander must obtain the building pre-plan and determine if the building will conduct a full or partial evacuation of the building. The Incident Commander will rely on reports from the Division Supervisor on the fire floor regarding the necessity of a systematic full building evacuation. Many high-rise buildings within Cincinnati only conduct partial evacuations.

Search efforts must be systematic and include a complete primary search of the fire floor and floors above the fire. As search and rescue team proceed with a systematic search, they must provide status reports to their division commander and mark areas searched using the chalk marking system as described in 203.01G. Search teams must utilize the wide area search rope secured in the stairwell to provide a lifeline to safety. The tenability of floors above the fire must be assessed if the building has not fully evacuated.

Occupants may display "convergence cluster" behavior by gathering in certain rooms, thought to be safe and for the feeling of safety gained when others are present. Searching firefighters may not find anyone in several rooms or on an entire floor area, while one room may contain far more victims than anticipated.

Helicopter rescues are extremely dangerous and in most cases unnecessary. Few cases warrant the use of a helicopter in removing occupants from a roof. There is no agreement in place for helicopter rescues.

Fire Control

In a high-rise building, confining and extinguishing the fire will do more to save lives than any other single factor. Once the fire is extinguished, the toxic products of

combustion are no longer being produced, and the whole operation becomes more manageable.

THE PRIMARY RESCUE TACTIC IS A WELL-PLACED, AGGRESSIVE INTERIOR ATTACK.

Fire fighters conducting fire attack operations shall remain in contact with the hose line at all times. The hose line shall serve as a lifeline to the safety of the stairwell.