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City of Alexandria: Captain Mark Dalton
Arlington County: Captain Jeffrey Liebold
City of Fairfax: Captain Joel Hendelman
Fairfax County: Deputy Chief Jeffrey Coffman, Battalion Chief John Gleske, Captain John Caussin, Captain Michael Deli, Captain Floyd Ellmore, Captain Larry Jenkins, Captain Thomas Wealand, Captain Greg Lange
MWAA: Battalion Chief Michael Roberts

The following members of the Firefighting and Emergency Operations Technical Writing Workgroup participated in the revision of the manual in March 2012:

City of Alexandria: Captain Dan McMaster, Captain Jason Wehmeyer
Arlington County: Battalion Chief Jeffrey Liebold, Lieutenant David Santini
Fauquier County: Battalion Chief Randy Arft
Fairfax City: Captain Gregory Thuot, Captain Joseph Schumacher
Fairfax County: Battalion Chief Tyrone Harrington, Captain Dan Shaw, Captain David Barlow, Technician Matthew Tamillow
Fort Myer: Assistant Chief Bruce Surette
Loudoun County: Lieutenant Nicole Hankin
MWAA: Captain Gary Hubble, Captain Jason Graber
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PREFACE

Northern Virginia has several hundred high-rise buildings with many more under construction or in the planning stages. Preplanning is critical so that personnel can familiarize themselves with the wide variety of building layouts, sprinkler systems, standpipes, fire detection systems, and fixed fire suppression systems used in high-rise buildings. In addition, there are a significant number of high-rise buildings, both residential and commercial, that have nothing more than a standpipe for fire protection.

Each fire station shall ensure that preplans exist for the high-rise structures in their area. Where possible, a copy shall be placed in the fire control room at each building.

Fires in high-rise buildings have the potential to be one of the most challenging incidents to which fire department personnel respond. The potential loss of life is high and substantial resources may be required to evacuate building occupants. Also, due to their size and construction, fires can burn for extended periods of time before firefighters can locate and reach the fire area to initiate suppression operations.

The purpose of this manual is:

- To describe the differences between residential and commercial high-rise buildings;
- To identify the construction features and firefighting problems associated with fires in high-rises;
- To establish priorities for firefighting operations during high-rise incidents;
- To identify risks and hazards unique to high-rise buildings that must be understood by personnel engaged in operations at these buildings;
- To reiterate the priorities of life safety followed by property conservation;
- To provide guidance to company officers in directing and coordinating fire attack and all support activities; and
- To identify and establish assignments for apparatus responding on initial and greater alarms.

Significant changes from the original manual include:

- An expanded discussion of building construction.
- The addition of a fifth engine on the first alarm.
- The assignment of Lobby Control to the fifth-due engine.
- The assignment of forming a Rapid Intervention Team (RIT) to the fourth-due engine.
- The addition of content on strategy and tactics for wind-driven fires and fires in parking garages.
- The addition of content on the use of positive pressure fans.
DESCRIPTION

A high-rise building is defined as: *a building with either six or more stories or a building where the highest occupied story/floor is greater than 75 feet from the lowest level of fire department vehicle access.*

In February 1976, the Virginia Uniform Statewide Building Code was modified to require a fire control room in buildings having occupied floors located more than 75 feet above the lowest level of fire department vehicle access. Fires that occur in structures with fewer floors, or a lower building height, can still present the same challenges experienced in much higher buildings. A building four stories or more with at least one standpipe and one elevator may require the same tactical considerations as a high-rise but may not have the same built-in fire protection systems.

General Characteristics

High-rise buildings are present throughout Northern Virginia. These buildings vary greatly in height, ranging from six or seven stories to structures that exceed 30 stories. Most are built using fire-resistive construction; the fire protection systems across this variety of high-rise buildings will also vary widely.

High-rises contain a wide variety of occupancies including assisted living facilities, hospitals, business offices, apartments/condominium units, and hotels. Common features in such buildings include: community rooms, restaurants, gymnasiums, swimming pools, parking garages, trash rooms and chutes, compactors, dumpsters, and mercantile occupancies. Typically, these areas/rooms are located on the lower floors. Restaurants, bars, or clubs may also be located on the top floor of any high-rise. Depending on the occupancy, personnel may encounter a floor with many compartments, or in the case of an office setting, several thousand square feet of open area with cubicle workstations.

Specialized security features may be encountered in many government and private technology-type occupancies. These features can include vaults with lead-shielded walls and doors with raised floors to accommodate computer and communications wiring. Additionally, personnel may find reinforced and/or special locks that pose a forcible entry challenge.

Due to their height, a large portion of a high-rise building will likely be beyond the reach of aerial apparatus. Further, there is the potential for stack effect, reverse stack effect, and stratification related to the movement of smoke and heated gases.

Personnel must be aware of the time needed to assess the situation upon arrival of the first units, gather information from the annunciator panel or fire control room and building personnel, identify and confirm fire floor, proceed to that floor, locate the fire on the floor, and prepare to operate. This is known as “reflex time,” and may vary depending on the size of the building and complexity of the situation. For example, at a fire on the sixth floor of an office high-rise, 11 minutes elapsed from the time the fire department received the call until fire was out the windows. By the time crews got into position, five floors above ground level, two 2½-inch lines could not advance on the fire. The additional time that elapses during the reflex time allows the fire to grow in intensity and significantly change the conditions observed during initial size up.
Construction

Modern high-rise buildings are of two basic designs: residential and commercial.

**Residential** high-rise buildings with living and sleeping quarters can include hotels, apartment buildings, condominiums, hospitals, or assisted living facilities. These occupancies are characterized by center hallways, numerous interior compartments (such as rooms, closets, etc.), and 24-hour occupancy, Figure 1.

![Figure 1: Typical Floor Plan in a Residential High-Rise](image)

**Commercial** high-rise buildings are characterized by center-core construction, Figure 2, with circuit corridors around the core of the building and may have relatively large, open expanses on each floor. Occupancy loads are usually greater during normal business hours. Elevators, stairwells, and mechanical rooms are located in the middle core of the building. The office or residential space makes up the perimeter of the floor.

![Figure 2: Center Core Construction (May or May not be Compartmentalized)](image)
A common feature in newly-constructed hotel and office high-rise buildings is an atrium, shown in Figure 3 and Figure 4. These are typically located at the main entrance and are the focal point of the structure.

The atrium makes it difficult to control smoke conditions as many floors can be simultaneously exposed to smoke and fire conditions. Typical requirements for buildings with atriums include full sprinkler protection, smoke exhaust systems, and smoke curtains.

Figure 3: Open Atrium

Figure 4: Overhead View of Commercial High-Rise with Atrium
In buildings with long hallways, personnel may encounter fire-rated doors at various locations throughout its length, Figure 5. To best determine their location in relationship to the fire area and the standpipe, firefighters should observe a lower floor when possible. If the hallways are sectioned off by the use of fire doors, you will typically find a stairwell and standpipe for each area or section.

High-Rise with Long Hallways and Fire Doors

![Hallway Compartmentalized Fire Doors]

Figure 5: Fire Doors

Locally, there are two basic types of high-rise buildings: those constructed before February 1976, when modern high-rise requirements were enacted, and those that were constructed after the code change.

Buildings that were constructed prior to the 1976 code requirements are typically steel and concrete and may have a wide variety of design features and systems. Most are not sprinklered and do not have fire control rooms, modern fire alarms, or elevator control systems. Some have been, or are in the process of being, retrofitted to meet modern standards. Some features common to older structures include:

- Compartmentalized office and residential spaces with mazelike corridors;
- Non-compartmentalized open floor plans for commercial office occupancies;
- Presence of window air conditioning (AC) units and/or lack of building-wide heating, ventilation, and air conditioning (HVAC) systems;
- Conventional windows that may be opened;
- Lack of suspended ceilings (less hidden void space);
- Steel structural members encased in concrete;
- Exterior, masonry walls that are tied directly into each floor;
- Pre- or post-tensioned concrete floors; and
- Reinforced concrete columns.
A high-rise building constructed after the 1976 code change will be of fire resistive construction, which provides resistance to collapse of structural members and floors and resistance to the passage of fire through floors and horizontal barriers. Fire resistance does not address life safety concerns or the movement of toxic combustion products.

Required fire protection features include:

- A class III standpipe system. The outlets on this system are 2½ inches in diameter and have 1½-inch reducers;
- A compartmentation option existed for buildings built prior to April 1991, however, the vast majority of high-rise buildings in northern Virginia were constructed after 1976 and are either partially or fully sprinklered;
- Firefighter’s service to the elevators;
- HVAC systems capable of exhausting smoke;
- At least two approved means of egress from each floor;
- A local fire warning system;
- A building communications system;
- A fire control room; and
- Standby and emergency power systems.

With a few rare exceptions, all occupied high-rise buildings in Northern Virginia have:

- At least two approved exits from each floor;
- Enclosed stairwells; and
- Some type of smoke control system or compartmentation. This includes: windows that can be opened, tempered glass panels on at least two sides of the building that can be broken out, or a modified HVAC system that can exhaust smoke to the outside without contaminating other floors.

Building codes offer multiple opportunities for the builder to use “Trade-Offs.” For instance, compartmentation may reduce or eliminate the need for sprinkler protection. This fact reinforces the need for effective preplanning.

