Leading Community Risk Reduction

High Rise Firefighting Strategies for the Durham Fire Department

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Certification Statement

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

Signed: _________________________________
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Abstract

The problem addressed was that the Durham Fire Department has no high rise procedure in place to guide firefighters. The purpose was to examine how firefighters may formalize and implement strategy and tactics during a high rise fire. Using action research, these questions were addressed:

What are accepted methods of rescue, evacuation, ventilation, and attack?
What priorities do similar departments use to implement procedure?
How can resources be deployed for safe operations?
How can the procedure be evaluated for effectiveness?

The author utilized textbooks, library and on-line searches, interviews, and a questionnaire to provide answers. The results showed a need for a procedure designed to accomplish fireground objectives. The author recommended procedural changes and continuing training to address the issues.
Introduction

Fighting and suppressing fires in high rise buildings are some of the most difficult operations in which a fire department can engage (O’Hagan, 1977). Without a clear plan for all department members to support, the likelihood of injuries and deaths to firefighters and civilians increases. This is a problem because a fire department is charged with the safe mitigation of natural and man-made emergencies. The research problem is that the Durham Fire Department has no high rise firefighting policy in place to guide its firefighters during emergency incidents involving fires in high rise structures. The purpose of the research is to examine how Durham Fire Department's firefighters may formalize and implement strategy and tactics during a high rise fire incident. The research questions are as follows.

What are generally accepted methods of rescue, evacuation, ventilation, and fire attack for a high rise fire situation?

What strategic and tactical priorities and ordering do fire departments of similar size to the Durham Fire Department typically use implement a standard operating policy during a high rise fire situation?

How can the Durham Fire Department effectively deploy its resources to provide for the safety of occupants and firefighters involved in a high rise fire?

Once implemented, how can the Durham Fire Department evaluate the effectiveness of the high rise firefighting policy?

The research method used is the action research method.
By learning more about the high rise problem, the Durham Fire Department can better prepare and deploy its resources to safely and effectively mitigate high rise fires that occur within the city limits of Durham.

Background and Significance

The Durham Fire Department is an organization of 301 full time employees within four divisions, Suppression, Special Operations, Prevention, and Administration. The department provides expanded services including fire suppression, emergency medical services at the Emergency Medical Technician – Intermediate level, hazardous materials response, technical rescue, fire prevention, and public education. The Suppression Division consists of fifteen engine companies, four ladder companies, three squad units, and various other units all under the daily supervision of three battalion chiefs. The city of Durham is comprised of approximately 206,000 people within 100 square miles. The fire department’s operating budget is approximately $19.4 million in fiscal year 2006-2007. Call volume for calendar year 2006 consisted of 16,160 calls for service, including 6,750 fire calls and 9,410 medical calls. The city includes many different types of structures including numerous residential and commercial high rise buildings.

Within the previous 24 months, the Durham Fire Department has experienced four serious greater alarm fires and a multitude of smaller fires within high rise structures. The four serious fires included two fires in occupied housing facilities for the elderly, one fire in a medical building on the campus of Duke University, and one in a mixed use high rise
that occurred during the writing of this paper. There was one civilian fatality as a result of these fires. During the critiques of these fires, there were several common occurrences noted by the fire department’s command staff. In three of the four fires, the primary engine company bypassed the fire department connection; the task of connecting to the fire department connection was left to a later arriving engine company. Also, in three of the four fires firefighters used the building’s elevators without placing the elevators in firefighter service mode. The command officers were overwhelmed at the volume and pace which information flowed to the command post and felt they could not effectively coordinate the fire attack and rescue efforts. The Durham Fire Department does not have a standard operating guideline for handling high rise fires; the department does have a procedural draft from 1996 that was never adopted by the department. As population and population density increase in the City of Durham, the fire department will find itself unprepared to safely handle high rise fires if a formalized plan is not adopted for high rise firefighting operations. By developing guidelines for its firefighters, the Durham Fire Department will provide the community with a comprehensive plan that addresses multiple hazards within the community; this will provide a proactive approach for the fire department to provide for the safety of citizens and firefighters.

The research will include an investigation of the policies and procedures currently used by other fire departments to identify common practices as they relate to fire department activities in high rise structures. These data may suggest initiatives that could be of use to the Durham Fire Department.
When one attempts to study the high rise fire problem, it is useful to begin with the definition of a high rise structure. There are numerous definitions in use for high rise structures. One definition is that the building is 75’ in height with a standpipe and or sprinkler system (Avillo, 2002). Vincent Dunn (lecture, April 30, 1998), retired Deputy Chief of the Fire Department of New York, simplifies this definition by stating a high rise is any structure above 75’. O’Hagan (1977, p. 1) uses a more detailed definition in his book “High Rise Fire & Life Safety”; the components of his definition are a building that lacks viable exterior access, a structure in which firefighters must place almost complete reliance on the building systems currently in place. Additionally, his definition encompasses all buildings higher than 100’ and taller than a standard aerial ladder. Yet another definition is any building in which the building is higher than the ground equipment the fire department has available (Klaene and Sanders, 2000). E. Reid (personal communication, February 28, 2007), the Assistant Fire Marshal in Durham Fire Department’s Fire Prevention Division said that the Durham Fire Department defines a high rise structure as any structure which is 70’ or higher from the lowest point of fire department access.

What are generally accepted methods of rescue, evacuation, ventilation, and fire attack for a high rise fire situation?
Regarding rescue and evacuation, Avillo (2002, p. 253) states that effective control of the occupants will be the deciding factor as to whether the incident will or will not progress smoothly for the fire department. Further, he states that how the occupants react is directly related to the fire safety education they receive prior to the emergency event. Norman (1998), Avillo (2002), and McGrail (2007) point to two choices when evaluating rescue within a high rise structure; these two options are evacuation or defend-in-place. Evacuation of the fire floor and the floor above the fire are advisable when there is any fire past the incipient stage (Avillo, 2002). Additionally, the fire department must have a systematic search order in place to evacuate occupants. The suggested order for this search is, in priority order, the fire floor in close proximity to the fire, the floor above in close proximity to the fire, the top floor, and all floors between the fire floor and the top floor (Norman, 1998). Norman (1998) points to the fact that a distinction needs to be made between those occupants closest to the fire and those most severely exposed to the fire and products of combustion. The evacuation of the most severely exposed occupants is the rescue priority. The other recognized option regarding rescue is to “defend in place.” T. Van Buskirk (lecture, August 17, 2006), in a lecture given at the Chicago Fire Department’s 2006 Life Safety Conference, Large Scale Incident Evacuations, indicates that the defend in place option is to essentially use the building itself as a means of protection. He points to a change in occupant behavior when comparing evacuation and defend in place actions before and after the terrorist events of September 11, 2001. He indicates that, before September 11, occupants were prone to heed the fire department’s advice as to whether to evacuate or defend in place. After September 11, building occupants desire to evacuate the building during an emergency, even if the fire
department recommends defend in place action. In many cases, workers are not being informed of the defend in place option regarding high rise rescue procedures (Occupational Safety and Health Administration [OSHA], 2003). Buskirk’s information is echoed by V. Dunn (1995) when he states that the defend in place option is dependent on two factors, the ability of the building to stop the spread of smoke and fire remote of the original fire area and the willingness of the occupants to obey the fire department order to not evacuate the building. He further states that during the first World Trade Center bombing on February 26, 1993 there were 50,000 occupants, 25,000 from each of the two towers, who self-evacuated because either the buildings’ communications systems were damaged or the fire department’s communication systems would not function within the buildings. The lesson for the Fire Department of New York (FDNY) was that the defend in place option does not exist.

When attempting to decide whether to evacuate or defend in place, it is advisable to consider the amount of smoke entering the stairway. If smoke is in the stairway, the defend in place option may be the best choice. The occupants may be in greater danger should they attempt to exit the building by traveling through smoke. Further, the decision to defend in place is advisable if there is built in fire protection to aid in the control of the fire. If occupants are left in place, a greater amount of resources can be directed toward extinguishment efforts (Clark, 1991).

Choosing the defend in place option for occupant rescue is dependent upon the fire department’s ability to control the fire; if the fire is not extinguished in a timely fashion
or exceeds the fire department’s ability to contain, then the occupant load inside the structure becomes a liability that needs to be quickly addressed (Klaene and Saunders, 2000).

Ventilation during a high rise fire will differ from normal ventilation procedures used at one and two story dwellings (O’Hagan, 1977). Most high rise buildings are fire resistive construction which means that, although there is a decreased likelihood of building collapse, the design of the building allows heat to build up rapidly within the structure (Brannigan, 1992). Additionally, since there is an increased likelihood that a fire in a high rise structure will be beyond the reach of fire department aerial apparatus, the ventilation of the structure opposite the hoseline advance will be difficult at best and may prove to be impossible (Avillo, 2002).

The movement of air within high rise structures can generally be broken into three categories of interest to fire department personnel. First, there is the natural air movement both inside and outside the building. Next is the mechanical air movement provided by heating, ventilation, and air conditioning (HVAC) systems within the structures. Lastly, there is the operational movement of air caused by firefighters during ventilation practices during a high rise fire (McGrail, 2007). The natural movement of air will affect the path that smoke takes during a high rise fire (O’Hagan, 1977). The temperature difference inside and outside high rise buildings products a situation referred to as stack effect. Although it is more pronounced within taller buildings, it is present to some degree in all high rise structures (Avillo, 2002). J. Tracy (lecture, April 17, 2007) states
that stack effect is further characterized as positive, when the draft flows upward, or negative, when the draft flows downward. When there is a strong stack effect present, fire and smoke can be drawn down a hallway toward the entrance used to gain access to the fire area, thus impeding the advance of hoselines on the fire (Mason, 2005). J.McGrath (interview, May 16, 2007), current chief of the City of Raleigh Fire Department and former Deputy Fire Commissioner of the Philadelphia Fire Department, warns of the possible contamination of the stairs as a result of smoke and heat movement in the fire area. To combat this, the vertical ventilation of the structure is a possible remedy. He cautions that firefighters need to identify which stairs in a high rise building terminate with roof access at the top prior to committing to vertical ventilation operations. At a fire at One Meridian Plaza in Philadelphia on February 23, 1991, three firefighters were killed after becoming disoriented while attempting to locate a roof access to ventilate a fire in a thirty-eight story high rise structure. The stairs the firefighters used to gain access to the upper floors of the structure terminated in a mechanical room on the thirty-eighth floor; roof access was through available in another stair (United States Fire Administration [USFA], 1992).

