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## **High-Rise Firefighting Preparedness**



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# **Fire Engineering**



## **HIGH-RISE FIREFIGHTING PREPAREDNESS**

One of the most demanding and major challenges to firefighters and their respective departments is in the area of high-rise firefighting. In order to protect lives and save property in these types of structures places incredible physical demands as well as an unbelievable depth of resources that shape successful strategic and tactical decision making. When it comes to high-rise firefighting we can become restricted and limited to how we maneuver within these structures while also dealing with an array of complicated building systems that can affect everything we do and the final outcome regarding savable property and saving lives. Within the fire service many departments define high rise structures in several ways. Some indicate that any building taller than 5 to 6 floors or stories is considered a high rise structure while others simply define it as any building so configured as to be out of reach of ladders. This is to include the tallest ground ladder as well as any tower ladder or straight ladder apparatus. This also may include any structure or building in which fire departments must rely on a buildings systems for assisted fire suppression such as fire pumps and smoke removal and handling systems. From a firefighting standpoint it is or can be defined as a structure in which a fire cannot be controlled because of limited access to its exterior, ingress and egress points as well as the ability to provide controlled ventilation. It is also a structure in which the fire operations we use for attack are restricted to the interior of the building.

Throughout the years high rise fires have generated millions of dollars in lost property and more importantly the loss in life both to civilians and firefighters. The new generation of high rise structures involves many types of lightweight construction features even though many are made of solid components of steel and concrete. Unlike the generations of high rise buildings before the new components of materials, enclosed stairwells, the rate of heat release are many times preventing occupants of a safe and quick means of egress. Even though sprinklers can contain fires the smoke that is generated can be forced into areas through the buildings air handling systems along with firefighter suppression operations allowing for smoke travel as well. Fire fighting operations then are faced with extreme challenges in rescuing and protecting in place occupants while being tasked with moving tools and equipment up and down stairs when elevators may not be available creating extended reflex times in getting water on the fire and its exposures within the structure. Additional concerns are many times the amount of square feet at any given high rise floor or area many times exceeding 40,000 feet or more that may be affected in portions of fire. In large high rise structures the occupancy load can be in the thousands during the day in which pre planning of evacuation methods must be in place. Even with evacuation plans in place there are many instances of forms of chaos by occupants descending stairwells that may not be the best routes to safety especially during fire operations. High rise firefighting is most often restricted to fighting fire within the interior of these structures which require a different set of strategies and tactics in gaining control of not

only fire and its byproducts of combustion but also its occupants. It is important for firefighters and their respective officers and chiefs to note that a high rise structure as so defined in your area could be 100 stories or 6 stories tall each requires experience and pre planning in gaining control of these incidents. Fire extinguishment and life rescue are extreme challenges for departments mounting adequate resources and personnel not to mention departments they may not be able provide the forces needed are nonetheless both faced with overwhelming odds. Those that have gained real experience in high rise firefighting know all too well its demands on firefighters and resources.

One of the major factors in utilizing your strategies and tactics throughout a high rise fire is many times dependent in understanding and gaining control of the buildings systems. Some of the basic elements of success applied to high rise firefighting strategies are the following.

- **Manpower and Equipment.**
- **Building Engineer or Building Management Assistance and Cooperation.**
- **Controlling Building Systems and Components**
- **Radio and Land Based Communications.**
- **Elevator and Stairwell Control.**
- **Fire Pump and Standpipe Operations.**

Before we can even deal with the above strategies we should be aware of not dropping our guard down because for many departments false alarms are quite numerous. This lends itself to complacency which in turn drives our policies and procedures along with our attitude that we can arrive with less than adequate resources and take shortcuts in our approach. Firefighters should never think for a moment that a new building cannot burn. We entrust so much in fire protection systems in these structures that many who respond to what they consider as nuisance alarms proceed in even without proper PPE or tools and equipment. We should consider that there are a host of potentials that can cause fires in these structures and that we should respond with those possibilities in mind. Instead the mindset of firefighters and their departments is to get into these buildings and train before an incident could ever occur. High-rise training should be part of every departments training protocols along with established fire ground operational guidelines even if it's only a 5 story multi dwelling. When false alarms do occur that is when it is probably the best time to take time and provide firefighters a learning experience in operating within these structures. Familiarization by both Incident Commanders and firefighters in construction features, layouts, stairwells and elevators will help in size-up and decision making when and if the real deal of even the smallest fire is encountered.