**Fire Walls**

Multiple layers or thick gypsum and masonry walls are typically used to enclose stairway, elevator, and other shafts. These will typically have a two-hour fire resistance rating, at a minimum. Masonry fire walls may be found separating occupied areas from storage, utility, and commercial areas.

**Roofs**

The roof of a high-rise may be of much lighter construction than the floors. It may consist of an insulated metal deck roof or be of the same construction as the floors below, but with a weather barrier installed.
Figure 6: Q Decking

A common type of flat roof construction uses composite Q decking with a rubberized or tar and gravel top layer (also known as a “built-up roof”) supported by steel bar joist, Figure 6.

The top floor/roof itself may use a different construction technique from the non-combustible lower floors. It is not uncommon to find a roof top community or party room constructed of light weight combustible materials.

Flat roofs may be surrounded by facades that give the appearance of a decorative pitched roof or an additional floor. They may protrude high above the actual roofline, such as mansard-style facades. Some high-rises have scuppers, which allow personnel to determine the height of the facade relative to the roofline, Figure 7.

Figure 7: Scupper
Access to the roof area is normally through a hatch or a bulkhead at the top of the stairwell(s) or through the penthouse machine room areas, Figure 8. Many buildings will have signage indicating which stairwells access the roof.

*These access points should be indicated in the first due company's preplan.*

![Figure 8: Bulkhead](image)

HVAC units may be found on the roof area or on various floors. Shut-off switches will be found adjacent to these units and possibly in the fire control room. Taller buildings may also have HVAC units at a midway point within the structure.

In most cases, elevator control rooms are located on the roof. The control panel (shut off) for each elevator is located in this room and should be labeled by the respective elevator car number.

Vertical ventilation shafts for the occupancies below terminate at the roof level.

Roof areas may also contain helicopter pads, communications equipment, antennae, microwave dishes, and guy lines.

**Attics and Ceiling Areas**

High-rise buildings typically do not have an attic. However, as discussed above, the top floor or penthouse often contains mechanical and elevator rooms. Companies must be familiar with these areas and realize that they could be found fully charged with smoke, as a result of a fire many floors below.

Steel truss ceiling assemblies provide an inherent and useful void space for piping, wiring for communications, and other building systems. Buildings with slab concrete floors lack an inherent void space; suspended and drop ceilings are often used to create void spaces. The plenum area
created by these void spaces is extensive, may lack fire stopping, and is often used for the return air side of the HVAC system.

In both instances, wiring/cabling is fed through poke-throughs and vertical utility shafts, providing avenues for vertical fire extension.

**Walls**

The interior walls of a residential high-rise, and when present in office use, will typically be made of gypsum board mounted to metal studs. Rarely, interior walls may be of masonry construction.

![Figure 9: Lexan Substrate Wallboard](image)

Due to increased security concerns, some occupancies (government facilities, mercantile occupancies, etc.) have begun to use reinforced drywall, shown in Figure 9. From an outward appearance, it looks identical to regular drywall but encased inside the drywall is either a wire mesh or a solid sheet of Lexan.

Interior walls can be constructed using 2”x4” wood, metal, or cubical partitions depending on occupancy, code, and age.

![Figure 10: Cubicles](image)
As shown in Figure 10, commercial occupancies may contain large open spaces with few interior walls and partitioned workstations, cubicles, etc.

Many buildings with newer construction have exterior curtain walls constructed of glass or pre-cast metal or masonry panels, Figure 11.

Due to the way curtain walls are mounted to the floor sections or frame of a building (bolted or welded brackets), gaps of 6 to 12 inches are common between the floor and exterior wall. Fire-stops are required; however, the efficiency of this barrier is questionable at best.

Expect vertical extension between these curtain walls and floor sections. Downward extension should be anticipated as well, including into the plenum on the floor below.

*Curtain wall construction should be denoted in the preplan and personnel aware of the construction method.*

![Figure 11: Illustration of a Curtain Wall](image)
Floors

Floors may be reinforced post-tensioned, cast-in-place concrete, or of reinforced pre-tensioned, pre-cast concrete. Another type of floor found in high-rise construction actually forms both the floor and the ceiling area for the level below. This is a composite “Q” floor assembly. As described by Francis Brannigan: “[t]he whole assembly including the ceiling, hangers, electrical fixtures, floor joists, left-in-place form-work for the concrete floor (corrugated steel), air ducts, diffusers, and the concrete floor, make up the entire floor/ceiling assembly.”

![Figure 12: Spray-on Fireproofing](image)

Fire resistive measures for floor/ceiling support systems include the direct application of spray-on fireproofing (also known as intumescent coating, it is shown in Figure 12) and suspended ceiling assemblies (known as membrane fireproofing). Note: In buildings built prior to 1980, sprayed-on asbestos fiber may be present.

The effectiveness of fireproofing depends on the installation and the original building inspection. Fire department personnel should document and report any compromise of these systems while on regular building familiarization visits.

Like other lightweight building materials, there has been a push in recent years for builders to use lighter versions of concrete. Low mass concrete was first patented in 1923 but it did not become popular until the early 1990s. Low mass concrete is also referred to as formed concrete and can consist of up to 20% air to reduce the density of the concrete. The concept behind low mass concrete is the use of alternative aggregates (used to solidify the concrete and make it stronger) instead of traditional aggregates, such as stone and sand. These alternative aggregates include foam polystyrene balls (super lightweight concrete) or shale, clay, vermiculite, pumice,

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and scoria (lightweight concrete). In addition, it is 10-88% lighter than traditional concrete depending on how the mixture is proportioned.

Alternative and low mass concretes carry the same benefits of traditional concrete and insulate better, are easier to handle, and resist freezing, all while carrying the same life expectancy as traditional concrete. Another form of low mass concrete that is currently available is hollow-core precast, pre-stressed concrete, which has hollowed out midsections reducing the overall mass of the finished product.

Traditional concrete has a density range of 150 pounds per cubic foot (pcf). Lower mass concretes can be broken down into two categories—light weight concrete, which ranges in density of 60 to 100 pcf, and super light weight concrete, which carries a density of less than 60 pcf. Low mass concretes provide a higher compression strength at 60,000 psi compared to traditional concretes which only offers a 20,000 psi strength.

Research shows that under fire conditions failure occurred at 80% of the designed load after 45 minutes of fire exposure. Additional studies have shown that thermal cracks appear within 14 to 16 minutes of fire exposure. Personnel need to be aware that this kind of material, in a solid state, can be considered a stable product suggesting a fire resistive building material. But when the additives break down the material is no longer in its finished composition, leading to failure, Figure 13.

![Failed Lightweight Concrete](image)

**Figure 13: Failed Lightweight Concrete**

**Basements**

Basements or below grade areas contain a multitude of uses including: parking garages, trash compactors, mailrooms, dumpsters, storage areas, and utility rooms or tunnels. Smoke migration can occur via the stairwells and doors leading from the garage. A fire condition in any of these areas above can lead to a smoke-filled building.
In particular, parking garages present a number of challenges. Specifically:

- The garage may extend out beyond the main structure and even serve the area below an adjacent structure.
- The covering slab of concrete may be designed to carry only the weight of automobiles, making apparatus access to the area complicated or impossible.
- Radio operations may be difficult.
- Garages may not be sprinklered; a dry standpipe may be all that is present.

**Windows**

Most windows in a commercial high-rise are covered with a sun-screening plastic coating, which may run from floor-to-ceiling, and surround the entire building. Many high-rise buildings, particularly those with newer commercial construction, have fixed windows that cannot be opened; this is to help control the loss of treated (heated or cooled) air. These windows typically are plate glass, tempered glass, or Lexan.

Generally, buildings with fixed windows are required to have certain windows that can be broken in the event of an emergency. The windowpanes that *can* be broken are marked with a Maltese cross or a fire helmet etched in the lower corner of the pane. Some of these windows may also be opened with special keys or devices. *This information should be contained in the building preplan.*

Buildings with windows that can be opened are primarily found in residential occupancies. These can include casement and double-hung windows.

**Doors**

Doors that separate the various occupancies within a high-rise are either fire-rated metal or wood in metal frames. These are inward opening – that is, the door swings into the apartment or office from the hallway. The presence of outward opening doors indicates an electric or telephone room, or other type of closet.

Doors from the stairwell to the hallways swing into the stairwell. Personnel should keep this in mind as they plan a hose advance from the standpipe. At a minimum, any doorway a hoseline passes through should either be controlled by a firefighter or chocked open.

Doors leading from the stairwell to the hall, roof, or mechanical room may be locked above the lobby or first floor level. The first engine, truck, and/or rescue squad proceeding to the fire floor should be equipped with keys and always have forcible entry tools available.

In buildings with fire control rooms and electric locks on stairwell doors, the doors will usually unlock automatically when the system goes into alarm to provide unimpeded access/egress. Keep in mind that the doors will lock again if the alarm system is reset. If the doors are locked and personnel enter the stairwell from any floor above the first, it will be necessary to return to the main lobby level in order to exit the stairwell. A stair door unlock switch, which will simultaneously unlock without unlatching stairway doors, may be in the fire control room.
In occupancies such as hospitals, hotels, or assisted living facilities, sections of hallways are usually divided into compartments by self-releasing, fire-rated doors. These doors are usually held open by electromagnetic devices and may be closed either manually or by fire alarm activation.