Ventilation in high rise structures must be coordinated through the incident commander or his designee (McGrail, 2007). There are several reasons for this. Wind speed and direction are often different when comparing higher and lower elevations, which could effect the movement of smoke, heat, and fire within the fire compartment and internal exposures (Norman, 1998). Kleane and Saunders (2000) indicate that wind gusts at higher elevations can occur in a different direction and at a different velocity that at
ground level. A high rise fire on December 18, 1998 claimed the lives of three firefighters in New York City. The fire occurred on the tenth floor of a ten story residential high rise building. Since there are no surviving witnesses to the events that lead to the deaths, investigators surmise the firefighters opened the door to a fully involved apartment fire, which allowed a wind driven fire to quickly enter the hallway and engulf the firefighters, who died from a rapid rise in core body temperature. It is estimated that wind speed at the tenth floor was fifteen miles per hour, gusting to twenty-six miles per hour (National Institute of Occupational Safety and Health [NIOSH], 1999). O’Hagan (1977) recommends that for a fire in a residential high rise, the incident commander dispatch a team to gauge wind speed and condition from the floor below the fire. This location will give the incident commander accurate information regarding the effect of wind on any ventilation effort involving the fire compartment. If the wind is blowing into the fire building, it is recommended that fire crews not horizontally ventilate the structure since this action could greatly exacerbate fire growth and spread (LaFemina, 2007).

A byproduct of ventilation operations is the danger to personnel operating at ground level. Broken glass, either plate or tempered, creates a serious hazard to those below. The glass can travel great distances and injure those operating in a remote location (Klaene and Saunders, 2000). The glass also poses the possibility of severing hoselines used to supply the sprinkler and standpipe systems (USFA, 1992). For this reason, it is recommended that access around the building be controlled within a radius of 200 feet in all directions (McGrath, personal interview, May 16, 2007).
Klaene and Saunders (2000) recommend two methods by which to ventilate a high rise structure. The first method is to reverse the heating, ventilation, and air conditioning (HVAC) system. This is beneficial because it will work in high rise buildings with sealed windows. The second method is to open, not break, windows. Both methods afford the opportunity to reverse the processes if the ventilation does not provide the desired results. J. Tracy (lecture, April 17, 2007) echoes the use of the HVAC system for ventilation efforts. He indicates that the system can either be reversed for ventilation or the desired zones can be placed in “dump” mode for a form of natural ventilation. Further, firefighters can be sent to the top of the stairway to open the scuttle or bulkhead to the roof. This action also has the ability to be reversed should the ventilation not provide the desired results (McGrail, 2007).

Fire attack in a high rise structure poses many challenges that differ from one and two residential structures, which is where most of America’s fires are located. There are differences posed by the construction of high rise structures; most, if not all, firefighting efforts are undertaken solely in the interior of the building. If a fire is located above the reach of outside streams and aerial apparatus, the possibility of outside means to combat the fire and rescue occupants is nullified (McGrail, 2007).

V. Dunn (1996) reports that 95% of all high rise fires are extinguished by the first attack team and, more importantly, 95% of lives are saved by the first attack team extinguishing the fire. He states that the most critical piece of information affecting the fire attack is to
determine the location of the fire. Once determined, Dunn recommends the next fire
attack decision to be which stairwell to use for fire attack and which to use for
evacuation. Other important considerations include the verification of the fire’s size and
whether it can be contained by one hoseline, supplying of sprinkler and standpipe
systems, and the verification that water is being discharged on the fire. He points out that
with so many concurrent activities taking place at a high rise fire, it is easy to overlook
and forget to periodically check on the status of the fire attack.

J. Smith (1988) agrees that determining the location of the fire is the most important
consideration regarding fire attack; however, he states that the next consideration should
be confinement of the fire. The size of the fire will determine the type of fire attack used,
the number of hoselines required. If the fire is small, he states that a frontal attack can be
used. If the fire is larger in size, a flanking attack may be necessary. If the high rise
building is in a center core constructed building, he cautions that the fire attack may
cause the fire to wrap around the core and be pushed on attack teams from the rear. He
further cautions that should fire start or extend into the core of the building, fire extension
may occur in the poke-through holes that allow utilities to pass from floor to floor.
Another method of fire extension that should be guarded against is fire spread at the
connection joining the building’s steel frame and the exterior windows (McGrail, 2007).
To deal with the problem of fire spread from floor to floor, J. McGrath (interview, May
16, 2007) states that an option is for fire crews to access the floor above the fire and
aggressively soak the floor with water from a hoseline. Although this creates water
damage, it may prevent fire spread, which is the greater problem.
When attempting to reach the fire area, firefighters should take the stairs if the fire is located on a lower floor of the building (Dunn, 1996). T. Brennan (1989) suggests that firefighters use the stairs if the fire is located on the tenth floor or below. Further, he states that the stairs should always be used if the elevator cannot be controlled by firefighters. D. McGrail (2007) echoes the use of the stairs if the fire is located on a lower floor; however, he recommends that firefighters walk up the stairs if the fire is located on the seventh floor of below.

Another consideration regarding fire attack is the hose and nozzle combination used to connect to the standpipe system and suppress the fire. There are three types of standpipes available to fire departments (National Fire Protection Association [NFPA], 2007). A Class I System provides two and one-half inch hose connections and is primarily designed for use by a fire department and others trained in the handling of heavy fire streams. A Class II System is equipped with one and one-half inch connections while a Class III System is equipped with two and one-half inch and one and one-half inch connections. A pressure regulating device is required if the pressure encountered at the hose outlet exceeds 100 pounds per square inch (psi). This device is designed to reduce residual pressure to 100 psi at the hose outlet. When the pressure at the hose outlet exceeds 175 psi, a pressure restricting device is required to reduce residual pressure to 100 psi at the hose outlet. Further, the pressure restricting device cannot be located more than seven feet six inches above floor level.
Most fire departments use either one and one-half inch (1 ½”), one and three quarter inch (1 ¾”), or two and one half inch (2 ½”) hoses for fire attack in a high rise structure. Additionally, either a fog or smooth bore nozzle is used in conjunction with the hose. The fire service has tended to gravitate to two basic hose and nozzle combinations for high rise fire attack; these are the 1 ¾” hose with fog nozzle and the 2 ½” hose with smooth bore nozzle. There are benefits and hindrances to each, including the gallons per minute (gpm) delivered by the handline, the maneuverability of the handline, the nozzle reaction experienced, and nozzle operating pressure (McGrail, 2007).

D. McGrail (2007) states the most important factor in selecting a handline and nozzle combination for fire attack is the need for there to be sufficient gpm to absorb the British Thermal Units (Btu’s) being produced by the fire. He reports that 175 gpm is the maximum flow for a 1 ¾” handline and the maximum flow for a 2 ½” handline is 250 gpm. The fire environment has changed significantly in the last twenty years, resulting in firefighters experiencing more Btu’s than in year’s past. This change is primarily attributed to the use of plastics in building components and furnishings. Previously, firefighters were mainly exposed to wooden components, which average 8,000 Btu’s per pound. In today’s fire environment, plastics have replaced wood in many uses; plastics average 20,000 Btu’s per pound (Fredericks, 2000).

J. Tracy (lecture, April 17, 2007) states that the maximum flow for a 2½” handline is 326 gpm. This size handline, with the large amount of gpm available, is the recommended handline when standpipe operations are employed. There are several
reasons for this. Although one fifty foot section of 2 ½” hose charged with water can weigh 106 pounds, as compared to the same length of 1 ¾” hose weighing 52 pounds, its benefits outweigh the negatives. The 2 ½” handline provides high volume flow between 250 to 300 gpm, has long stream reach, low friction loss when equipped with a smoothbore nozzle and 1 1/8” tip, little premature water vaporization, and is easily reduced to a smaller handline after knockdown of the fire (Fredericks, 1996).

What strategic and tactical priorities and ordering do fire departments of similar size to the Durham Fire Department typically use implement a standard operating policy during a high rise fire situation?

During a fire in a high rise structure, a standard plan of operation is critical for responding firefighters and occupants (J. Norman, lecture February 26, 2001). Generally accepted strategic and tactical priorities at a high rise fire include ensuring the life safety of occupants and firefighters, location and confinement of the fire, and the extinguishment of the fire (McGrail, 2007). How these priorities are accomplished depends greatly on the resources available to the responding department (J. Tracy, lecture April 17, 2007).

First arriving companies in the Worcester Fire Department in Massachusetts are charged with the investigation of the reported fire, the removal of exposed occupants to an area out of danger either through evacuation or defend in place strategies, the initiation of fire attack, the initiation of any immediate support activities designed to enhance the safety of
firefighters and occupants, and to set up Base, Staging, and Lobby Control, in addition to fire attack. If a fire is evident while responding or once on-scene, a second alarm is immediately transmitted to bring additional resources to the scene.

Tactically, Worcester firefighters are charged with immediately recalling the elevators to the lobby and making sure all elevators return to the lobby. As the first unit ascends to the reported fire floor, it must carry a high rise pack for fire attack. If the fire is reported on the fifth floor or below, firefighters are required to use the stairs to reach the upper floors. If the fire is above the fifth floor, elevators may be used. Additional responsibilities for this unit are to ascertain the correct location of the fire, determine if any rescue problem exists, designate both attack and evacuation stairways, and initiate fire attack. Fire attack is initially mounted with one hundred feet of 1 ¾” hose with a breakaway nozzle, which may be used as a fog nozzle or smoothbore nozzle. Subsequent handlines are 2 ½” handlines with smoothbore nozzles delivering 250 gpm. The first two engine companies are responsible for placing one handline into operation; the third engine company provides a second handline. The fourth engine company supplies the sprinkler and standpipe systems. The first ladder company on-scene reports to the fire floor for search while the second ladder company reports to a staging location two floors below the reported fire floor. The rescue company is charged with clearing the attack stairwell above the fire floor and then to search all floors above the fire floor. Regarding ventilation, the breaking of windows is generally prohibited. The chief officer may confer with the building engineer to use the HVAC to accomplish ventilation.
Regarding Command at a high rise fire, the Worcester Fire Department places one chief in the lobby of the building for Command and designates the first arriving company officer as the Operations officer on the fire floor. (Worcester Fire Department [WFD], 2005).

The Charlotte Fire Department establishes fireground strategies and priorities; however, these are listed as a group and not placed in priority order. Strategic priorities include rescue and evacuation, confirmation of the fire floor, water supply, checking for upward fire extension, lobby control, sector assignments, and additional alarms. The first arriving engine company establishes Command, determines the location of the fire, and ascends to two floors below the fire; the method of ascension is not specified in the department’s procedure. For fire attack, this engine company utilizes one hundred feet of 1 ¾” hose with a nozzle of unspecified type, connects to the standpipe connection two floors below the fire floor, and initiates fire attack. This attack is augmented by a ladder company whose assignment it is to force entry for the engine company as well as search of the fire floor. All additional assignments are the responsibility of the Incident Commander to assign through the use of sector officers, such as Lobby Control, Staging, and Operations. Regarding ventilation, the Charlotte Fire Department recommends positive pressure ventilation at the base of the stairs in conjunction with an open stair hatch (Charlotte Fire Department [CFD], 2001).