When responding to high rise fires many difficulties can be encountered which increase our reflex time in getting water on the fire as well as removing occupants that are threatened by fire and smoke. Many times when getting into these buildings even the best of plans may still be taxing our abilities to gain control. Communication and control are key essentials along with strategies and assignments that make sense while realizing that these initial efforts take time. It should be clearly understood that reflex time is required for things to effectively proceed in extinguishing fire and saving lives. Even when approaching the fire area in these structures we are usually faced with tightly closed and well insulated areas as well as furnishings and construction materials that are highly combustible producing many times uncontrolled events in fire behavior. Incident Commanders must have a solid handle on the strategies that are chosen regarding the fire area as well as the floors above and at least two floors below. IC's must have reliable and up to date pre plans that provide sound information which in turn will allow proper strategies in managing the fire. Accompanying these factors is also the IC's command of the logistical nightmare that some of these structures reveal during fire conditions. High rise fires produce logistical consequences such as managing not only fire attack but also civilian rescues, occupant evacuations, elevator control, stairwell management, transporting of tools and equipment, staging areas and lobby control to name a few. Logistics is right up there in importance with fire attack and saving lives. If logistics aren't planned for correctly fire attack and civilian rescues may fail or produce increased fire growth along with increased fatalities. There is a direct imbalance when it comes to high rise firefighting unlike residential fires and that is that the firefight itself will require a limited number of firefighters engaged in the firefight while the logistic support with personnel and equipment is much larger.

Beginning an attack on a fire in a high rise structure means everything has to be in place before the advance into the fire area in order to avoid having to retrieve additional resources from the street level of the building. IC's must think in terms in building an overwhelming force with a sustained fire attack in order to prevail. It is imperative that commanders and officers realize the need for tremendous resources that need to get in place into upper floors from the lobby with confirmed high rise fires. Preparing and gaining control while also building your resources within high rise structures is known as Reflex Time. As much as everyone wanting to get into the aggressive task of fighting the fire the more important issues are getting commanders and officers into key logistical positions while still providing for occupant rescues and assistance from the fire area. This is a daunting task. Getting personnel and equipment into upper floors and in position for the aggressive advance protects our firefighters and will give us the upper edge in winning the firefight. It is important for commanders to provide for the possible rotation of personnel and equipment through staging areas throughout the building preferably from 2 to 3 floors below the fire area when possible.

We must basically think of it as preparing a tiered system that establishes the first company on the fire floor to move into action while another company is prepared with a second line in the stairwell or to relieve the first crew and so on. Also an additional 3<sup>rd</sup> company ready from your staging area. All 3 of these companies' main responsibilities are to the task of advancing hose lines and getting water onto the fire. This reminds us also that other companies will be needed for occupant assistance and search and rescue from not only the fire floor but most importantly from floors above. Remember it still takes manpower to even protect and ensure that occupants are being secured in place if need be. In high rise firefighting where nozzle streams cannot be used due to out of reach upper floor fires from the exterior puts us into the position that true defensive operations are negated. We must think outside the box sometimes by possibly using other buildings nearby within their upper floors to possible use water streams to reach the upper floor windows from the exterior as was done at the well known LaSalle Street Fire in Chicago. We must realize though that this maneuver is rarely available at most high rise fires. There is simply only one way left and that is eventually fire companies must make a direct advance to the fire while using many times a larger diameter hose such as 2 ½ lines instead of 1 ¾ along with smooth bore nozzle applications . Volume and reach is the key when advancing into large floor areas in high rise structures. Another important factor for fire companies advancing into high rise fire floors is in knowing if possible the true volume of fire ahead of you, above you and possibly behind you. When advancing into open floor areas or down corridor areas the application of water streams should be directed periodically into the ceiling areas as you move forward. By directing streams into ceiling areas knocking out suspended ceiling tiles will help reveal fire travel above you while also avoiding fire travel unknowingly coming down behind you.