Exterior doors at the entrance level of the commercial or residential high-rise are typically glass aluminum-type construction with a mortise-type lock.

In buildings that contain balconies, the door from the office or residential unit is predominantly a sliding-glass type.

**Stairways**

Several different types of stairways can be expected in high-rise buildings, Figure 14. Openings for ventilation may be found at the top of some stairwells and some may be equipped with fans that can be used to pressurize the entire stairwell.

*The stairwells in the building should be clearly identified on the preplan and indicate whether natural openings are present for ventilation purposes.*

*Isolated stairs* usually have individual entrances and access only one section of the building.
Most high rise buildings will have at least one stairwell that provides access to the roof either through a hatch, such as the one shown in Figure 15, or bulk head door. Expect these access points to be locked. Many buildings provide signage indicating which stairwell accesses the roof. This information should be reflected in the building preplan.
**Scissor stairs**, shown in Figure 16, may be found in center-core construction, although this is rare. These stairs are simply independent stairwells on either side of the core. However, in some cases, each stairwell will only serve every other floor. In other words, one of the stairs may serve the even-numbered floors and the other the odd-numbered floors. This type of stair can lead to confusion on the fireground because the mislabeling of the stair can lead to companies entering the wrong floor or in the wrong area of a floor.

**Figure 16: Scissor Stairs**

**Accommodation stairs**, also known as *access* or *convenience stairs* are open, unprotected stairways leading from floor-to-floor within a single occupant’s space, Figure 17. They allow the tenant to move throughout their occupied space without using public stairwells or elevators.
Should a fire occur within the occupancy, it can easily spread to all of the floors serviced by this type of stairway.

![Accommodation Stairs](image)

**Figure 17: Accommodation Stairs**

In buildings constructed after 1976, the stairways should contain hard-wired communications linked with the fire control room. These are usually in the form of a red box containing a telephone handset and marked for use only by the fire department, Figure 18.
Newer high-rises may have a security gate installed at the lowest floor level that terminates at an exterior entrance, Figure 19. Personnel should recognize this feature when either attempting to exit or while assisting with the evacuation of civilians.

**Figure 18: Firefighter’s Use Phone**

**Figure 19: The Presence of the Gate Denotes the Last Floor with an Exterior Entrance**

**Standpipes and Sprinklers**

Automatic sprinkler systems are in place in high-rise buildings constructed after 1976, unless the compartmentation option was chosen. In earlier constructed buildings, the presence of sprinklers is intermittent. Companies must know in advance whether a particular building is fully or partially sprinklered and what areas are protected.
The majority of standpipes found in interior applications at a high-rise are wet systems. However, some older structures are equipped with dry standpipes. Be aware of added time requirements and the potential for foreign objects in the connections when charging these systems with water.

For buildings with standpipe and sprinkler systems, there is either a combination Fire Department Connection (FDC) that supplies both systems, Figure 20, or individual FDCs for each system. There have been instances where these connections have been incorrectly marked. \textit{Preplan and become familiar with the systems in your response area.}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure_20_combination_wallfdc.jpg}
\caption{Combination Wall FDC}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure_21_yard_stanchionfdc.jpg}
\caption{Yard Stanchion FDC}
\end{figure}
FDCs may either be mounted directly on multiple sides of a building (Figure 20) or away from the building in the surrounding yard, often referred to as a yard stanchion (Figure 21). Both will supply the system and must be noted in the building preplan.

Generally (after 1976), a hydrant should be located within 100 feet of the standpipe and sprinkler FDCs, Figure 22.

![Figure 22: Hydrant Located within 100 feet of FDC](image)

Personnel should be aware that newer or remodeled structures may have installed large diameter hose (LDH) FDCs, Figure 23. Many of these new FDCs have also incorporated locking caps, which can only be opened with a specific key (e.g., Knox), Figure 24. This information should be in the preplan and shared amongst responding companies as opening the FDC without the key is virtually impossible.
The location of standpipe riser outlets in stairwells can vary depending on the stairwell type and location. Some stairwells may lack standpipe riser outlets due to the proximity to other risers in the building.
Depending on the floor area and stairwell location, standpipe riser outlets may be located at midpoints in the hallways, Figure 25. Due to the level of protection provided by the landing door, where feasible, preference should be given to using risers in the stairwell. Personnel should refrain from using hallway risers unless absolutely necessary.

Figure 25: Standpipe Riser Outlet Located in Middle of a Hallway

Sprinkler control valves for each floor may be found at stairwell landings, Figure 26. Additionally, depending upon the length and size of the structure, valves may be located in hall closets or recessed above the drop ceiling. *The location should be noted in the building preplan.*

Figure 26: Sprinkler Control Valves

As shown in Figure 27 and Figure 28, there are pressure-reducing valves (PRV) on some of the standpipe riser outlets in the region, although many were removed in the early 1990s. These can severely restrict flow for fire streams being deployed in the fire attack. If possible, these must be
bypassed for fire department use. They can be defeated by breaking the “L” shaped arm that restricts the riser wheel. *Individual characteristics should be noted in building preplans.*

![Figure 27: Pressure Reducing Valve](image1)

![Figure 28: Pressure Reducing Valve](image2)

Many buildings are equipped with a fire pump designed to supplement incoming domestic water pressure. They run off various power sources such as natural gas, diesel fuel, or electricity. Many are connected to the building’s back-up emergency generator. A majority are centrifugal-type pumps. Their location should be indicated on the building preplan.

**HVAC Systems**

Central air conditioning within a high-rise may interconnect ten to twenty or more floors. Ducts, shafts, and poke-through holes penetrate fire resistive floors, walls, and ceilings. This allows smoke to spread throughout the floors.

HVAC ducts at perimeter windows of the building may be fed fresh air from the ducts located in the ceiling of the floor below. This permits rapid fire extension.
Many modern systems have full exhaust capabilities of the respective area. Some also have dampers, a form of passive fire protection installed in the ductwork, which is a device controlled by fusible links that limits fire spread through the ducts. Additionally, some structures have duct smoke detection systems that automatically shut down the HVAC system.

*Department personnel must work with building engineers and fire prevention personnel to become familiar with the features of HVAC systems in the buildings located within their response areas.*

**Elevators**

Elevators in high-rise structures are typically controlled by electric traction. Control rooms are located at the top of the elevator shaft. Some shorter buildings may contain hydraulic elevators.

Some newer high-rises have elevators that do not require a conventional elevator room. These elevators employ a flat belt design that allows the machinery to be mounted in the elevator shaft and/or on top of the elevator car. Figure 29 shows an example of the Otis Gen2 elevator that uses a belt-driven system; the elevator penthouse may only contain electrical cabinets for the elevators as shown in this figure.

![Otis Gen2 Elevator](image)

**Figure 29: Otis Gen2 Elevator**

Express elevators, which bypass a portion of the building via a blind shaft, are found in many high-rises throughout the area. A blind shaft serves only a specified portion of the building and has no openings on other floors. For instance, an elevator bank will allow entry at the lobby level but may only serve floors 13-26 of a 26-story high-rise, Figure 30. These elevators are sometimes referred to as low-rise and high-rise banks.
The fire control room in newer center-core construction, or lobby level, will typically have a master locator panel for the elevator banks. Communications to the fire control room is present in cars installed after February 1976.

Independent service is not to be confused with firefighter’s service. In independent service the elevator car doors will open automatically when arriving at the specified floor. In firefighter’s service, the doors will not open until the “door open” button has been activated. Freight (oversized) elevators may be present in an area remote from the main bank. Freight elevators should not normally be used during emergency operations. However, if the freight elevators are located in an area not affected by the fire, smoke, or products of combustion, personnel can exercise judgment as to their use.

Fire, heat, and water (even in small amounts) can cause elevators to malfunction. This can and has occurred regardless of firefighter’s service control. Firefighters should expect that if an elevator has been subjected to any of these conditions, there could be a malfunction.

Elevators, with car number designations, should be identified in the building preplans.

**Elevator Procedures and Operations**

Elevators are essential for vertical transportation of personnel during a high-rise fire and a working knowledge of their operation is imperative. All personnel should refer to the NOVA Elevator and Escalator Emergencies section on “Elevator Use During Fire Operations” for specific information on elevator use in high-rise fires.
Fire Control Room and Alarm System Features

The introduction of sophisticated electronics, sensors, and control mechanisms has altered the monitoring and suppression capabilities in high-rise buildings. These features are incorporated throughout the building and terminate at the fire control room. A fire control room is used for any system in a high-rise where detection, fire protection, air handling systems, and communication are centralized for fire department use. Status boards indicating operational modes for the systems present in the building are in the fire control room. (Note: These rooms are required in high-rises constructed after 1976.)

Fire control rooms are usually located near, or at the main lobby entrance, typically at an outside wall. Fire control rooms must be marked with a sign. However, companies should know their location from pre-incident planning and familiarization.

If present, fire control rooms will contain the following:

- Annunciator panel(s) – A unit containing one or more indicator lamp, alphanumeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location (e.g., pull station, duct detectors, etc.) Additionally, the panel may indicate the status of building systems (sprinkler water flow, fire pump, emergency generator, etc.), Figure 31.