The Raleigh Fire Department does not list strategic and tactical priorities within its standard operating procedure for high rise operations. It does state, however, that the first
arriving battalion chief will ascend with the first two engine companies to a location two floors below the reported fire floor. From that location, the battalion chief establishes the Operations Sector; this is later augmented by a Division Chief establishing Command in the lobby of the structure. From a location two floors below the fire, the first two engine companies form one attack team and initiate the fire attack utilizing either one hundred feet of 1 ¾” hose with a smoothbore nozzle or one hundred feet of 2 ½” hose with a smoothbore nozzle; the decision regarding hose size is left to the engine officer and the Operations Sector. While ascending to the reported fire, firefighters are prohibited from using the elevators if the fire is located on the seventh floor or below. Additionally, the first ladder company establishes Lobby Control and every fifth engine company on each alarm forms a rapid intervention team (Raleigh Fire Department [RFD], 2006).

The Chapel Hill Fire Department in Chapel Hill, NC mandates the first arriving engine company to report to the fire floor with a high rise kit, forcible entry tools, and a utility rope. The high rise kit consists of one hundred feet of 1 ¾” hose with a constant gallonage fog nozzle, a six foot section of 2 ½” hose connected to a gated wye, door chocks, elevator keys, and spanner wrenches (C. Mellon, interview, June 26, 2007). The second due engine company reports to and supplies the sprinkler and standpipe systems; if no sprinkler and standpipe systems are available, this engine stands by at a fire hydrant and awaits orders from Command. The ladder company positions the apparatus to provide access to the fire floor and/or the floors above the fire, as indicated by fire conditions. The first arriving chief officer established Command close to the entrance to the building on the exterior; the second arriving chief, after conferring with Command,
proceeds to the fire floor to supervise fire operations. All other units stage and await orders from Command.

General operations for the Chapel Hill Fire Department consist of the following. Elevator use at high rise fires is prohibited except in those instances where the elevators are controlled through the use of fire department key controls. At no time are elevators allowed to be used to evacuate occupants. All firefighters are required to wear full personal protective equipment in and around the structure and shall take one additional self contained breathing apparatus bottle to the staging area; staging for the fire attack will be at least one floor below the reported fire floor. The order of evacuation is recommended as, in priority order, the fire floor, the floor above the fire, the top floor of the structure, and other floors working downward from the top of the structure.

Regarding ventilation, it is recommended that a building engineer be sought out and kept at the command post for consultation. Additionally, positive pressure ventilation may be used to control or channel smoke within the structure (Chapel Hill Fire Department [CHFD], 1994).

In Lewisville, Texas, the Lewisville Fire Department defines a high rise structure as any building whose height is five stories or taller. The standard operating procedure states that logistical issues should be at the forefront of all responders’ thought processes and that the following should be considered: the control of elevators, stairways, HVAC and other utilities, the location of the rapid intervention team, and special command considerations. A representative from the building should be sought out and directed to
the command post to assist with fire department operations. The building elevator may be used if its use will enhance the safety and efficiency of the fire department’s operation. Should the elevator be used, Command must be informed of the elevator being used and its destination. One firefighter shall remain in the elevator as its operator and shall be equipped with a portable radio, handlight, and basic forcible entry tools. Responding companies are required to designate an attack stairway and evacuation stairway; the responsibility for these designations falls to the most senior fire officer within the building. These designations are reported to Command.

Regarding command functions, it is the responsibility of the incident commander to expand the command structure as needed. The command positions employed may include a lobby division, floor divisions, and functional divisions such as evacuation and ventilation. The incident commander is required to call for an additional alarm of fire companies for each handline placed into operation (Lewisville Fire Department [LFD], 2003).

The high rise kit for the Lewisville Fire Department consists of 150’ of 1 ¾” hose equipped with a smoothbore, “Vindicator” nozzle, 50’ of 2 ½” hose with a gated wye, door chocks and spanner wrenches (R. Lasky, interview, June 22, 2007).

How can the Durham Fire Department effectively deploy its resources to provide for the safety of occupants and firefighters involved in a high rise fire?
There are many facets of high rise firefighting that the fire department cannot control, such as where the fire occurs within the building and the exposures developed as a result of the fire. What a fire department can do is deploy its resources in a proactive manner and prepare for a worst case scenario regarding the total fire problem. Although prepared, the incident commander may have too many tasks to accomplish initially without the resources to commit. Most departments have to prioritize tasks and match resources as they become available (McGrail, 2007). According to Clark (1991), most departments mistakenly prepare for the usual and not for the potential. Further, he states that determining strategy and resource deployment are not solely dependent on water, apparatus, and personnel needs. Rather, strategy and resource deployment must consider how to effectively use firefighters to achieve the desired outcome of the emergency in the desired manner.

The first priority for the fire department is to stop the fire; while other resource deployment is important, nothing eclipses the fire attack and the extinguishment of the fire. For fire departments hampered with limited staffing, mounting a fire attack means uniting two engine companies to advance one handline. This tactic will begin by hooking the attack hose to the standpipe outlet on the floor below the fire. Once the hose is ready to advance on the fire, firefighters should be placed at friction points on the floor below and in the stairway. The job of these firefighters is to push forward the hoseline at each turn to the attack team advancing on the fire floor. This attack team must consist of at least two firefighters; however, three firefighters and an officer is preferable. Most of the available resources should be channeled to getting the first handline into operation prior
to deploying a second handline. The strategic plan for moving a handline at a high rise fire involves six engine companies per handline; this accounts for two engine companies on the attack handline, two in staging, and two in rehab. It is recommended that a chief in charge of a fire in a high rise building summon at least six four-person engine companies to a high rise fire in the first fifteen minutes. Additionally, resource deployment includes one firefighter to connect to the fire department connection(s) and supply the sprinkler and standpipe connections (McGrail, 2007).

When considering ladder company operations at a high rise fire, the responsibilities generally include laddering, overhaul, ventilation, forcible entry, rescue, salvage, and utility control (Norman, 1998). Laddering becomes a priority should the fire be located on the lower floor of a building. Deploying ladder company resources for overhaul occurs in two scenarios, pre-control and post-control overhaul. Resources deployed for pre-control overhaul are exposing the structure prior to the fire being extinguished by the attack team. This is valuable when attempting to ascertain if the fire is burning undetected overhead in the plenum, which usually acts as an air return for the HVAC. Ladder companies must initially be committed to the fire floor, floor above the fire, and top floor for forcible entry, search, and rescue operations. Generally, occupants three floor above the fire can be protected in place (McGrail, 2007).

When deploying command officers in a high rise structure, there should be a lower command post in the lobby, an upper command post two floors below the fire, and a staging area one floor below the upper command post (Clark, 1991). Additionally, a
command officer may be needed as a search and rescue coordinator above the fire floor.

If this need is determined, there should one chief officer and one search team for every five floors above the fire floor (Norman, 1998).

Once implemented, how can the Durham Fire Department evaluate the effectiveness of the high rise firefighting policy?

The evaluation of policy strives to determine the operations and activities associated with the standard operating procedure to determine effectiveness. Evaluation is meant to determine if changes have occurred due to the implementation of the standard operating procedure and to determine if the goals of the procedure have been met. The evaluation process is on-going and should not be viewed as an end to the standard operating procedure but as a feedback tool to make necessary modifications to refine and improve departmental operations. Evaluation assesses the results of a policy and strives to determine what employee behaviors were prior to implementation, what operational problem the policy is addressing, if the policy was fully implemented or if problems were encountered prohibiting full implementation, if employee behaviors and responses changed after the implementation of the policy, whether the changes were intended, and if the policy still current and relevant. There are two types of policy review, the standard review and special evaluation. A standard review occurs at after a pre-determined period of time, while a special evaluation is a limited study designed to solve a specific problem that has been identified, such as an incident that resulted in a negative outcome for the department. The evaluation process can be divided into four steps, which are to establish
standards, measure performance, compare measured performance with standards, and analyze and act (USFA, 1999).

Once the policy is established, the initial method by which to test a procedure is through comprehensive training. Through training, the groundwork of validating the policy is designed; training further points departments in directions that require further training and development. In Columbus, OH the fire department obtained a high rise structure and used it to test their department’s standard operating procedure for high rise firefighting. Once the training was completed, the fire department had reinforced the need for additional training in several areas, including elevator use, apparatus placement, incident command, team search, accountability, high rise pack contents, multi-company team concepts, thermal imaging, occupant control, and fire control. In the case of the Columbus Fire Department, the myriad of issues identified through training caused the fire department to revisit the standard operating procedure to determine whether the procedure was flawed and contributing to less than optimal performance by firefighters. Additionally, there was an identified need for the fire department to provide continual training in all areas of high rise training (Cannell, J., Reall, J., & Bernzweig, D, 2001).

The training phase of evaluation is an on-going evaluation. The Chicago Fire Department experienced a serious high rise fire at 135 South LaSalle Street in Chicago on December 6, 2004. As a result of the fire, the Chicago Fire Department conducted post incident critiques to identify problem areas improve responses. The department identified numerous areas needing improvement, including the redeployment of command vans.
throughout the city, a Emergency Medical Services presence closer to the fire floor at high rise fires, the need of a firefighter identification system to be used when injured firefighters are moved for medical treatment, and the need to equip a helicopter with thermal imaging capabilities; this would assist with rescue as well as help to identify fire patterns (Fire Chief Magazine, 2004).

Following the identification of several high rise fires that injured or killed firefighters, the New York City Fire Department (FDNY) recognized the need to evaluate the effectiveness of its standard operating procedures as they relate to wind driven high rise fires (Norman, 2007). The department teamed with the Chicago Fire Department, the Toledo Fire Department, and the National Institute of Standards and Technology (NIST) to evaluate the effects of wind on high rise fires. In evaluating their policies, it was found that it may be possible to either remove the wind from the building or place positive pressure fans in stairwells to combat the extreme effects of wind on fire growth and spread (NIST, 2007). J. Tracy (lecture, April 17, 2007) stated it is unclear as to what changes to standard operating procedures, if any, will result from these findings.

Employee opinions need to be surveyed prior to and after policy implementation; the goal is to determine employee thoughts and views to gauge if the desired change was achieved with the policy (USFA, 1999). Younger workers, in particular, demand personal contact and want to be involved in the decision-making processes of the company (Meredith, G.E., C. D. Schewe, PhD, A. Haim, & J. Karlovich, 2002).
Many methods were utilized to gather information. The author utilized resources from his personal collection of resource materials to collect information. Additionally, computer searches utilizing Google were conducted to retrieve information from the worldwide web. The computer searches were done using the Durham Fire Department’s desktop computer assigned to Battalion 2 and the author’s personal laptop computer. Google searches were used by searching the keywords high rise, high rise fire, high rise evacuation, attack stair, evacuation stair, standpipe procedures, evaluating standard operating procedures. The author contacted Chief Bobby Halton, editor-in-chief of Fire Engineering Magazine, to obtain contact information for Battalion Chief Jerry Tracy of FDNY and for District Chief Dave McGrail of the Denver Fire Department. The latter relayed that he recently had a book on high-rise firefighting published; a search of www.amazon.com revealed that the book was available for purchase. The author purchased the book for research.