### **Understanding Stack Effect in High-Rise Buildings**

Wind and the movement of air throughout these types of structures should be of judicious concerns to firefighters and those commanding when there is smoke and fire present on arrival on a particular floor. However slight even the minimalist amount of wind or air movement could impact smoke and fire conditions. Good size-ups along with pre-planning these structures before an alarm occurs will give us a better understanding how stack effects can occur. Each structure depending on configuration and height will be affected differently from stack effect.

The circumstance under which stack effect is presented involves two major considerations. Lower floor fires in buildings on cold weather days and upper floor fires in buildings in hot weather days. Either one will produce different conditions on smoke, heat and fire travel. Even the slightest breeze coming through a revolving door in a large building will affect the stack effect. In cold weather days the stack effect seems to force heat and smoke to upper floors while hot weather days will move smoke and heat to lower floors. Taller buildings produce

more of the stack effect than shorter buildings. Hot air will rise throughout the structure traveling upward through anything it can get through such as stairways, elevator shafts and a host of other voids and pipe chases. Once it reaches the top it will escape to the outside of the building to cooler air while some of it will drop back down. So air is constantly moving from the lower floors upward and outward while other air is replacing it. Part of the conditions of stack effect is that an inflow of air is brought in through the lower floors. Air will always be taken in from the lower areas to replace air in the upper areas that has escaped. In some buildings it can be felt slightly while in taller buildings it can be felt quite strong. This affect creates movement of air and sometimes can provide conditions of a pronounced wind that would definitely affect smoke and heat conditions during firefighting operations which can affect our strategies and tactics.

Wind is usually an outside force but in buildings of this type the building is helping create the winds involved with stack effect. There are 3 elements that firefighters should concerned about when dealing with these kinds of winds.

- **The weather and temperature outside the structure.**
- **The height of the structure or number of floors.**
- **On what floor is the fire or area involved.**

The wider the difference in temperature from outside to inside will create stronger effects of this phenomenon. In simpler terms how much warmer or colder the air outside is to the air inside. The greater the difference in temperature the greater the effect. In cold weather conditions the hot air and smoke if present will travel through the interior stairwells and shafts while the building sucks in air on the lower floors. While in warm weather conditions with the buildings HVAC and natural spaces the stack effect begins to reverse, meaning the hot and smoke if present will drop down to lower floors and air is drawn in from the upper floors.

When fires are present in high-rise structures the location of the fire and the floor involved becomes very important as it relates to stack effect. Wind impacted conditions whether coming in from elevated areas or from lower areas will experience the influx of air. Temperatures affect the dynamics of conditions. Usually in colder weather the inward movement of air will occur on the lower floors while in warmer temperatures the inward movement of air will be on the upper floors. Stack effect increases the further away from either side of the midpoint of the building so the middle floors will experience very little effect. In colder temperatures will affect the lower floors while warmer temperatures affect the upper floors.

It also important to realize flow path conditions involving the main entryways into the structure such as revolving doors and larger hinged doors or automated sliding doors. You can feel the

inertia of wind from behind sucking you into the building when the temperatures are colder while during the warmer weather you were met with wind pushing out when entering. This is the presence of stack effect in a constant state of equalizing pressure within the structure.