- Telephone communication systems (also known as “fire phones”) – A system distributed throughout the building for fire department communications. Phones are located in elevator cars, floor lobbies, and stairwell landings on each floor. When a fire phone is taken off of the hook, it triggers a notification/indicator in the fire control room.
Figure 31: Fire Alarm Annunciator Panel

- Public address systems – A system is designed to allow personnel in the fire control room to communicate to any single floor, combination of floors, or the entire building. Speakers are located in hallways, elevators, stairwells, rooms, or tenant space exceeding 1,000 square feet, and all dwelling units. In addition to the use of the public address system, individual floors can be placed into alarm to assist in the evacuation operation.

- Pressurization/smoke control systems – These systems will activate in the presence of an alarm. Several types may be found in a high-rise, such as:
  - Stairwell Pressurization. Upon activation of an alarm, large fans will pressurize stairwells to reduce and eliminate smoke that enters the stairwell. In some systems a smoke ventilation system is used, which is a small fan at the base of the stairwell.
  - Corridor Pressurization. Fans that pressurize the fire floor hallway to prevent the entry of smoke into the common area from the involved unit.
  - Elevator Pressurization. This is an additional feature found in some high-rises. The elevator shaft becomes pressurized to prevent the entry of smoke.
- HVAC – These can be controlled to assist in removing areas of smoke during an incident via HOA (Hand-Off-Auto) switches in the fire control room.

- Emergency generator and standby power status – Provides emergency lighting and power when needed. The generators are designed to operate the elevators one at a time in order to bring each car to the lobby and open the doors in the event of a power failure.

- Automatic door unlocking systems activate when the building goes into alarm. These electric locks must also release with loss of electrical power and under manual override. This includes those corridor doors held open by electromagnetic devices.

- Telephone with an outside line for communication.

- Key box with multiple sets of keys.

- Copy of building plans indicating a typical floor plan, means of egress, fire protection systems, and fire department access.
HAZARDS

This section covers the wide variety of hazards that may be present during high-rise fires and emergency incidents.

Life Hazards to Occupants

Experience has shown that there is the potential for a high loss of life in any high-rise building, regardless of occupancy; fires in both office and hotel situations, such as the MGM Grand fire in Las Vegas, have had disastrous outcomes.

Fires in commercial occupancies have the ability to involve an entire floor, or large portion thereof, since often there is little or no compartmentation. This feature is due to the use of workstations and cubicles rather than separate, divided offices. Fires that occur in either hotel or residential occupancies have the advantage of a greater level of compartmentation and therefore have significantly less potential for both horizontal and vertical fire extension.

Due to smoke contamination of stairwells, elevator shafts, and other common areas, occupants may panic as smoke spreads through the structure and elevators are recalled to the lobby. Smoke entering any floor is likely to cause occupants to attempt self-evacuation. Communication via the public address system, if available, can help to allay some of the occupants’ fears.

It is imperative that personnel quickly identify and establish evacuation routes to enable the safe and orderly movement of building occupants to locations below the fire. Personnel should also consider that the best way to control occupants and maintain their safety may be to “protect in place.” That is, rather than a complete evacuation of the building, only occupants on certain floors are evacuated as occupants moving down the stairs can pose a significant challenge to fire crews who are trying to move up the stairs. Firm direction from the fire department is crucial and should be preplanned and practiced prior to an emergency incident.

Evacuation of a high-rise building requires the commitment of a substantial amount of resources. If more than two floors above the fire still contain occupants, a Search and Evacuation Branch should be established with a chief officer in charge. An evacuation on a smaller scale may only require the use of a Search and Evacuation Group.

Collapse

Historically, collapse of high-rise buildings, or portions of these structures, has not been a significant problem. Even with the fire that occurred at One Meridian Plaza in Philadelphia, when engineers advised the Incident Commander that interior operations should be discontinued due to concerns about structural stability, there was no collapse. Fire resistive construction has proven to withstand incredible fire involvement without collapse. There have been instances where portions of a ceiling, including the Q-decking, have dropped in a localized area after intense fire exposure; however collapse of the building did not occur. On September 11, 2001, the World Trade Center collapsed due to the combination of flammable fuel and structural damage from the aircraft. This level of impact and subsequent fire is not typical in high-rise fires.
However, personnel should not view a high-rise as being impervious to collapse hazards. The collapse of a suspended ceiling with its spider web-type maze of cross-tees will trap firefighters, rendering escape impossible. If the membrane of the suspended ceiling has been compromised, firefighters should expect at least a partial failure of the ceiling assembly. Additionally, Internet and cable wires are often hidden behind crown molding which can quickly fail under fire conditions and expose low hanging wires.

**Smoke Movement**

The term “mushrooming” refers to the typical smoke movement found in residential and commercial structures without impact from environmental conditions, Figure 32.

Mushrooming results in smoke rising upward from the fire floor until it reaches the roof/ceiling level. The smoke then banks off of the roof/ceiling and migrates downward, back towards to the fire floor.

![Figure 32: Mushrooming Smoke](image-url)
Smoke may also move vertically through elevator shafts, stairwells, and other passageways, which can result in smoke contamination of any floor above the level of the fire.

Arriving companies should also consider the effects of sprinkler activation. “Cold smoke,” which is cool and low-lying, characterizes fires brought under control by sprinkler systems.

**Stack Effect**

The *stack effect* is the natural movement of air within a relatively tightly-sealed building due to the temperature difference between the air on the inside and outside of the structure, Figure 33. Hot air is less dense than cold air and tends to rise through stairways, elevator shafts, and utility chases.

Smoke will rise until the temperatures balance, at which point it begins to settle, or stratify. Stratification may occur in sealed buildings when the temperature of the smoke produced is not sufficient to cause it to rise all the way to the top of the building.

The stack effect is more noticeable in winter due to the considerable difference between inside and outside temperatures.

![Figure 33: Stack Effect](image-url)
Reverse Stack Effect

The stack effect can be reversed (referred to as reverse stack effect), resulting in the movement of air in a vertical shaft, due to the outside temperature being higher than that inside, Figure 34. Such is the case in tightly sealed air-conditioned buildings during summer. This can result in smoke migrating to a floor level below the actual fire floor.

The reverse stack effect is less significant because the amount of stratification is proportional to the difference between the two temperatures. The temperature differential in the summer months is far less than in the winter.

Figure 34: Reverse Stack Effect

Backdrafts, Flashovers, and Wind-Driven Fires

A backdraft or flashover can occur in any structure. In a high-rise, hazards associated with these phenomena are primarily related to contents, but can include interior finishes. Although fire codes have changed over the years to more closely regulate what interior finishes can be used, situations that allow rapid fire spread over wall and floor coverings may still be encountered.
In office or other commercial occupancies, much of the fire loading is exposed due to the lack of compartmentation. An advancing fire quickly heats the products that have not yet ignited which leads to rapid fire spread. Since the area is often not vented, nor able to be, temperatures within the involved area rise rapidly. As the contents continue to be heated, large amounts of smoke and other fire gases are produced. As these ignite, rollover extends outward from the seat of the fire, in turn causing radiant heat to expose much more of the contents, quickly leading to flashover conditions. Since the area is often undivided, this phenomenon is self-perpetuating until a large area is involved. This can rapidly spread over an entire floor, depending upon the layout.

To prevent flashover, it is imperative that the overhead area is cooled with hose streams. This is the most effective method for controlling and preventing flashover. Additionally, since crews are dealing with enclosed or confined spaces, straight or solid streams must be used.

Personnel must also be aware that a backdraft can occur in any enclosed area within a structure. The plenum space, or area above the ceiling, is a clear avenue for a rapid collection of smoke and super-heated gases. Advancing personnel must check this area either with a thermal imaging camera or physical inspection.

Along with the possibility of a backdraft or flashover, there is the threat of wind-driven fires on upper floors where the windows have been compromised. These fires may burn with such intensity that they can destroy fire barriers, posing a serious threat to firefighter safety. Numerous firefighters and civilians have been killed or injured in this type of fire. Most wind-driven fires occur in the upper stories of high-rises, but have also been documented in lower levels down to the third floor. Additionally, these hazardous conditions can exist with exterior winds as low as 10-20 mph.

Five conditions must exist for a wind-driven fire to occur:

1. Fire in the structure.
2. Failed or open window to the outside in the fire area/apartment.
4. Failed or open door to area/apartment leading into a common hallway (usually caused by the fleeing occupant leaving the door open).
5. Unobstructed path to an outlet for the fire to vent (open apartment door across the hall, open stairwell door, or open bulkhead door).

Recognition of a wind-driven fire from the street level along with proper tactical deployment of resources is critical for the safety of personnel.

To aid in size up of a wind-driven fire, personnel should be aware of the following:

- Presence and direction of the wind from the street level;
- Failure of windows to the fire area/apartment;
- Lack of smoke and flames pushing from the failed window AND/OR intermittent smoke and flames pushing from the failed window (depending on wind/gusts); and
- Presence of a large volume of fire within the fire area/apartment.
Once personnel reach the fire floor, they must ensure that they communicate the fire conditions to Command. The situation report should include the volume of fire, intensity of heat felt and temperatures observed through the use of a thermal imaging camera. Additionally, the first due truck should advise immediately if they can close the door to the fire area/apartment. Closing the open door will interrupt the flow of the wind driven fire and may allow companies to advance a hoseline from the stairwell.