Additionally, the author attended ten hours of high rise firefighting training conducted at the Fire Department Instructor’s Conference in Indianapolis, Indiana. Eight hours of training were conducted by Battalion Chief Jerry Tracy of FDNY on April 17, 2007; an additional two hours of training were conducted by District Chief Dave McGrail of the Denver Fire Department on April 18, 2007. The author also attended a high rise firefighting seminar sponsored by the Chicago Fire Department from August 15 through August 19, 2006. An additional eight hours of high rise training via classroom instruction
was obtained by the author at the Raleigh Fire Department in Raleigh, North Carolina on February 14, 2007.

To collect data, the author sent an informational questionnaire to various fire departments throughout the United States. The departments were chosen based on size, proximal location to Durham, North Carolina, known experience with high rise firefighting procedures, and departments known to have experienced significant high rise fires resulting in the deaths of firefighters. The purpose of the questionnaire was to gauge each department’s size, available resources, previous high rise firefighting experience, whether formal standard operating procedures were developed, and if the department had experienced significant issues at high rise fires. For those departments that indicated that they had experienced significant issues, a telephone interview was used to glean additional information. Additional information gleaned from the telephone interview was the contents of each department’s high rise firefighting pack.

The author also conducted personal interviews with personnel employed by the largest municipal fire departments surrounding Durham, North Carolina. These fire departments included those in the cities of Raleigh, Cary, and Chapel Hill. The purpose of the interviews was to determine whether these organizations have addressed high rise firefighting issues and to obtain detailed information regarding resource deployment and contingency plans. Included in these interviews was an interview with John McGrath, Chief of the Raleigh Fire Department. He was chosen due to his being a retired Deputy Commissioner from the Philadelphia Fire Department. Chief McGrath was the captain of
an engine company and was present at the One Meridian Plaza fire in Philadelphia; this fire resulted in the deaths of three Philadelphia firefighters. Chief McGrath was interviewed on May 16, 2007 at the Raleigh Fire Department’s Headquarters. Chief McGrath was asked to recount his actions at One Meridian Plaza and to provide an overview of the actions undertaken by the Philadelphia Fire Department. He was asked to detail difficulties the department encountered regarding pressure reducing valves, water supply, fire attack, ventilation, and rescue. He was also asked to compare the information gained at the One Meridian Plaza fire with additional knowledge of high rise firefighting gained while in the Philadelphia Fire Department. Since he is now the Fire Chief of a much smaller organization, he was asked to compare the actions that could be undertaken by a large fire department versus a smaller fire department.

Results

The research compiled during the course of writing this paper contained sufficient information to answer the research questions set forth in the Introduction section of this paper.

What are generally accepted methods of rescue, evacuation, ventilation, and fire attack for a high rise fire situation?

Rescue of trapped occupants on a high rise structure generally fall into two categories; defend in place and evacuation (Norman, 1998). If there is a fire past the incipient stage,
it is recommended that firefighters initiate evacuation of the fire floor and the floor above the fire (Avillo, 2002). This may lead to additional evacuations, since there is a propensity of building occupants to initiate evacuation in any emergency situation involving a high rise structure. This is in response to the events that transpired on September 11, 2001; the World Trade Centers collapsed, killing many civilians and firefighters. After the first World Trade Center bombing in 1994, the FDNY expressed doubts that any defend in place strategy could be accomplished (Dunn, 1995). Based on the type of construction used in high rise buildings, the defend in place strategy is largely the preferred method of rescue (O’ Hagan, 1977).

When a high rise building is in need of total or partial evacuation, it is important to channel occupants to a stairway designated by the fire department as an evacuation stairway. This is important because another stairway will be designated as the attack stairway and will be open to the products of combustion flowing from the fire floor and contaminating the stairway (McGrail, 2007).

Ventilation in a high rise structure differs from ordinary ventilation practices undertaken at one and two story structures (O’ Hagan, 1977). Since the fire in the structure may be out of the reach of fire department aerial apparatus, the ventilation of the building opposite the hoseline advance will be difficult, if not impossible (Avillo, 2002). There are three areas of interest to fire departments when considering ventilation within a high rise building; these are the natural movement of air inside and outside the building, the movement of air by mechanical means, and the movement of air caused by firefighters...
undertaking ventilation practices during a high rise fire. Any ventilation undertaken at a high rise fire needs to be closely coordinated with the incident commander since ventilation of the building could possibly have adverse effects if the wind is blowing into the structure at the point of ventilation (McGrail, 2007). It is recommended that fire crews attempting ventilation either do so by reversing the flow of air within the HVAC system, by opening windows, or by opening the scuttle at the top of the stairs. Each of these actions can be easily reversed if the results are not what is desired (Klaene and Sanders, 2000).

Fire attack in these structures also differs from one and two story structures. Most, if not all, of the fire attack will need to occur within the interior of the building. There are many activities that need to happen at the same time; these include the determination of the fire’s size and location, the determination of the attack and evacuation stairways, whether the fire can be controlled by one handline, the supply of the sprinkler and standpipe systems, and whether water is actually being discharged on the fire. Additionally, fire crews need to determine the method by which they will ascend to the fire; their options are to use the stairs or take the elevator (Smith, 1988). If the fire is located below floors seven to ten, it is recommended that firefighters walk to the upper floors. Once firefighters are ready to attack the fire, the type of attack to be used needs to be determined; Smith (1998) reports that these options are the frontal attack and the flanking attack. The flanking attack may be necessary if the fire is located in a core constructed building since the frontal attack may allow fire and heat to wrap around the core and relocate behind the nozzle team.
As fire attack commences, firefighters will deal with different factors regarding hose and nozzle selection. Most fire departments have gravitated to using either 1 ¾” or 2 ½” hose as their attack line; each size hose is equipped with either a fog or a smoothbore nozzle. The benefits of the smaller line include better maneuverability and quicker advance, which enables firefighters to discharge water on the fire quicker. The benefit of the larger handline is its increased flow and ability to handle fires that have grown past the incipient stage. A drawback of the larger handline is its weight, which is more than double the 1 ¾” handline’s weight (Fredericks, 1996).

What strategic and tactical priorities and ordering do fire departments of similar size to the Durham Fire Department typically use implement a standard operating policy during a high rise fire situation?

Fire departments vary their responses to fires in high rise structures but strive to meet the strategic objectives of occupant and firefighter safety, location and confinement of the fire, and extinguishment of the fire.

Departments with standard operating procedures generally specify that the first engine company investigate the cause of the alarm; this engine company may be augmented with another engine company or a ladder company. The first companies on scene are responsible for the evacuation of occupants, the identification of the reported fire floor,
the transmission of additional alarms, identification of attack and evacuation stairways, and the recall of elevators to the lobby. The handline size and nozzle selection varies by department; the Worcester Fire Department in Massachusetts initially employs a 1 ¾” handline with breakaway nozzle; all subsequent handlines are 2 ¼” hose with smoothbore nozzles (WFD, 2005). The Charlotte Fire Department utilizes 1 ¾” hose with an unspecified nozzle type (CFD, 2001) while the Raleigh Fire Department allows first due officers to utilize either 1 ¾” or 2 ¼” handline, each equipped with a smoothbore nozzle, depending on the situation found on arrival (RFD, 2006).

Chief officers are responsible for the command and control of the fire. In Worcester, the first due chief remains in the lobby as the incident commander while a line officer handles operations on the fire floor (WFD, 2005). The Charlotte Fire Department tasks the initial arriving officer with establishing command; this is subsequently assumed by an arriving chief officer. Additional chief officers may staff Lobby Control, Staging, and Operations (CFD, 2001). The Raleigh Fire Department mandates the first chief officer to report to a location two floors below the reported fire to establish an Operations Division; a responding Division Chief establishes Command in the lobby of the structure (RFD, 2006).

How can the Durham Fire Department effectively deploy its resources to provide for the safety of occupants and firefighters involved in a high rise fire?
At high rise fires, there are often several actions that need to occur at the same time. Since most departments are taxed regarding responding and available personnel, departments must prioritize the order of tasks to be completed as well as the deployment of resources. A mistake often made by fire departments is to plan for the actual event rather than the potential event (McGrail, 2007).

The first and most important action undertaken by the fire department is to extinguish the fire; all other actions, while important, are driven by this priority (Smith, 1988). To accomplish this objective, it is recommended that engine companies team up to place a handline in service; the minimum personnel needed to advance a handline during fire attack is two personnel. It is much better to have three firefighters and an officer on the first handline. If needed, additional resources should be allocated to establish the first handline prior to the second handline. Firefighters are needed at friction points to help advance the hoseline. There is a need for six engine companies, each staffed with four firefighters, to advance each handline; two engine companies each are needed on the attack handline, in staging, and in rehab. An additional firefighter is needed to connect the fire department pumper to the fire department connection; this will supply the sprinkler and standpipe system with water (McGrail, 2007).

Ladder companies are generally responsible for laddering, overhaul, ventilation, forcible entry, rescue, salvage, and utility control. Resource deployment will include ladder companies to the fire floor, the floor above the fire, and the top floor for forcible entry,
search, and rescue. Additionally, they may be needed for laddering the lower floors of the building and pre-control or post-control overhaul (Norman, 1998).

Command officers at high rise fires are generally deployed in the lobby of the structure for a lower command post, two floors below the fire for an upper command post, one floor below the upward command post at a staging area, and possibly above the fire to coordinate the search and rescue activities above the fire. If this is deemed necessary, there should be one chief in charge of search and rescue activities for every five floors above the fire (Clark, 1991).

Once implemented, how can the Durham Fire Department evaluate the effectiveness of the high rise firefighting policy?

The goal of evaluation of the standard operating procedure is to determine operations and activities associated with the procedure in order to determine effectiveness. To do this, the department needs to determine what operational problem the policy was attempting to address, what employee opinions and behaviors were about the problem both before and after the implementation of policy, and whether the policy was totally implemented or if problems were encountered in the implementation phase. Additionally, employee behavior needs to be assessed to determine if behavior changed after the implantation of policy and if so, if the behavioral change was intended (USFA, 1999). Younger workers desire to provide feedback and help to determine the course of the organization (Meredith et al., 2002).
The policy needs to be examined to determine if it is still current and relevant. As the policy is examined, there may be areas that need to be modified or areas that require further training for the employees (USFA, 1999). Some examples of this, as it deals with high rise firefighting, are use of elevators, apparatus placement, incident command, search procedures, accountability, tools and equipment, team concepts, thermal imaging, occupant control, and fire control (Cannell et al., 2001).

The evaluation of policy is an on-going process and should be viewed as an integral part of the policy development process. The review of policy generally falls into two categories, the standard review and the special evaluation. A standard review can occur after a specified period of time, while the special evaluation may occur after an incident that resulted in negative consequences for either the department or the community (USFA, 1999).