### **High-Rise Vertical and Horizontal Ventilation and Feasibility**

Ventilation practices involving high-rise structures may be limited regarding vertical ventilation. There are many considerations when attempting to establish some form of vertical ventilation which can prove to be positive or less than desirable in conjunction with fire operations and extinguishment. Windows should not be broken especially in office high-rise structures. Even in low-rise structures between 4 and 7 floors many times should be avoided if possible. One of the major deterrent elements in taking windows out is related to wind currents which can affect fire conditions rapidly as well as hindering the attack of advancing hose lines into the fire area. We must also consider that vertical ventilation also includes opening doors, scuttles and fire towers above the fire floor and if so considered should coincide with a coordinated fire attack. If windows are to be considered for ventilation above the fire floor in order to attempt to establish vertical ventilation fire companies should first go to floors below the fire floor and to open or remove a window inward allowing members to check on wind conditions that would affect fire companies operating on a particular side of a building. This will give members and commanders a general idea of how forcible wind will affect the fire floor.

Another important consideration in taking windows at high-rise and low-rise structures is falling glass in the form of shards tumbling to the street below endangering firefighters, civilians, severing water supply lines not to mention falling onto closely staged apparatus around the structure. The basic premise in taking windows at these types of structures is in establishing horizontal ventilation and should only be considered when absolutely necessary. Any horizontal ventilation procedures must be conducted under strict command advisement especially if it involves the fire floor. If the procedures are necessary with all things taken into consideration as mentioned then we should ensure that it is performed on the correct side of the building. The conditions must be totally favorable or otherwise you will have created a severe and compounding threat to the firefight, search and rescue and occupant survivability. Many times high rise incidents involving fires that have grown to considerable proportions due to failure or late detection by building systems along with lengthened reflex times can also result in windows failing prior and during arrival of firefighters. Windows that have failed prior to arrival can result with wind driven effects which can be very abusive and difficult to extinguish by engine companies trying to advance on these types of fires. What we can say about horizontal ventilation at high rise fires is that it should rarely be used unless absolutely necessary. When it is undertaken especially on the fire floor it should be directed upon orders by the incident commander and under supervision by chief officers. There is no question that when employing

horizontal ventilation tactics at low rise and high rise structures that it be done on the correct side of the building with wind conditions in a favorable path of travel drawing smoke to be vented away from the structure not back in to the structure. Wind conditions may increase from floor to floor especially at higher elevations. Wind conditions should be checked on lower floors before attempts are made to ventilate horizontally on the fire floor or floors above.

If the decision is made to ventilate windows strict coordination employing chief officers as well as all personnel involved to ensure the safety areas on sidewalks below that have firefighters, occupants and wandering pedestrians protected from falling glass and debris. Also the consideration in using horizontal window ventilation at low rise and high rise structures require in some cases increases reflex time to get the job done depending on the techniques used and manpower available. The following guidelines should be considered and employed when using horizontal ventilation at low rise and high rise structures:

- **Identify and confirm the exposure side to be ventilated.**
- **Establish enough chief officers or fire officers to help coordinate the process.**
- **Establish all danger zones.**
- **Designate officers and personnel to clear all streets and areas below the intended ventilation area.**
- **Designate officers to any entry and exit areas from the building to the street side of the ventilation procedure.**
- **When ready to ventilate move and position chief officers and personnel into safe areas across the street or at distances that are adequate from falling debris.**
- **Encourage the procedure by firefighting personnel to remove glass preferably into the building rather than breaking or pushing glass and framing to the streets below.**

### **Firefighter Elevator Usage at High-Rise Fires**

When arriving on the scene of a confirmed high-rise fire just getting first-in companies parked and into the building with needed equipment can be challenging. Even more precarious is getting to the fire floor using elevators. Many departments are in controversy over the use of elevators at high-rise structures with confirmed fires. It is obvious that getting to floors above for both civilian needs and firefighting is the best way to travel through these buildings depending on what conditions we consider their use. During high rise fires elevators can

provide the means in getting personnel and equipment where it needs to be cutting down an already hampered reflex time. If used correctly elevators can provide a strong tactical advance to the fire area or improperly used they can be a death trap to firefighters and civilians alike.