The wind-driven fire requires that either the first due truck and/or rescue squad establish a safe haven/refuge area by forcing entry into an adjoining apartment. Personnel should not force entry or open the door of the apartment directly across the hall from the fire apartment as this will allow the wind driven fire to have an outlet and increase the intensity of the fire. Additionally, by forcing or opening the doors of the apartments next to the fire apartment, personnel can establish alternate means of suppressing the fire. This may be accomplished by breaching an adjoining wall and directing the stream through the wall and on the fire. If this tactic cannot be employed, personnel can deploy their hoseline to the adjacent balcony and direct the stream into the fire apartment from there.

The National Institute of Standards and Technology (NIST) recently demonstrated several alternative tactics that have shown positive results when personnel cannot make entry into the hallway. They are:

1. An exterior attack using elevated master streams through the fire apartment window.
2. Exterior attack via portable ladders.

*If either of these tactics is employed, communication is paramount and must be coordinated between interior and exterior companies. The exterior personnel preparing for attack must ensure that no fire department personnel are present in the apartment or common hallway prior to flowing water.*

Coordinated ventilation is also critical to the suppression of a wind-driven fire given the intensity and behavior of these fires. *If wind-driven fire conditions are present, no horizontal ventilation should be performed until directed by Command.* Additionally, personnel should not vent the bulkhead of any stairwell until personnel on the fire floor can confirm that the stairwell doors are closed and controlled.

**Fire Extension**

Fire resistive construction is designed to limit the spread of fire and not contribute to the fire load. Additionally, the extensive use of sprinkler systems in Northern Virginia minimizes the threat of large-scale fires. However, the concern is for those situations where, for whatever the reason, the sprinklers do not control the fire or are turned off. Contents of these buildings have a rate of heat release that can allow a fire to double in size every 90 seconds.

Fire extension will be a significant concern if the fire is located on the lower two or three floors of a high-rise with mercantile occupancies (restaurants, bars, hair salons, etc.) Meeting rooms, ballrooms, and storage areas may also contribute to the fire problem. Fires in these areas can be quite severe, as the fire loading is higher than the light load in the guestrooms or residences. For
this reason, locating the fire and identifying what is involved is paramount in making strategic and tactical decisions. These same occupancies can occasionally be found in some office buildings.

Horizontal fire extension in commercial occupancies can quickly involve a large portion of a floor area since there may be little or no separations. Floor areas in excess of 15,000 square feet are not uncommon. If a fire goes unchecked by sprinklers or other extinguishment systems, involvement of large areas is likely.

Vertical fire extension can occur by several means:

- Fires leap frogging out of windows and extending into windows above (auto exposure).
- Fire extending up through unprotected or compromised void spaces.
- Fire extending up the space between the floor and curtain wall.
- Fire entering elevator and other shafts.
- Fire extending upward within an occupancy that occupies more than one floor and has installed an access or convenience stairway.

Other Hazards Found in High-Rises

**Floor-Length Windows**

Some buildings have windows that extend from floor to ceiling. These can be found in any occupancy type. Cases have been documented where windows have either failed or were taken out by firefighting crews resulting in personnel nearly crawling out of the structure. Extreme caution must be exercised when visibility is significantly reduced or non-existent.

**Open Shafts**

Unfortunately, open shafts have led to serious injuries and firefighter fatalities. As noted above, personnel must be vigilant while operating in low or zero visibility environments. This caution must be exercised at all locations and floor levels in the building.

**Vents for Hood Systems**

Vents for hood systems may be present anywhere there is a food processing operation. Restaurants may be located off the lobby or mezzanine levels as well as the top floor of the building. However, other kitchen areas may be present for food preparation for banquet halls and ballroom facilities. All of these will have ventilation for the hood systems leading to the outside. In some cases, this ductwork may run great distances, including the full height of the building, terminating at the roof level. A fire in these ducts can lead to fire extension far removed from the cooking area should the duct be compromised or combustibles located close to the duct ignite.

**Laundry, Mail, and Trash Chutes**

Laundry, mail, and trash chutes are building features exist for the convenience of building occupants, Figure 35. However, they also provide an unobstructed path for smoke movement and
fire extension and may or may not be protected by sprinklers. Smoke may be reported on a floor far removed from the actual location of the fire, which is most likely in the basement or first floor loading dock area.

Figure 35: Trash Chute

An additional problem with laundry and trash chutes is the possibility of a bag of clothing or trash becoming suspended in the shaft. If this occurs just at or below the access door to the shaft, fire could enter the floor area if the door is opened to investigate. Personnel should check the trash chute doors on each floor to determine the location of the obstruction. An effective suppression method for chute fires with an object lodged along the chute is to drop a heavy object from a level higher than the lodged object. The object will become dislodged and travel down to the end of shaft so it can be extinguished and removed. Communication is paramount for this operation to occur safely.

**Dumpsters and Compactors**

These containers can be a particular hazard when attached to or located inside the building. Often, trash chutes allow rubbish to be deposited from any floor level and the shaft leads directly into the dumpster or compactor, Figure 36. Smoke from a fire in such a container can contaminate a large part of the building with smoke and toxic gases. While the possibility for fire extension exists, smoke and gas contaminating the structure is the greatest concern. Some dumpsters have a 1½-inch outlet for drainage.
Utility Shafts

As with other vertical shafts, utility shafts often run the entire height of the building. Plumbing and electrical components must enter and exit every floor level and these voids provide this access. Should fire or smoke enter these areas they can be transmitted upward or downward. In particular, fires involving kitchen and bathroom areas should be a signal that extension into one of these shafts is a possibility.

Hazardous Storage

Due to the wide variety of occupancies found in high-rises, many different products are often found within these structures. However, the greatest concern is for the storage of products used in the operation of the building and its amenities. Many hotel and residential high-rise buildings have pool facilities and the storage of the associated chemicals is just one example of what may be encountered. Additionally, paints and janitorial supplies are likely to be stored at various locations in the building.

Electrical Vaults

These rooms may be present almost anywhere within the building. Firefighters operating in limited visibility must be extremely careful not to inadvertently enter one of these rooms. Firefighters who come across a metal door which opens toward them should suspect one of these rooms. While no longer commercially available, carcinogenic Polychlorinated Biphenyls (PCBs) may be present.
Falling Glass and Debris

As fires become more severe and the outer skin of the building is compromised, great care must be exercised in the protection of firefighters, evacuees, and spectators from falling materials. Shards of glass have been known to travel great distances in windy conditions and can be extremely dangerous. Protection must be provided for firefighters operating apparatus, advancing hoselines, and those entering and exiting the building.

Buildings Under Construction

Units that respond to fires in high-rise buildings under construction must carefully evaluate the stage of completion of the building.

Buildings under construction are required to have a riser two floors below the finished floor. However, if concrete work is still underway and the formwork is in place and burning, personnel must not be committed to the interior for operations. Every effort must be made to fight the fire from exterior positions, as the formwork supporting the curing concrete is being destroyed.

Heavy caliber streams will probably be necessary if the fire is located on upper floors. Use of tower ladders and ladder pipes is recommended. A severe hazard associated with this situation is falling debris. Construction materials, tools, and other items not attached may be washed off the building by these streams. Officers must ensure that the perimeter of the building is secured to avoid injury from these falling items.

Personnel must also consider the possibility of propane cylinders being involved. In addition to the possibility that cylinders are the source of the fire, explosion hazards and the threat of cylinders dropping off the building must also be considered.

The potential collapse of walls or portions of walls must be taken into account. Buildings under construction often have sections or pieces of the outer skin of the building fastened into place along the floor lines. Fire impinging on these wall sections can cause the connections to fail and drop the section. Personnel should position accordingly in a flanking position and/or at the corners of the structure under construction.

High Security Areas

Various businesses and agencies have the need for high-level security. Accessing these areas for search or fire attack may be challenging and creative forcible entry may be necessary. Additionally, due to security needs, occupants of these areas may be very reluctant to evacuate.
Radio Communications

Communication between operating units and Command functions is imperative for a successful outcome. However, due to the construction of these buildings, fire department radios often do not function as well as they might under normal circumstances. This must be recognized and addressed. Also, personnel should consider using building communication systems, when available.
FIRE OPERATIONS

As discussed throughout this manual, the unique features of high-rise buildings result in strategic and tactical challenges. A working fire in a high-rise often is not always apparent from the exterior of the building. Serious fire can develop in a location that is remote from the exterior skin of the structure; as such, a report of “nothing showing” needs to be aggressively investigated. Additional signals that are received on the annunciator panel(s) in the fire control room are a strong indicator of an advancing fire.

If smoke or fire is showing or once a fire is confirmed within the structure, requests for additional resources must be considered quickly. Experience has also indicated that a routine fire in a high-rise building will require more resources than a similar fire in other structures. The Incident Commander should evaluate the need for additional resources and make requests for additional alarms commensurate with the severity of the situation. Command officers should also consider requesting a RIT Level II response to supplement the operation.

Due to the need for an unusually high commitment of resources, the process of control and accountability of each unit is of paramount importance. An exceptionally high level of discipline will be required of all officers and personnel during high-rise operations. Failure to follow any portion of the operational plan can lead to a breakdown of the entire operation and could result in firefighter casualties.