The author distributed a questionnaire to assist with research (Appendix A). The questionnaire consisted of sixteen questions and was distributed via electronic mail to forty two fire departments across the United States and Canada. Departments were chosen based on size similar to Durham, North Carolina, cities in which a large number of high rise structures are known to exist, cities in which the author has knowledge that high rise fires have occurred, cities in which firefighters have died during high rise fire operations, and cities proximal to Durham, North Carolina (Appendix B). Of the forty two questionnaires sent, 14 were completed and returned. Questions one through three
solicited general information such as the respondents name and rank, the name of the fire
department represented, and the city and state represented. Question four inquired as to
the approximate population served by the fire department. Additional questions inquired
about the respondent’s total department strength, number of firefighters on duty per day,
the total number of engine and ladder companies as well as specialized units, average
staffing on engine and ladder companies, and total number of chiefs working per day.
Additionally, respondents were asked whether their departments have a high rise policy,
if the policy could be sent, if there have been any fires that reinforced certain aspects of
the high rise policy, and whether the respondents would be willing to participate in a
follow up telephone interview. Follow up phone interviews were conducted to solicit
input regarding the contents of each department’s high rise firefighting pack and any
specific lessons gleaned from high rise fires in each municipality.

The results of the survey showed of the fourteen departments responding, seven
municipalities were above 250,000 in population, three were between 150,000 and
250,000, and four had populations of less than 150,000. Total results showed that the
average number of firefighters employed is 988, while the average number of firefighters
on duty per day is 416. The average of all departments in terms of units is 48 engine
companies, 12 ladder companies, nine additional units, and 7.4 chief officers per day. The
average staffing on both engine companies and ladder companies is 3.77 personnel per
day. For high rise fires, all departments dispatched the following: mean response is 3.57
engine companies, 2 ladder companies, and 1.8 chief officers. Median response is 4
engine companies, 2 ladder companies, and 2 chief officers. The mode response is also 4 engine companies, 2 ladder companies, and 2 chief officers.

For departments with a population above 250,000, the results were as follows. These departments average 1,707 firefighters within their departments, with 416 firefighters on duty per day. These departments average 48 engine companies, 20 ladder companies, 13 chief officers per day, and average staffing of four personnel on both engine and ladder companies. The mean, median, and mode responses for high rise fires for these departments consists of four engine companies, two ladder companies, and two chief officers.

For departments with a population between 150,000 and 250,000, the results were as follows. These departments average 263 firefighters within their departments, with 62 firefighters on duty per day. These departments average nine engine companies, four ladder companies, two chief officers per day, and average staffing of four personnel on both engine and ladder companies. The mean, median, and mode responses for high rise fires for these departments consists of three engine companies, two ladder companies, and two chief officers.

For departments with a population below 150,000, the results were as follows. These departments average 164 firefighters within their departments, with 51 firefighters on duty per day. These departments average nine engine companies, two ladder companies, two chief officers per day, and average staffing of three personnel on both engine and
ladder companies. The mean response for high rise fires for these departments consists of three engine companies, one ladder company, and one chief officer. The median response is 2/3 engine companies, 1 ladder company, and one chief officer, while the mode response is 2 engine companies, one ladder company, and one chief officer.

Of all departments responding to the questionnaire, 71% have high rise firefighting policies in place for their departments. This includes 86% of departments serving a population above 250,000, 67% serving a population of 150,000 to 250,000, and 50% of departments serving a population of less than 150,000 (Appendix C).

Follow-up telephone interviews revealed that the fire departments utilized a varied equipment cache within each high rise firefighting pack. This equipment include hose in the sizes of 1 ½”, 1 ¾”, and 2 ½” and lengths ranging from 100’ to 150’. The departments also utilized a variety of firefighting nozzles, including low pressure fog nozzles, constant gallonage fog nozzles, smoothbore nozzles, and specialty nozzles. Results also varied as to whether departments included an in-line pressure gauge within the high rise packs, with the majority of the departments not equipping units with the in-line pressure gauge. Equipment that was consistent among departments interviewed includes 2 ½” spanner wrenches and door chocks or wedges in all high rise equipment packs.

The author conducted action research and developed a high rise firefighting procedure for the Durham Fire Department (Appendix D); the procedure provides a general guideline for firefighting operations within high rise buildings. The general response for a high rise
High Rise Firefighting Strategies

fire will consist of five engine companies, four ladder companies, three battalion chiefs, three squad units, one safety officer, and one mobile support unit. The procedure provides a general guideline of fire unit location, equipment needs, and strategy and tactics to initiate upon the report or discovery of a fire in a high rise building. The first two engine companies will form an attack team on the fire floor of the building; this is followed by the third and fourth engine companies forming a back-up team with a second handline. The first due ladder and squad companies will form one team and be responsible for the investigation of the alarm, the control of the elevators, the designation of attack and evacuation stairs, search, and forcible entry on the fire floor. The second ladder company will perform searches for life and fire extension on the floor above the fire, while the third due ladder company will ensure that the stairs are clear of occupants. With the exception of the first squad company, additional squad companies will report to the forward staging area and function as the rapid intervention team. The first due battalion chief will establish Command of the incident in the most advantageous location, whether inside the building at the lobby, in the fire command center, or outside the building. Upon the arrival of the second due battalion chief, the first due battalion chief will proceed to the floor below the fire and establish an Operations post; the second due battalion chief will assume Command of the incident. The third arriving battalion chief initiates accountability for the incident. Per Durham Fire Department policy, upon the arrival of the safety officer, the Safety Division shall be established.

The procedure also defines the number and type of additional units to be dispatched when additional alarm assignments are requested by the incident commander. Within the
High Rise Firefighting Strategies

The action research will be implemented in phases. To establish a baseline regarding high rise fireground operations, all Durham Fire Department Operations personnel will participate in high rise “performance readiness evaluations” in October, 2007. The positive and negative results of this training will be collected and compared to the desired outcome of the proposed high rise firefighting procedure. Any needed modifications will be made to the draft procedure. In November, 2007 Operations Division personnel will be provided with the draft procedure and will be trained in its content. Training will include the specifics regarding the fireground positions established by the procedure, the tools and equipment needed by each responding fire company, and the general responsibilities placed upon each responding company. Training will be conducted utilizing a vacant floor of the People’s Security Building in downtown Durham, or another high rise structure should the People’s Security Building prove to be unavailable; this building is an eighteen story high rise building in which the fire department has previously trained. Following input from Operations Division personnel, the procedure will again be reviewed for needed changes. The formal procedure will be implemented in January 2008 with additional training on-going into calendar year 2008. Training will include standpipe operations, large area search, and elevator use (Durham Fire Department Command Staff, meeting, June 25, 2007).
Definitions of high rise structures vary greatly, from the stipulation that a high rise be higher than 70’ from the lowest point of fire department access to more general requirements that include a building that lacks viable exterior access and a structure in which firefighters must place almost complete reliance on the building systems currently in place (O’Hagan, 1977).

There are various methods discussed regarding the rescue and evacuation of occupants, the ventilation of the fire building, and the methods of fire attack to employ. The rescue of occupants generally falls into two categories, the actual evacuation of the occupants and a defend in place strategy (Avillo, 2002). There are conflicting views as to which approach is more favorable; it is generally advisable to evacuate the fire floor if the fire has progressed past its incipient stage (Avillo, 2002). Dunn (1995) reports, however, that the New York City Fire Department has found the defend in place strategy to be non-existent as a result of the first World Trade Center bombing. During that incident, it took hours for the occupants to evacuate the structure although they were told to use a defend in place strategy. Dunn’s viewpoint is echoed by Van Buskirk (lecture, August 17, 2006) in which he states that occupants in high rise structures have abandoned the defend in place strategy of rescue due to the events in New York City on September 11, 2001. On this date, the World Trade Centers were attacked and subsequently collapsed, killing thousands of civilians and responders. Again, the occupants were originally requested to return to their workstations for a defend in place strategy. Given this information, it
appears as though the evacuation strategy is the method to adopt in a high rise firefighting situation. While it may be advisable for the occupants to remain in place during the fire department’s operations, it would be naïve to assume that occupants will not initiate an evacuation, even if it is contrary to the fire department’s request.

Should either the fire department or the occupants decide upon an evacuation strategy for the building, it is vitally important for the fire department to establish which stairway to use for the evacuation of the occupants and which stairway to use to attack the fire (Dunn, 1995).

The ventilation of a high rise will differ considerably from the normal ventilation procedures undertaken at a one or two story structure (O’Hagan, 1977). The construction of the building will generally allow for the buildup of heat and smoke within the structure (Brannigan, 1992). A problem that will be encountered by firefighters is the inability to ventilate the structure opposite the advancing hoseline, which is a general fire tactic in low rise buildings (Avillo, 2002). Regarding ventilation, fire departments are concerned with three components; these are the natural movement of air, the mechanical movement of air, and the operational movement of air. The natural movement occurs both inside and outside the building and is caused by the height of the building and temperature differences between the inside and outside the building. The mechanical movement is caused by the HVAC and the operational movement of air is caused by firefighters as they attempt to exhaust smoke and heat from the building during fireground operations (McGrail, 2007). Due to the possible adverse effect of utilizing the HVAC to ventilate the
building, McGrail (2007) recommends leaving the HVAC off unless a qualified building engineer can assist with its operation.

McGrail’s opinion is seemingly contradicted by Klaene and Saunders (2000), who state that two viable methods by which to ventilate a high rise structure are to reverse the HVAC system or to open, not break, windows. They also state that wind conditions on the upper floors of a building can differ from those found on lower floors. This was a contributing factor in the deaths of three New York City firefighters in 1998. During that fire, the windows failed in the fire apartment on the tenth floor of a ten story high rise structure (NIOSH, 1999).

J. Smith (1998) states that determining the location of the fire is one of the most important aspects of fire attack. He states that the location of the fire and its size will determine the size and number of hoselines required to extinguish the fire. V. Dunn (1996) agrees with these statements but cautions that it is easy to overlook the aspect of fire attack with the myriad of activity surrounding a high rise fire situation. Once the fire’s location is determined, he further states that the next consideration should be to determine which stairways are to be used for fire attack and evacuation.

The methods of fire attack available to firefighters are the frontal attack and the flanking attack. The frontal attack may be advantageous if the fire is small and easily extinguished; the flanking attack may be necessary if the fire is larger or is located within a center core constructed building (J. Smith, 1998). Fire units need to guard against fire
spread within the structure. A common point of fire spread is on the outside of the building, via auto-exposure (McGrail, 2007). An additional avenue of fire spread that needs to be guarded against is through poke through holes within the structure (Smith, 1998).