There are two well documented ways firefighters can lose their lives at these structures and that will be when firefighters become lost and disoriented or it's going to be the result in the use of elevators. Many times elevators don't operate correctly even under firefighter control or even during firefighter operations due to as little as a gallon of water knocking them out. An elevator and the shaft it rides in provides excellent construction for fire, smoke, and heat traveling upwards like a chimney while also affecting mechanisms that operate the elevator car from within as well as mechanisms that run the car from the top. Just realizing these few considerations we can see that elevator use can become a calculated risk. For most firefighter operations at high-rise fires elevator usage is necessary due to the expenditure of energy required when manually carrying the equipment needed up tall high-rise buildings with many walking floors that may be involved. This means that when utilizing elevators that all precautions and training in their use be extensively covered.

Many departments especially city departments with several high-rise structures have operating procedures that ensure when an elevator is used that certain tactical procedures are used to ensure firefighter safety as well as occupants. When using elevators it is a good idea to make sure you have control while knowing where all stairwells are located throughout the structure. When moving elevators many departments make sure that the elevator is stopped at every 5 to 6 floors checking the floors for smoke while also checking the elevator shaft for the same. If a hatch is present inside the top of the elevator it should be opened when possible to monitor the shaft during the intermittent ascent upwards. Be prepared to stop the elevator at the given intervals when approaching the fire floor. If the elevator is not responding correctly you should press the emergency stop button and get off and walk up the rest of the way. You may also be presented with elevator doors that may need to be forced if an elevator is not responding correctly. The assembled team which is riding and controlling the elevator should always carry the appropriate equipment such as, forcible entry tools, portable radios, extra cylinders, high-rise hose packs and portable water while wearing SCBA.

Getting a first response team or fast team up to 2 floors below the fire floor is most desirable as quickly as possible when using elevators since the possibility of losing the elevator during firefighting is or could be probable. When water and smoke start filling the elevator shaft its control will most likely be lost. Once you arrive to the floors below the fire floor get off and check the layout of the floors and any maps they may be mounted on walls regarding stairwells. It is important to know their locations in relation to the fire in order to designate what will be attack stairwells and those that will be designated civilian stairwells. Stairwell management at

high-rise fires is one of the highest priorities for both firefighters and the evacuation of civilians. During high-rise fires many times occupants are fleeing down or even up stairwells. Many times you may have to withhold the fire attack in order to clear the descending occupants in order to prevent compromising the integrity of the stairwell.

The following list of tactics and concerns should be part of your operations at high and low rise structures.

- **At low-rise structures of 7 floors or less use the stairs to increase safety and reflex time.**
- **If heavy fire is present on arrival with fire venting use the stairs to compromised elevators.**
- **High-rise structures with multiple elevator banks provide for safer operations especially when using the low-rise banks available to get you closer to the fire floor.**
- **Do not use elevators that have elevator machine rooms whether being run from below or above that have indications of smoke or fire involvement.**
- **When multiple elevator banks are present use the ones that do not involve the fire floor if possible.**
- **Make sure elevators that are used are equipped with an approved fire service control system such as Phase II type elevators.**
- **Carry the appropriate equipment while wearing full PPE/SCBA**
- **Avoid overloading an elevator with personnel and equipment. Most elevators cannot handle more than 6 fully equipped firefighters.**
- **Make sure that your forcible entry needs provide for room to work if an elevator needs to be forced open from the interior due to compromise or improper landing alignments preventing hoist way doors from not opening properly.**
- **Remember that some elevators can open from both sides.**
- **Once an elevator is used for firefighter ascent one member should be left there with the proper equipment to control the elevator throughout the operations.**
- **Continue to inspect and control the elevator every 5-6 floors to examine conditions in the elevator shaft and the floors for smoke, fire and water runoff.**
- **Avoid using elevators that serve below grade areas.**

- **Never take the elevator directly to the fire floor. The minimum safest distance is getting off 2 floors below the fire floor.**

High-rise preparedness takes into account several disciplines which must be addressed by departments responding to these types of structures. Training and pre-planning these buildings is a must for every member of the department. Cooperation between building engineers who have more in depth knowledge of these buildings and their operating systems and those responding must be established prior to any incident that may occur. Building engineers and your communications with them on arrival at possible fires is the definitive edge in controlling fires and the safety of occupants and firefighters.