Operational Plan

The operational plan for high-rise fires must consist of five basic points:

1. Determine fire floor.
2. Verify fire floor.
3. Control occupants.
4. Control of building systems.
5. Confine and extinguish the fire.

Determine the fire floor from information on dispatch, information from building occupants, obvious smoke or fire showing from the structure, and by checking annunciator panels or fire control room indicators.

Units must investigate to verify the exact location of the fire, including the specific location on the fire floor and the extent of fire involvement.

If necessary, evacuation of the immediate fire area may be needed as well as facilitating movement of people already in the stairwells. Size-up may also indicate that control of occupants will be accomplished by protecting in place.

Building systems must be brought under fire department control. At a minimum, this must include control of the elevators, fire pump, and any air handling system(s).
Fire load characteristics are also an important consideration. The 17th edition of the Fire Protection Handbook\(^2\) states that fire load in general office space is about 7.7 pounds per square foot (psf). A conference area is approximately 5.9 psf while a file area is over 16 psf. Moreover, fire loads are typically higher in government buildings, of which are prominent throughout Northern Virginia. As a result, personnel must be aware that a tremendous amount of heat can be generated in a very short amount of time.

Due to the high degree of compartmentation in residential or hotel high-rise buildings, fires are less likely to involve the entire floor. Even though compartmentation helps control fire spread, extreme caution must be exercised when advancing down a hallway as fire can move rapidly down a corridor if an entrance door to an involved occupancy is open.

Exposure protection not only involves checking the floor above, but also requires companies to be assigned to check areas extremely remote from the fire floor. Fire can extend via hidden voids and break out many floors away from the original fire.

Ventilation, forcible entry, and fire attack must be coordinated. A significant fire may be present on a floor that has confined itself to that floor but also prevented any heat and smoke from venting to the outside. Punishing conditions should be expected. Wind conditions, in terms of force and direction, must be determined near the fire. At high-rise fires, wind conditions at the level of the fire can be very different from what is happening at ground level.

At residential high-rises, ventilation is more likely than at commercial occupancies. In residential high-rise fires, companies that are assigned to vent the fire floor should take the time to open a window on the same side of the building as the fire and check the wind conditions before opening the fire door. Engine crews should not open doors into the fire area until this information is relayed to them, or risk being driven off the floor or seriously injured should fire be blown over them.

Command Considerations

The fire departments in Los Angeles, Philadelphia, and New York City have all developed extensive operational procedures for high-rise fires. Common amongst them is the identification of key assignments for Chief Officers that are critical to the success of an operation. The first chief at the scene must establish Command. In addition to overall Command, chief officers may also be used in tactical positions that include directing operations on the fire floor, lobby control, search and evacuation, planning and logistics, and others as needed by the Incident Commander. Chief officers should be assigned to Tactical Command positions early into an incident to establish and build an effective, efficient command structure. The second due chief will likely assume the first of these positions. In most cases, this will be as the fire attack group supervisor.

Hoseline Selection and Advancement

Most hoseline operations in high-rise buildings will involve the use of standpipes. However, for fires that are located on the first or second floor or below grade, personnel may choose to stretch pre-connected lines from the engine, as they are faster to deploy and place in service. Often, the engine can be positioned at or near an entrance that provides quick and easy access to the fire, without taking the time to find and connect to a standpipe outlet. _Whenever the stretch will be made from the apparatus and not the standpipe, this must be communicated to other units._ Also, when this tactic is employed, the engine operator must remain at the pump panel rather than abandon the apparatus and assist with standpipe operations on the fire floor.

It is imperative that the standpipe system still be supplied, even if the initial attack is made with handlines stretched directly from the apparatus. Later hoselines may be deployed from the standpipe if needed. _All other roles and responsibilities outlined in this manual shall be assigned regardless of how the initial hoseline is deployed._

Prior to advancing hoselines into areas with suspended ceiling assemblies, firefighters should always check for fire in the plenum, either physically or with a thermal imaging camera. The ceiling assembly could fall on the crew, resulting in firefighters being trapped in a maze of cross-tees, hanging wires, and cables. Firefighters have died in situations where a suspended ceiling assembly dropped and escape was impossible.

As in all structures, crews must contend with a wide variety of obstacles while advancing hoselines in a high-rise. Office layouts using workstations will present a maze of furniture and partitions for crews to negotiate. Fires that are located in other areas of the building can contain stored and stacked furniture, inventory, food handling carts, luggage carts, etc.

_The fire load in residential occupancies is considered low and requires a fire flow of 10 gpm per 100 square feet of involved area._ If the fire is in a residential or hotel type of building, use of the 1¾-inch hose standpipe pack is preferred. This provides 185 to 210 gpm and one or two lines of this size should be sufficient to handle the fire load expected in residential settings. It is also more mobile, which is necessary to negotiate all the turns that are inherent to compartmentation.

Officers should give strong consideration to 2½-inch lines in advanced fires or fires in upper floors in residential high-rises. A significant fire will require the use of 2½-inch lines and command officers will need to ensure that two engine crews are paired up to deploy and operate these lines. Should the fire be on the windward side of the building and the door to the fire apartment blocked open, extremely heavy fire conditions may be present in the public hallway. In this case, the higher flow from the larger line may be required just to overcome the conditions caused by the wind blowing into the fire apartment.

_The fire load in commercial occupancies is considered moderate and requires a fire flow of 20 gpm per 100 square feet of involved area._ If the fire occurs in a commercial occupancy, engine companies should be paired up and 2½-inch lines used for attack. This requires a minimum of two engine companies, each carrying 100 feet of 2½-inch hose. To obtain better reach and penetration, a smooth bore nozzle should be used. Another option would be to operate two 1¾-inch lines side-by-side utilizing smooth bore nozzles. This requires the same amount of
personnel, but provides better maneuverability. In office structures that have been compartmentalized, the 1¾-inch lines would be a better option.

Once the fire is knocked down or reconnaissance reveals that the fire is not well advanced, engine officers can choose to use a single 1¾-inch line. Great care must be exercised in making this decision. If the fire is not quickly extinguished, it can rapidly overwhelm the flow/reach capability of the smaller line.

**Standpipe Operations**

Standpipe packs provide the officers a great deal of flexibility in deciding the appropriate line for the attack. Conditions and location of the fire will dictate whether the standpipe connection is made on the fire floor, or on the floor below. Crews must drill on the deployment and use of standpipes. Lines that are deployed and charged in the stairwells must be deployed in a manner that allows the line to be advanced onto the fire floor as easily as possible. Hoselines in stairwells are a tripping hazard, but a necessary part of the operation and one with which personnel must contend. (This is also a reason for clearly identifying which stairwell is being used for fire attack and which for evacuation.) Companies should not use the well-hole to assist in hoseline advancement unless they have practiced this technique, and are confident that the hose will not become lodged, Figure 37.

![Figure 37: Use of Well Hole for Hoseline Deployment](image)

**Vehicle Fires in Attached Parking Garages**

Locally, fires in parking garages are relatively routine incidents. However, when the garage is connected to a high-rise, the hazards are increased. Parking garages can easily exceed several thousand square feet and the variable number of vehicles parked within can create a considerable fire load.
Firefighters should be prepared to confront fires in parking garages that are at grade, below grade, and above ground. A particular hazard is the garage with easy pedestrian access into the common stairwell and occupant areas. This design allows an unimpeded path for smoke migration from the garage into the high-rise.

Additionally, there will be an extended reflex time in identification and location of a vehicle fire and the stretching of hoselines to extinguish the fire. This task may take several companies to accomplish and quickly tax the resources deployed. Considering these factors, personnel should treat a reported vehicle fire in a parking garage attached to a high-rise as a high-rise building fire, rather than a simple vehicle fire.

Vehicle fires in attached parking garages are typically encountered in two attached configurations, adjacent and underground. Preplanning is essential for successful mitigation of these incidents. Personnel shall be familiar with the location and operation of the parking garage ventilation system. Typically, these large fans will activate upon receipt of an alarm but if not, manual control will be required.

Personnel shall consider the following options:

1. Deploy a hoseline directly from the engine to the vehicle fire. Command must be notified and the FDC still supplied, Figure 38.
2. Charge the FDC and operate the hoseline off the riser on the fire floor, Figure 39.
3. In a below grade garage, charge the FDC and operate the hoseline off the riser on the fire floor. Use a combination of PPV and the garage ventilation system to keep the attack stairwell clear of smoke, Figure 40.
Figure 38: Hoseline Deployed Directly from Engine to Vehicle Fire

Figure 39: Hoseline Operating Off of the Riser on the Fire Floor
Figure 40: Using Exhaust Fan to Keep Attack Stairwell Clear of Smoke
RESOURCES FOR FIRES IN HIGH-RISE BUILDINGS

The minimum initial alarm assignment for a high-rise fire consists of:

- 5 engines
- 2 trucks
- 1 rescue squad
- 1 EMS unit
- 2 Battalion Chiefs
- 1 Command Aide
- 1 EMS Supervisor

The unit assignments outlined in this document are based on typical common tasks in a logical order. Officers may need to make adjustments to any assignment as is deemed necessary based upon the specific problems encountered at an incident.