Most fire departments utilize either 1 ¾” or 2 ½” diameter hose for fire attack, with the hoselines having fog or smoothbore nozzles attached (Fredericks, 2000). The 1 ¾” handline offers mobility with a lower gpm than the larger 2 ½” handline; the maximum flow of an 1 ¾” handline is 175 gpm (McGrail, 2007). J. Tracy (lecture, April 17, 2007) states that the maximum flow of the 2 ½” handline is 326 gpm and that the 2 ½” handline with a smoothbore nozzle is the hose and nozzle combination preferred for standpipe operations. This is due to the increased water flow, low nozzle reaction, increased reach of the stream as compared to a fog nozzle, and the minimal increase is hoseline weight. D. McGrail (2007) states that the overriding factor in hoseline selection should be to have enough GPM to overcome the Btu’s being produced by the fire. This is important due to the increased use of synthetics in manufacturing; the increased use of plastics results in fires fueled by 2.5 times the amount of Btu’s than previous fires fueled by Class A combustibles (Fredericks, 2000). The author found that departments use a variety of hose and nozzle combinations for fire attack. Hose length ranged from 100’ for the Worcester Fire Department (WFD, 2005) to 200’ utilized by the Lewisville Fire Department (LFD, 2003). Departments also employed a variety of nozzles in their high rise packs. The Lewisville Fire Department used a smoothbore nozzle (LFD, 2003). Fog nozzles, either low pressure automatic nozzles or constant gallonage, are used in Raleigh (RFD, 2006),
Chapel Hill (CHFD, 1994), Houston (Flanagan, interview, June 26, 2007), Toledo (Coleman, interview, June 26, 2007), and Cary, NC (Cone, interview, June 22, 2007). The fire departments in Denver (Farnsworth, interview, June 26, 2007) and Worcester (WFD, 2005) equip their fire companies with both fog nozzles and smoothbore nozzles.

Fire departments of similar size to the Durham Fire Department take varied approaches regarding the implementation of standard operating policy for high rise fires. Some departments, such as the Charlotte Fire Department (CFD, 2001), provide general recommendations for strategic and tactical priorities. These recommendations rescue and evacuation, confirmation of the fire floor, water supply, checking for upward fire extension, lobby control, sector assignments, and additional alarms. Other departments follow the same strategic and tactical priorities, but some are more specific regarding which units are responsible for these actions. The Worcester Fire Department (WFD, 2005) specifies which units are responsible for tactical operations. Other department that follow similar procedures are the Chapel Hill Fire Department (CHFD, 1994), the Raleigh Fire Department (RFD, 2006), and the Lewisville Fire Department (LFD, 2003). Similarities in tactics are found in the area of elevator operations. Although departments may differ in when firefighters may use an elevator for access to an upper floor fire, each department specifies that firefighters must be able to control the elevator through Phase II, or firefighter mode, operation.

The dispatch of units to a reported high rise fires varied in different communities. Departments for communities larger than 250,000 people dispatch an average of four
engine companies, two ladder companies, and two chiefs to each fire. As communities reduce in size, so does the amount of apparatus dispatched; communities serving between 150,000 and 250,000 people average three engine companies, two ladder companies, and two chiefs, while communities of less than 150,000 people average a dispatch of three engine companies, one ladder company, and one chief.

Of all departments returning questionnaires, 71% had procedures in place for high rise firefighting operations, including 86% of larger departments, 67% of medium size departments, and 50% of smaller departments.

Several steps need to occur as the fire department strives to evaluate the procedure put in place. The evaluation process, as it relates to policy, strives to assess the results of a policy and determine what employee behaviors were prior to implementation. Additionally, evaluation identifies the operational problem the policy is addressing, if the policy was fully implemented or if problems were encountered prohibiting full implementation, if employee behaviors and responses changed after the implementation of the policy, whether the changes were intended, and if the policy still current and relevant (USFA, 1999).

Training will comprise a large portion of the evaluation phase of the procedure. In Columbus, OH, the fire department obtained a high rise structure for the purpose of training its firefighters. The results of the training showed that elevator use, apparatus placement, incident command, team search, accountability, high rise pack contents,
multi-company team concepts, thermal imaging, occupant control, and fire control were all issues that needed to be further evaluated to determine if the high rise procedure was flawed. The department also determined that on-going training in the area of high rise firefighting was necessary (Cannell et al., 2001). The training phase can also result from an actual or perceived problem that results in a department revisiting its procedures (USFA, 1999). In the case of the New York City Fire Department, training resulted after a problem with wind driven high rise fires was identified (Norman, 2007). In one case, three firefighters were killed during fire operations on the tenth floor of a ten story high rise building. The resulting report on the firefighter deaths identified a wind driven fire as a contributing factor (NIOSH, 1999). As a result of that incident as well as others, the New York City Fire Department partnered with the Toledo and Chicago Fire Departments as well as the NIST to examine wind driven high rise fires and the resulting impact on fire conditions, firefighter safety, and occupant safety (NIST, 2007).

As a result of the information gathered, the author feels that a specific procedure needs to be developed for high rise firefighting operations. When interpreting the results of the research, it should be noted that high rise firefighting is an infrequent activity undertaken by the average fire department. It is also one of the more dangerous activities undertaken. Fire departments need to be aware that the aspects of rescue, evacuation, ventilation, and fire attack are going to differ in a high rise building versus a one or two story residential structure, which is where the majority of America’s fires are located. Due to this difference, firefighters will benefit from having an established procedure in place for this low frequency, high risk event.
The results of the research do provide a clear course of action regarding the strategy and tactics to be initiated at a high rise fire. It is apparent that first arriving companies need to accurately determine the fire’s location and then designate attack and evacuation stairways to support the fire attack and occupant evacuation. What is not clear is whether the occupants will heed the fire department’s recommendation for evacuation or defend in place strategies. The next issue generally agreed upon is that there needs to be an attack on the fire in some form. There are no clear trends established regarding what tools and appliances are needed to initiate this attack. There are a myriad of hose and nozzle combinations employed by various fire departments; these combinations seem to revolve around the use of either 1 ¾” or 2 ½” hose, although some departments utilize 1 ½” or 2” hose. Another aspect of fire attack that seems to have no clear answer is the type of nozzle to use with the hose. Research indicated that departments utilize smoothbore nozzles or fog nozzles; the fog nozzles were either constant gallonage or low pressure automatic. Given the limitations in personnel encountered by the Durham Fire Department, the author feels that the 2 ½” hose with smoothbore nozzle and 1 1/8” tip is the best option for the department. Although considerable heavier, the increased flow and penetration seemingly afforded by this combination will benefit the department.

Most agree that ventilation needs to be closely coordinated by the incident commander since the results of ventilation in a high rise building are unpredictable. It is clear that any ventilation undertaken by the fire department, whether through the use of the HVAC, ventilation of the stairway, or the breaking or opening of windows needs to be reversible.
There are differences in how departments of similar size to the Durham Fire Department approach the deployment of resources, with some departments just listing strategic and tactical objectives and others specifying which units will handle different responsibilities. The listing of specific units assigned to handle specific tasks will introduce a degree of accountability and redundancy into the procedure and should be strongly considered. The needs of rescue, fire containment, and fire extinguishment need to be addressed immediately and should be addressed procedurally.

The evaluation of a high rise firefighting procedure needs to be on-going and undertaken in conjunction with a strong training program. The evaluation needs to start prior to the implementation of the procedure to determine the thoughts and actions of firefighters prior to the procedure being in place. By starting the evaluation process before the procedure is in place, any change in behavior as a result of the procedure can be gauged. Evaluation needs to continue through the implementation of the procedure. The training phase of the procedure may identify areas that require modification of procedure or training. On-going evaluation, whether through regularly scheduled review or as a result of an incident in which the procedure was employed, will enable the fire department to either modify its operations to maintain the relevance of the procedure or devise further training to address identified issues.

The Durham Fire Department does not currently have a high rise firefighting procedure in place. As a result of the research, there is an identified need to develop, implement,
and evaluate a procedure for this firefighting situation. This process will enable the
department to better serve the citizens of the city and provide for the safety of both
citizens and firefighters. The procedure will provide for an improvement in the operations
of the fire department by providing a framework for fire operations that was developed,
tested, and refined in an atmosphere devoid of the high stress of an actual fire situation.
The results of this paper provide new knowledge in the areas of occupant rescue and
evacuation, ventilation, and fire attack. An examination of other departments also
provides new knowledge regarding their operations during high rise fires. There is a new
awareness, accented by an examination of the procedures of other fire departments, that
there are numerous methods currently in place to effectively handle a high rise fire
situation and that the specific tactics and tasks employed to accomplish the strategy are
largely a matter of departmental preference and resources. It is clear that once the
Durham Fire Department’s procedure for high rise firefighting is implemented, it needs
close monitoring to ensure the tactics and tasks set forth procedurally are able to be safely
accomplished by the department’s firefighters. Additionally, the department needs to
monitor the procedure to ensure the desired results in the areas of fire attack, rescue and
evacuation of occupants, and ventilation of the structure.

Recommendations

It is recommended that the Durham Fire Department adopt the standard operating
procedure for high rise fires. To increase the safety of both citizens and firefighters,
several actions should be undertaken in conjunction with the adoption and implementation of the procedure.

The fire department needs to undertake a comprehensive training initiative during and after the implementation of the procedure. The training should begin prior to the adoption of the procedure with the goal of the training to be assessment of current fire department practices regarding high rise firefighting operations. The department should strive to gather information regarding hoseline selection, nozzle choice, unit deployment, tool selection, and general strategy and tactics as they relate to high rise firefighting. The training should be conducted in an actual high rise building within the City of Durham and consist of hands-on drills designed to assess the thinking and actions of the department’s officers and firefighters.

Once the pre-procedure training is complete, the department should compare the results of the training with the content of the high rise procedure to determine if content needs to be added, deleted, or revised. Additional training topics may result from the high rise training. Once the procedure is implemented, continual training needs to occur regarding high rise firefighting. Additionally, the procedure needs to be periodically reviewed to ensure the content is relevant and up to date.

Changes recommended for the Durham Fire Department include the adoption of the high rise firefighting procedure, since none currently exists. Included with the adoption of the procedure will be a standardized plan of attack for high rise structures; currently, the
Durham Fire Department does not utilize a standard plan for any structural fire attack. The current climate within the fire department is for all fire units to base strategic and tactical decisions in reaction to the actions of the first arriving fire unit; the adoption of this procedure will allow the fire department to transition into a proactive organization with standard actions designed to produce standard outcomes. Part of this change will entail the modification of the number and type of apparatus dispatched to a reported high rise fire. Currently, the fire department dispatches three engine companies, two ladder companies, one squad company, one safety officer, one mobile support unit, and two battalion chiefs on any reported fire in a structure; this ranges from a shed behind a house to a high rise structure. The change in dispatching will result in five engine companies, four ladder companies, three squad companies, one safety officer, one mobile support unit, and three battalion chiefs being dispatched to a reported fire in a high rise; there will be no change in the apparatus compliment for an automatic fire alarm with no smoke or fire reported or indicated.

An additional change recommended is the change in the contents of the high rise hose packs issued to all Durham Fire Department engine and ladder companies. The fire department currently issues one hundred feet of 1 ¾” hose with a low pressure fog nozzle. Other contents of the high rise hose pack are a six foot section of 2 ½” hose with a gated wye attached, door chocks, and two spanner wrenches. The recommended change will be for the department to issue 150’ of 2 ½” hose equipped with a smooth bore nozzle with 1 1/8” tip size. Additionally, the department should issue an in-line pressure gauge to be attached at the standpipe outlet between the outlet and the initial fifty foot section of
2 ½” hose. This change in procedure will require extensive training to emphasize the importance of teaming two engine companies for the advance of one hoseline. Additional training is required in the handling of the 2 ½” handline.

The benefits expected from the research include common stated objectives for all department members to follow. The procedure will allow all firefighters to initiate tactics, strategies, and actions designed to support a common, known plan of attack. By supporting an existing plan for high rise firefighting operations, firefighters increase the safety of occupants and firefighters responding. The support of a standard plan helps to ensure the fireground priorities of life safety, fire confinement, and fire extinguishment. These priorities will be reinforced due to the designation of attack and evacuation stairs, the increase water flow from a larger size attack handline, and the increased number of firefighters initially available to accomplish the department’s goals and objectives.

The author believes the Durham Fire Department needs to conduct additional research to increase the effectiveness of the procedure and the safety of occupants and firefighters. The department should, on a quarterly schedule, perform training in one of the numerous high rise buildings within the city limits. Research needs to be conducted to determine the optimal number of firefighters need to advance the larger 2 ½” handline outlined in the procedure. Additionally, the department needs to research the number of firefighters needed to adequately and safely search the floors of a high rise building. This research may lead to the department incorporating search rope procedures into the high rise procedure.
Research also needs to be conducted regarding the initial alarm response to a high rise fire. The increased response to a high rise fire places more firefighters on scene to accomplish initial fireground actions. It needs to be determined if emergency coverage can be maintained for the remainder of the city since a high rise fire dispatch will engage five of fifteen engine companies and all the department’s ladder companies, squad companies, and battalion chiefs. The department needs to determine whether mutual aid agreements with surrounding municipalities will adequately augment the remaining fire department resources for city-wide coverage.

The changes recommended should be implemented after the initial training for department. The initial training will be designed to determine current fire department thinking and actions regarding high rise fire operations. Follow-up training will be designed to introduce the new high rise firefighting procedure. Once this training is complete and the department makes any needed additions, deletions, or modifications to the procedure, the procedure should be fully adopted. Since it may be a fiscal hardship for the fire department to re-equip all engine and ladder companies with additional 2 ½” hose, smoothbore nozzles, and in-line gauges, the units responding to the greatest number of high rise structures should be equipped initially. This implementation would involve five engine companies.

Once the procedure is implemented, it needs to be reviewed quarterly for its first year and then no less than annually thereafter. This procedure involves a major change in the
implementation of strategy and tactics for the department and should be regularly monitored. The frequent review of the procedure will also enable the department’s administration and training divisions to provide support, as needed.

Follow-up evaluations will help to determine the effectiveness of the procedure. These evaluations should involve multiple formats. The formal procedural review will provide one form of evaluation. The procedure should also undergo review after each use and should be modified as necessary. The department should make a concerted effort to solicit input from all members of the fire department, not just the chief and line officers. By soliciting input from all levels, the department will be able to evaluation the task level aspects of the procedure. An example of this follow-up evaluation would be in determining the ease or difficulty in advancing 150’ of 2 ½” hose into a high rise fire.

Should others attempt to replicate some or all of this study, the author offers the following recommendations. First, the focus of the paper should be narrowed to one or two phases of a high rise fire operation. For example, there are numerous sources just for the topics of high rise fire attack and ventilation. When attempting to determine what policies and procedures are in place in other departments, the author recommends a primary focus on departments of similar size to the department initiating the research. An examination of the practices of larger departments may expose one to the strategic and tactical priorities that need to be accomplished during a high rise fire; however, it may prove difficult to translate the data from larger organizations to useful information for a smaller fire department. An examination of similar-sized departments will enable others
to review strategy and tactics within the framework of limited or similar resources. This will enable other researchers to better design and implement procedures. The author would further recommend that questionnaires be completed in a form other than electronic mail. While this mode of communication is extremely convenient, it may be easy for a questionnaire to be overlooked. The author recommends regular mail as the method to distribute questionnaires. If electronic mail is used, the author would recommend that telephone contact be made with the intended receiving party prior to the questionnaire being sent; this may increase the chance that he questionnaire will be completed and returned.
Reference List


Dear Fire Service Professional:

Thank you for assisting me with my Applied Research Project for the National Fire Academy’s Executive Fire Officer Program. My research paper deals with the development of a high rise firefighting guideline for the City of Durham Fire Department in Durham, North Carolina. As part of my research, I am attempting to gather as much information as possible from departments around North America regarding their high rise firefighting operations. If you could take a few minutes to complete the questionnaire below I would appreciate it. Once completed, please e-mail your response to Dcuria@aol.com. I can be reached at 919-618-1531 if you have any questions. Again, thank you in advance for your assistance.

1. Your Name and Rank:  
2. Your Department Name:  
3. Your City and State:  
4. Approximate City Population:  
5. Total Personnel Strength of Your Department:  
6. Approximate Number of Personnel On-Duty Per Shift:  
7. Total Number of Engine Companies:  
8. Total Number of Ladder Companies:  
9. Description of Other Units (rescue, rehab, etc.):  
10. Average Daily Staffing on an Engine Company:  
11. Average Daily Staffing on a Ladder Company:  
12. Total Number of Chiefs Per Shift:  
   Could you describe the chief officers (number of battalion chiefs, assistant chiefs, deputy chiefs, etc.)  
13. Does your department have a policy or guideline for high rise firefighting?  
   If yes, could you e-mail a copy with this response?  
14. What is your alarm response for a
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Have you experienced any high rise fires that reinforced certain aspects of your high rise policy?</td>
<td></td>
</tr>
<tr>
<td>16. Would you be willing to participate in a telephone follow-up to this questionnaire?</td>
<td></td>
</tr>
<tr>
<td>a. If yes, could you please include your telephone Number:</td>
<td></td>
</tr>
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### Appendix B – Departments Sent Questionnaires

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<th>Department</th>
<th>Date Sent</th>
<th>Date Returned</th>
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</thead>
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<td></td>
</tr>
<tr>
<td>Indianapolis FD</td>
<td>Week of 2/4/07</td>
<td></td>
</tr>
<tr>
<td>Raleigh FD</td>
<td>2/15/07</td>
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</tr>
<tr>
<td>Charlotte FD</td>
<td>2/15/07</td>
<td>Policy only</td>
</tr>
<tr>
<td>Atlanta FD</td>
<td>2/15/07</td>
<td></td>
</tr>
<tr>
<td>Washington DC FD</td>
<td>3/1/07</td>
<td></td>
</tr>
<tr>
<td>Houston FD</td>
<td>2/15/07</td>
<td>4/1/07</td>
</tr>
<tr>
<td>Memphis FD</td>
<td>2/15/07</td>
<td>2/16/07</td>
</tr>
<tr>
<td>FDNY</td>
<td>3/1/07</td>
<td></td>
</tr>
<tr>
<td>Boston FD</td>
<td>3/1/07</td>
<td></td>
</tr>
<tr>
<td>Worcester FD</td>
<td>2/15/07</td>
<td>2/16/07</td>
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<tr>
<td>Jacksonville, FL FD</td>
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<td>St. Louis FD</td>
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</tr>
<tr>
<td>Los Angeles FD</td>
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<td>2/16/07</td>
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<tr>
<td>Richmond FD</td>
<td>2/15/07</td>
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<td>2/15/07</td>
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<td>Greensboro FD</td>
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<td>High Point FD</td>
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<td>Charleston (SC) FD</td>
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<td>Baltimore FD</td>
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<td>Calgary FD</td>
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<td>Tampa FD</td>
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<td>Toledo (OH) FD</td>
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<td>2/16/07</td>
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<td>Cary FD</td>
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<td>6/21/07</td>
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<td></td>
</tr>
<tr>
<td>Phoenix FD</td>
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</tr>
<tr>
<td>Montgomery County (MD)</td>
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<td>Albany (NY) FD</td>
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<td>Philadelphia FD</td>
<td>2/15/07</td>
<td></td>
</tr>
<tr>
<td>Los Angeles City FD</td>
<td>2/17/07</td>
<td>2/21/07</td>
</tr>
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<td>Fort Worth FD</td>
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<tr>
<td>Memphis FD</td>
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<td>2/19/07</td>
</tr>
<tr>
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<td>2/25/07</td>
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<td>Chapel Hill FD</td>
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### Appendix C – Questionnaire Results

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<tr>
<td>Number of Respondents</td>
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<tr>
<td>Number of respondent departments above 250,000 population served (A)</td>
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<tr>
<td>Number of respondent departments between 150,000-250,000 population served (B)</td>
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<tr>
<td>Number of respondent departments below 150,000 population served (C)</td>
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<tr>
<td>Average number of firefighters all departments</td>
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<tr>
<td>Average number of firefighters (A) departments</td>
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<td>Average number of firefighters (B) departments</td>
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</tr>
<tr>
<td>Average number of firefighters (C) departments</td>
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<tr>
<td>Average number of firefighters on duty all departments</td>
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<td>Average number of firefighters on duty (A) departments</td>
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<td>Average number of firefighters on duty (C) departments</td>
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<tr>
<td>Average number of engines all departments</td>
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</tr>
<tr>
<td>Average number of engines (A) departments</td>
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<tr>
<td>Average number of engines (B) departments</td>
<td>9</td>
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<tr>
<td>Average number of engines (C) departments</td>
<td>9</td>
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<tr>
<td>Average number of ladders all departments</td>
<td>12</td>
</tr>
<tr>
<td>Average number of ladders (A) departments</td>
<td>20</td>
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<tr>
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<tr>
<td>Description</td>
<td>Value</td>
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<td>---------------------</td>
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<td>Average number of ladders (C)</td>
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<td>Average number of “other” units</td>
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<td>Average staffing of engines all departments</td>
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<tr>
<td>Average staffing of engines (B) departments</td>
<td>4</td>
</tr>
<tr>
<td>Average staffing of engines (C) departments</td>
<td>3</td>
</tr>
<tr>
<td>Average staffing of ladders all departments</td>
<td>3.77</td>
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<tr>
<td>Average staffing of ladders (A) departments</td>
<td>4</td>
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<tr>
<td>Average staffing of ladders (B) departments</td>
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<tr>
<td>Average staffing of ladders (C) departments</td>
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<tr>
<td>Average number of chiefs (daily) all departments</td>
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<tr>
<td>Average number of chiefs (daily) -- (A) departments</td>
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<tr>
<td>Average number of chiefs (daily) -- (C) departments</td>
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<tr>
<td>Percentage of departments with high rise policies</td>
<td>71%</td>
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<td>Percentage (A) departments with high rise policies</td>
<td>86%</td>
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<td>Percentage (B) departments with high rise policies</td>
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<td>Percentage (C) departments with high rise policies</td>
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<td>Mean alarm response all departments</td>
<td>3.57 Engines, 2 Ladders, 1.8 Chiefs</td>
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<td>Mean alarm response (A) departments</td>
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<tr>
<td>Mean alarm response (B) departments</td>
<td>3 Engines, 2 Ladders, 2 Chiefs</td>
</tr>
<tr>
<td>Mean alarm response (C) departments</td>
<td>3 Engines, 1 Ladder, 1 Chief</td>
</tr>
<tr>
<td>Median alarm response all departments</td>
<td>3/4 Engines, 2 Ladders, 2 Chiefs</td>
</tr>
<tr>
<td>Median alarm response (A)</td>
<td>4 Engines, 2 Ladders, 2 Chiefs</td>
</tr>
<tr>
<td>departments</td>
<td>response</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------</td>
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<tr>
<td>Median alarm response (B)</td>
<td>3 Engines, 2 Ladders, 2 Chiefs</td>
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<tr>
<td>Median alarm response (C)</td>
<td>2/3 Engines, 1 Ladder, 1 Chief</td>
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<td>Mode alarm response all</td>
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</tr>
<tr>
<td>Mode alarm response (C)</td>
<td>2 Engines, 1 Ladder, 1 Chief</td>
</tr>
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</table>
I. PURPOSE

To standardize the fire ground operation in a high rise structure by giving direction to the sequence of events that must transpire for safe extinguishing.