Unless otherwise directed by the Incident Commander, companies shall position and report as follows.

**First Due Engine Company**

The first due engine’s responsibilities are as follows:

- Park in proximity to the building so as to not block access for other apparatus.
- View as much of the structure as possible. Take note of fire/smoke location, number of floors, conditions evident, and persons in distress.
- Determine the number of floors of the high-rise. If fire is on the upper floors of the building, it may be quicker to identify the fire floor relative to the roof (e.g., three floors down, etc.)
- Take note of wind direction and strength.
- Bring rapid entry keys (e.g., Knox) and retrieve building keys in fire control room or other designated location.
- Abandon the rig – all personnel proceed to the lobby to continue size-up. Ascertain as much information as possible, by gathering information from building occupants, building employees, and any fire control systems that may be present.
  - Check the annunciator panel to determine what has activated: manual pull station, heat, smoke, or duct detector, water flow, or more than one device.
  - If building maintenance or security is present, determine whether they have been on the reported fire floor(s) or any of the floors immediately above and below.
  - In a commercial high-rise, check the building directory located in the lobby for the occupancy type on the floor(s) involved. A copy of the floor layout should be available in the fire control room and should be reviewed quickly before proceeding up.
  - Recall all elevators.
Determine the elevator and stairwell that is used to proceed to the fire floor and confirm that the doors from the stairwells to the floors above are unlocked. This information must be communicated to the incoming companies and chief officers.

- Any evacuation that has commenced needs to be reported to Command. Also, the status of elevators and HVAC systems should be checked and communicated.
- Officer and crew proceed to the reported fire floor, along with the crew of the first due truck or rescue squad, to verify the location and extent of fire and commence firefighting operations.
- If the truck or rescue squad is delayed, the engine should proceed up to the reported fire floor alone. The officer must exercise discretion on committing to an attack position prior to any other company arriving on the fire floor.

It is the first due engine officer’s responsibility to identify and verify the fire floor. The officer should also advise if the entry level is other than the first floor, or if the floors have an odd configuration. Taking a moment to quickly gather this pertinent information will save time in the long run.

If smoke conditions are found in the lobby, personnel must determine if the fire is located on the lobby level or possibly on a floor below, or in the elevator pit. Elevators equipped with automatic recall will stop at an alternate floor above this area. The location of these cars must be determined and the car checked for occupants.

The first engine, along with the first due truck crew and rescue squad, shall proceed together to the reported fire floor. In addition to standpipe packs, at a minimum these crews shall also take the accessory bag, radios, handlights, and forcible entry tools.

If elevators are equipped with fire service controls, the shaft shall be checked for smoke, fire, and water. If clear, the crews can take the elevator, stopping at intermediate points to confirm control of the car and to check the shaft again for smoke, fire, and water. Elevators that do not have fire service control shall not be used until the first engine and truck/rescue squad have climbed the stairs and assessed the fire floor situation. The first engine officer will advise Command if the elevators can then be used.

If smoke and heat are encountered in the stairwell, personnel must determine its origin before continuing upstairs.

Companies must stop at least two floors below the fire floor and use the stairs for the remainder of their ascent to the fire floor. No more than two companies should be in the elevator together. If the fire is reported to be six floors above ground level, or lower, personnel should walk up.

Proceed to the floor below the reported fire floor. Note: Due to the sheer size of these structures, the initial reported fire floor may be incorrect. Personnel must thoroughly inspect the surrounding area.

Whether the stairs or elevator have been used, companies should attempt to conduct a quick assessment of the floor below, noting the layout of the entire floor, type of contents, location of
the mechanical rooms, window type, and presence of access stairways. Personnel may also be familiar with the building’s layout based on previous incidents, preplanning, walk-throughs, etc. Regardless, conditions on the floor below the fire should be communicated to incoming units.

The first due engine, truck, and rescue squad officers must understand the importance of working as a team. Unless there will be a significant delay in the arrival of the truck or rescue squad on the fireground, the engine officer is expected to proceed to the fire floor along with the crew of the truck and/or rescue. Once on the fire floor, the truck and/or rescue squad should commence reconnaissance operations locating and identifying the extent of fire. The engine crew should be prepared to connect to the standpipe outlet, but must be disciplined enough to be able to relocate to a different stairwell once the exact location of the fire is determined. The attack must normally begin from the stairwell closest to the fire that contains a standpipe. Failure to do so can result in the hoseline failing to reach the fire area. Wind conditions blowing fire within the building may necessitate using a different standpipe outlet that also requires a longer hose stretch.

The officer of the first engine should communicate the information gained prior to going up to the location of the fire. This officer shall also announce via radio to which floor the crew has gone and the stairwell used to get there. The crew should expect the arrival of the second engine’s crew to assist with the deployment and operation of the first hoseline and the second engine should utilize the same stairwell. This should not be delayed if fire attack is ready to begin and the second engine has not arrived.

The officer of the first engine, in conjunction with the officer of the truck or rescue squad, shall identify the standpipe outlet that is closest to the fire. The stairwell that contains this outlet shall be announced as the attack stairwell. All companies and chief officers must know which stairwell has been identified as the “attack” stairwell. Those assigned to evacuation must then use a different stairwell that shall be clearly identified as the “evacuation” stairwell.

Before the attack commences, take into consideration the possibility that occupants may be present in the stairwell above the point of attack. Once the door to the fire floor has been opened and the line advanced, the door will remain open and the stairwell may become polluted with smoke. This area should be confirmed clear of building occupants prior to commencing attack, if at all possible.

If the door to the fire floor is hot to the touch, or if fire and heavy smoke conditions are encountered (i.e., personnel must don SCBA to enter the area), the attack line should be charged prior to opening the door. If the fire is on the windward side of the building and winds are strong, it may not be possible to conduct the attack through the apartment’s entrance door. Assessment of the wind’s potential effect and control of the door to the fire area is imperative.

**Second Due Engine Company**

The second due engine company’s responsibilities are as follows:

- Establish water supply – driver/operator must remain with the apparatus.
- Remaining crew reports to the *fire floor* to assist the first engine in placing the first hoseline in service.
- Prepare to deploy a second hoseline, depending on fire conditions.

Upon arrival, the driver shall establish water supply and stretch three inch or larger lines into the FDC. *Note: Refer to the Engine Company Operations manual for further details on pressures and when lines are to be charged.* All connections, except test connections (Figure 41), at the FDC in use shall be supplied. If there are FDCs at other locations on the building, Command must ensure that they are also supplied.

![Figure 41: Test Connections Should NOT be Used by Fire Department Personnel](image)

The officer shall obtain keys, if available, and check the status of the fire control station or annunciator panel(s) to note any changes that may have occurred since the first engine checked and proceed to the location of the first engine.

The crew shall take their standpipe pack and be prepared to assist the first engine in deploying the initial attack line. The officer should be positioned at the standpipe outlet if the crews are paired up on one line. This will provide communications between the officer supervising the line and the officer at the outlet to ensure proper nozzle pressure. One firefighter should work at the door from the stairwell to feed the hose as it moves. Additional firefighters should be positioned at obstacles, pinch points, and turns.

Once the first line is operating, members of the second engine may be used in different roles, depending on the needs of the situation. They may:

- Continue to staff the first line if a 2½-inch hoseline is in service.
- Standby in the stairwell, preserving their air supply and ready to relieve the first crew.
- Provide a rescue team until another crew is assigned to this duty. To comply with OSHA and NFPA requirements, the officer and a firefighter from the second engine should be stationed at the standpipe outlet in the stairwell as a rescue team in the event that is needed. These two persons must not be committed to tasks that could not be stopped if the initial hose team got into trouble. At that point, hoseline advancement would be stopped and these two personnel could move in to assist.
- Assigned to advance their own line onto the fire floor as a second attack line or back-up line. This decision will be made as determined by the officer of the first engine, unless the chief in charge of fire attack has arrived at the fire floor.

Third Due Engine

The third due engine company’s responsibilities are as follows:

- Establish water supply to the secondary FDC (if one is present). If so, the driver/operator will have to remain with the apparatus. If no secondary FDCs are present then the entire crew can abandon the apparatus.
- View the opposite side of the structure from where the first due engine positioned. Take note of fire/smoke location, number of floors, conditions evident, and persons in distress and report via radio.
- Proceed to the floor above the fire to work with the second truck company in checking for extension and for occupants.

Fourth Due Engine

The fourth due engine company’s responsibilities are as follows:

- Park away from the building.
- The entire crew proceeds to the attack stairwell one floor below the fire floor as the RIT. If the fire floor is below grade, the RIT shall position outside the IDLH however in close proximity of the fire floor. This may be one floor above the fire floor but not below the fire floor.

Fifth Due Engine

The fifth due engine company’s responsibilities are as follows:

- The fifth due engine will report directly to the Command Post. Upon conferring with the Incident commander, the entire engine crew will report to the lobby area of the building to assume Lobby Control.
- The crew should proceed to the lobby with their complement of tools. Lobby Control is a vital operation on a highrise and requires coordination among the personnel. A detailed explanation of Lobby Control operations is contained in the Other Considerations section.