The successful mitigation of a high-rise incident will be dependent on the actions of the first arriving company. First arriving officers must realize that incidents of this type will be personnel intensive and severely tax the Department's resources. Experience has shown that certain tasks must be completed in a sequential order for the operation to progress smoothly to a successful conclusion. It is the intent of this document to provide a standard for the first alarm assignment in order to cover critical tactical positions that are present in all high-rise fire scenarios.

II. DISCUSSION

Firefighting in high rise structures will pose several severe challenges for the firefighters responding. Although a sequential order of operations is preferred, it is recognized that there are often times when operations must occur concurrently and in dependence of one another. These situations are often fluid and must, in a complex form, be addressed on an individual situation-basis.

Nothing in this guideline should prevent the IC from making changes in tactical assignments as the event dictates.

III. DEFINITIONS
• High Rise – The Durham Fire Department shall define a high rise structure as a structure that meets any or all of the following criteria:
  • From the North Carolina Building Code, Section 403.1 – “Buildings with an occupied floor located more than 75’ above the lowest level of fire department vehicle access.”
  • Any building whose height is above the access of the tallest fire department ladder.
  • Buildings in which fire attack locations are dictated by the construction of the building.
  • Presence of a standpipe system

• Standpipe System – Defined by NFPA 14 (Standard for the Installation of Standpipe and Hose Systems – 2007 Edition) according to the size (diameter) of the hose outlets and as being either “wet” or “dry”.
  • Type I – 2 ½” outlets for firefighter use
  • Type II – 1 ½” outlets with 1 ½” hose for occupant use
  • Type III – 2 ½” outlets and 1 ½” outlets or 2 ½” outlets reduced to 1 ½” with a removable fitting for occupant and firefighter use.

• Fire Department Connection (FDC) – Siamese connection whose design will allow for water to supply sprinkler and/or standpipe systems.

• Pressure Reducing Valve (PRV) – Per NFPA 14 (2007 Edition), Valve designed for the purpose of reducing the downstream water pressure under both flowing (residual) and non-flowing (static) conditions.

• Pressure Restricting Device (PRD) – Valve or device designed for the purpose of reducing the downstream water pressure under flowing conditions only.

• Stairs –
  • Attack Stair – Designated for use of fire department personnel for fire attack and support activities.
  • Evacuation Stair – Designated for the primary purpose of occupant removal to an area of safe refuge either inside or outside the structure.

• High Rise Pack – Durham Fire Department high rise packs for engine companies shall consist of 150’ 2 ½” hose with smoothbore nozzle equipped with 1 1/8” tip. Additional equipment is as follows:
  • 2 hose straps
  • 5 door chocks (minimum)
  • 2 – 2 ½” spanner wrenches
  • In-line pressure gauge
  • Pipe Wrench
  • Rubber mallet

IV. RESPONSE ASSIGNMENT

A. Single source notification (AFA), (smoke/heat detector, pull station, sprinkler
activation)

1. Two Engines
2. One Ladder
3. One Squad
4. One Battalion Chief

B. Multiple notifications from separate sources and/or verbal report of fire/smoke condition require the High Rise Alarm to be dispatched, bringing the following additional units:

1. Three Engines
2. Three Ladder
3. Two Squad
4. One Safety Officer
5. Two Battalion Chief
6. One Mobile Support Unit

C. A 2nd alarm will bring the following assignment:

1. Three Engines
2. One Ladder
3. Deputy Chief
4. Notification to the Fire Chief
5. Second Rehabilitation Unit

D. A 3rd Alarm will bring the following assignments:

1. Three Engines

E. Subsequent Alarms will bring the following additional assignments:

1. Two Engines
2. One Ladder
3. Or as specified by the I.C.

Mutual Aid Fire Departments will be called to back fill for the Durham Fire Department units on scene or relocated.

V. PROCEDURE

A. General Procedures

1. First arriving engine and ladder companies will

   a) Establish command and provide a size up of the perceived fire problem
   b) First-due engine and first-due ladder will go to the fire control panel to determine fire location.
   c) Secure access keys; one set per company (if possible)

   Engine Companies
• Shall carry the following equipment:
  • Officer shall carry- radio, light, telephone handset (if unit is equipped with one), 50’ 2 ½” hose
  • Fire Technician of the first due engine company shall carry a light, 50’ 2 ½” hose, and operate as part of their assigned company. The Fire Technician of the second due engine shall function independently of his/her company’s personnel, with their apparatus, and report to the FDC and supply the system.
  • Firefighter(s) shall carry a light, 50’ 2 ½” hose and High-rise kit/bag.

Ladder Companies shall carry the following equipment:

• Officer - shall carry search rope, light, radio, Thermal Imager, elevator keys
• FT – set of Irons, the hydraulic door opener (Rabbit Tool), and light
• FF - shall carry a hook/pike pole, light, and water can.
• With the exception of the first two ladder companies, each ladder company will bring its RIT bag and leave at Staging (2 floors below fire)

Squad Companies shall carry the following equipment:

• FT – set of Irons, Hand light
• FF – RIT bag, NY Hook or Pike pole, Hand light

(Each person who is operating the elevator needs a set of Irons, elevator keys and water can)

2. First arriving Battalion Chief

a) Establishes a command post in the fire command center, lobby, or outside building, as communications require
b) Assumes command ensures evacuation is initiated, ensures required announcement is made over P/A to affected floors

B. Single source automatic alarms

• First arriving engine and ladder will investigate the alarm
• All personnel shall be in P.P.E. including SCBA
• All personnel shall carry assigned equipment
• Members shall not use elevators if the reported alarm is on floors 1 thru 7 Elevator that is used shall have Phase II Firefighter service activated

C. Multiple source automatic alarm and/or verbal report of smoke or fire
1. Request a full high rise assignment

D. **Confirmed Working Fire Tactics**

1. First and Second Due Engine Companies
   a) Operate as initial attack team
   b) Begin standpipe operation 1 floor below the fire floor
   c) Check for and identify pressure reducing/regulating valves – remove, if possible
   d) Connect pressure gauge and handline to standpipe; will begin fire attack
   d) The second due engine’s fire technician shall make all FDC connections and prepare to pump the system.

2. Third and Fourth Due Engine Companies
   b) The third-due engine officer will assume logistics division (two floors below fire floor) and reports to the I.C.
   c) These two companies will connect to the standpipe outlet in the stairwell two floors below the fire floor, and/or protect means of egress for operating companies with coordination of the attack officer.
   d) Officers should note hose requirements prior to ascending into the building.

4. Subsequent Arriving Engine Companies
   a) All additional engine companies will report to the lobby with the equipment as dictated by command.
   b) The I.C. should assign a company or companies to assist the lobby control officer.

E. **First Due Ladder Company and First Due Squad**

1. The first arriving ladder company and first arriving squad, with entire crews intact (including the ladder company fire technician) and operating as one unit, shall have the following initial responsibilities:
   a. Control of the elevator(s) to be used by fire department personnel
   b. Locate the fire floor and fire location
   c. Lobby control / chief’s aid
   d. Identify nature and location of the emergency
   e. Recommend Attack and Evacuation Stairs
   f. Forcible entry and search on the fire floor
F. **Second Due Ladder Company**
   1. Report to the floor above the fire for search, rescue, and extension
   2. Once the floor above the fire is cleared, the second due ladder company will ascend to the next higher floor for search, rescue, and extension.
      1. This assignment will be confirmed with Command or Operations prior to moving divisions.

G. **Third due Ladder Company**
   1. The third due ladder company will form the rapid ascent team (RAT team) and be responsible for the clearing of all stairs from the top floor to the lobby. This is an on-going process.

H. **Fourth due Ladder Company**
   1. Gain access to the roof and ventilate only upon the orders of the incident commander.
   2. Begin search of the floors above the fire working from the top floor down

I. **Squad Companies**
   1. The responding Squad Companies (with the exception of the first due squad, which operates with the first due ladder) will report to the forward staging post and function as the initial rapid intervention team until that function can be reassigned to a second alarm company(s).
   2. The Squad Company should be given tasks that allow them to remain mobile and ready to undertake any special operations that may occur during the incident.

J. **First arriving Battalion Chief**
   1. Establishes or assumes Command
   2. Utilizes P/A system, and ensures evacuation procedures have been implemented.
   3. When relieved by ranking officer or upon arrival of the second due battalion chief, becomes Operations one floor below the fire

K. **Second arriving Battalion Chief**
   1. Reports to IC, receives pertinent information, and assumes Command
L. **Third arriving Battalion Chief**
   1. Reports to IC, and then establishes Accountability.

M. **FD-5 (Safety Officer)**
   1. Reports to IC, then establishes safety.

N. **Deputy Chief**
   1. Relieves/reassigns the Incident Commander and assumes Command.

O. **Subsequent arriving Chief Officers and Training Officers**
   1. Ranking chief officers will assume command and re-assign present incident commanders to appropriate positions.
   2. Training officers must report to staging and should be utilized for filling of necessary NIMS functions as dictated by the incident requirements.

VI. **GENERAL REQUIREMENTS AND PROCEDURES**

A. Investigations of any alarms in a high-rise structure shall be undertaken by both the first arriving engine company and the first-arriving ladder company, ALL personnel, including chief officers entering the building will have full personal protective equipment and required equipment.

B. It is expressly forbidden to ever take the elevator to the floor on which the fire is reported. Companies may either use the stairs or take the elevator in phase II to not less than two floors below the reported fire floor. Safety stops are required at no less than 5 floor intervals.

C. Elevators shall not be used when the fire floor is reported to be on or below the seventh floor in any building.

D. The first and second arriving ladder companies will spot at the most advantageous location for use of the aerial. Uses of the aerial at fire buildings are in the following order of priority:
   1. Rescue/removal of occupants
   2. Access to target floors (fire floor, floors above and below)

E. All Members entering the structure should bring spare SCBA cylinders, whenever possible. The logistics officer will be responsible for establishing air supply/refill operations at the appropriate location.