First Due Truck

NOTE: The rescue squad and truck company’s functional duties closely parallel one another. Tasks such as searching for victims, locating the fire, forcible entry, ventilation, and control of utilities may be carried out by either of these units. Certain assignments are specific to the apparatus (e.g., laddering or the use of extrication tools or specialized equipment carried on the apparatus). If the rescue squad arrives on the fire floor well before the first due truck, they
assume the first due truck responsibilities on the fire floor. If this change in assignment is executed, the rescue company officer must announce this change on the radio and the first due truck shall acknowledge the change to the rescue company responsibilities.

The first due truck should park on Side Alpha unless fire location can be readily identified. If so, the truck should then park on the fire side of the building if it is accessible.

**If smoke, fire, and/or victims are evident and within reach of the aerial device, the aerial shall:**

- Be raised to access the unit/area involved in a manner that maximizes the aerial’s scrub area.
- The ladder should **NOT** be placed to a window or balcony showing fire unless there is someone at such a location in need of rescue or the elevated master stream tactic is being used for fire attack.
- If the apartment or unit is totally involved, then the aerial should be raised to an adjoining unit.

**If there is no need for the aerial or if the fire floor is out of reach, the entire crew should enter the building together.**

Several factors should be considered when the officer makes the decision whether to use the aerial:

- The irregular shape (H, T, Y, L, etc.) of these buildings make it extremely difficult to locate the apparatus near the fire apartment without some exterior indication of smoke or fire.
- The information normally provided by occupants regarding reports of smoke on one or more floors may be inaccurate and should not be relied on until verified by fire department personnel on the interior. If the original location is not correct, tiller trucks require two personnel to relocate if necessary. These trucks also usually require two personnel to set the jacks for aerial operations.
- The first truck company’s responsibilities on the fire floor are critical and in most cases require at least three personnel. If only three personnel are assigned to the apparatus, leaving the driver/operator at the vehicle could impede the crew’s ability to perform necessary tasks.

**Command must be advised whenever the aerial will be placed in operation, whether to affect an obvious rescue or for fire attack.** If immediate rescues are indicated and within reach of the ladders, one or both truck crews may have to engage in removal operations.

If the first due truck is a tower ladder, the crew may ride the bucket up to the fire floor. Depending on conditions, the officer will determine whether to enter the involved unit directly or by way of an adjoining apartment. *This MUST be communicated to the first engine and Incident Commander.*

All personnel shall bring their assigned portable radio and handlights.

Depending upon staffing levels, the following list of tools shall be brought to the assigned floor. Below is a suggested tool assignment for each riding position:
3-person truck/tower crew with 2 personnel entering the structure:
- Officer: Thermal imaging camera, hook, 2½-gallon water can
- Firefighter: Set of irons or hydraulic door opener (depending upon occupancy type) and lifeline\(^3\)

3-person truck / tower crew with 3 personnel entering the structure:
- Officer: Thermal imaging camera, hook, and a prying hand tool (Halligan)
- Driver: 2 ½ gallon water can, hydraulic door opener
- Firefighter: Set of irons, lifeline

If additional personnel are available the tool complement can be split among the additional personnel or additional tools, at the officer’s discretion, can be added.

The truck officer will assist the officer of the first due engine in gathering information at the lobby/fire control room.

Personnel shall proceed to the reported fire floor with the first engine. Generally, crews will be responsible for the following:

- Determine and communicate the location of the fire. If the location of the fire is not readily apparent on that floor, the truck should advance to determine the location, while the engine prepares the line to be stretched. At this point, the engine crew is the rescue team for the truck, if needed.
- Forcible entry on the fire unit.
- Initiating primary search in the fire unit.
- Coordinating the evacuation of the fleeing occupants.
- Removing obstructions hindering fire attack and hoseline deployment.

As in any structure, it is hazardous to open a door that is separating personnel from the fire without a charged line.

The truck crew is crucial to the engine being able to operate safely. They should open the ceiling on the fire floor to expose the plenum area, if one is present, to check for fire before the engine begins the attack. Crews shall not advance under fire in this area. It must be knocked down as the attack commences.

Once the fire is located and crews are preparing to advance the hoseline, the truck crew must begin to search the rest of the floor for victims. Crews should consider using a search line; use of a tag line is a necessity in commercial occupancies with large open areas to search.

In residential occupancies, search priority is as follows:

- The fire unit.

\(^3\) For the purposes of this manual, the term lifeline will apply to the rope, webbing, and hardware used for emergency escape and/or rescue.
• Exit hallways.
• The adjacent units and the unit(s) across the hall from the involved unit(s).

Otherwise, search priority is as follows:

• The immediate fire area and floor.
• The floor above the fire area.
• The top floor including the hallways, stairwells, and elevators leading to these areas.
• Floors between the floor above the fire and the top floor.

**Second Due Truck**

The second due truck company’s responsibilities are as follows:

• View as much of the structure as possible. Take note of fire/smoke location, number of floors, conditions evident, and persons in distress.
• Assess the need for elevated master streams.
• Take note of wind direction and strength.
• Bring rapid entry keys (e.g., Knox) and retrieve building keys in fire control room or other designated location.
• If not yet identified, the officer should ensure that a stairwell has been identified as the “evacuation” stairwell, and that it is clear of smoke.
• Communicate any previously unreported conditions.

If the fire and/or victims are within reach of the aerial, it should be raised to the fire floor. Otherwise, the entire truck crew should enter the building together.

If the second due truck is a tower ladder and operating with a crew of three, the operator should provide power to the bucket, enter the bucket, raise the tower to the level of the fire, and remain ready for placement as needed. *The operator shall not raise the bucket to a point above the fire except to make an immediate rescue.* If the tower ladder has a crew of four, the officer can split the crew into interior and exterior teams to accomplish the same objectives.

Depending upon staffing levels, the following list of tools shall be brought to the assigned floor. Below is a suggested tool assignment for each riding position:

**3-person truck/tower crew with 2 personnel entering the structure:**
- Officer: Thermal imaging camera, hook, 2½-gallon water can
- Firefighter: Set of irons or hydraulic door opener depending upon occupancy type and lifeline

**3-person truck / tower crew with 3 personnel entering the structure:**
- Officer: Thermal imaging camera, hook, and a prying hand tool (Halligan)
- Driver: 2 ½-gallon water can, hydraulic door opener
- Firefighter: Set of irons, lifeline
If additional personnel are available the tool complement can be split among the additional personnel or additional tools, at the officer’s discretion, can be added.

They will obtain a set of building keys (if possible) and proceed to the floor above the fire where they will work with the crew of the third engine on forcible entry, search, and evacuation.

**Rescue Squad (or Third Due Truck if no Rescue Squad is Dispatched)**

NOTE: The rescue squad and truck company’s functional duties closely parallel one another. Tasks such as searching for victims, locating the fire, forcible entry, ventilation, and control of utilities may be carried out by either of these units. Certain assignments are specific to the apparatus (e.g., laddering or the use of extrication tools or specialized equipment carried on the apparatus). If the rescue squad arrives on the fire floor well before the first due truck, they assume the first due truck responsibilities on the fire floor. If this change in assignment is executed, the rescue company officer must announce this change on the radio and the first due truck shall acknowledge the change to the rescue company responsibilities.

The rescue squad must park away from the building and with the entire crew proceed to the fire floor with the first due engine. The rescue squad must NOT park close to the building to avoid inhibiting engine company access to supply the building’s systems, trucks positioning for aerial use, and ambulances moving in and out of the area with patients.

All personnel shall bring their assigned portable radio and handlights.

Depending upon staffing levels, the following list of tools shall be brought to the fire floor for each position:

- **3-person rescue squad, truck/tower crew with 3 personnel entering the structure:**
  - Officer: Thermal imaging camera, hook, and a prying hand tool (Halligan)
  - Driver: 2½-gallon water can, hydraulic door opener
  - Firefighter: Set of irons, tagline

If additional personnel are available the tool complement can split among the additional personnel or additional tools, at the officer’s discretion, can be added.

The rescue squad will perform the same initial functions as the first due truck company until personnel reach the fire floor. Once on the fire floor, the rescue squad is responsible for the following:

- Deployment of a tagline from the attack stairwell.
- Forcible entry on the adjacent units for primary search and possible alternative fire attack options.
- Coordinating the evacuation of occupants.
- Assessment of fire extension into the adjacent units.
- Depending on the number and type of handlines deployed, personnel may assist in the movement and operation of hoselines. Specifically, the 2½-inch hoseline will demand
additional personnel to successfully deploy. If this task is handled by the Rescue Squad or third due truck it shall be communicated to Command.

**EMS Units**

The EMS unit should park away from the building in an area that allows for rapid egress if a patient needs to be transported. The crew should assemble their EMS equipment on their stretcher and report to Command. If the EMS unit is staffed with personnel trained as firefighters, the crew should have their protective clothing and SCBA with them. If an EMS supervisor has responded, he or she should report to the Command Post.

**Command Officers**

The first due chief shall immediately gather all available information from companies already at the scene and assume Command. The chief must exchange information with the initial Incident Commander and then determine the location of the Command Post. The chief can elect to use his/her vehicle or an area of the lobby near the fire control room, if access can be controlled.

The second due chief shall proceed to Command for briefing. It is expected that this chief will assume Command of the fire attack operations on the fire floor.

**Additional Alarms**

The need for additional resources has been demonstrated at high-rise building fires in Northern Virginia and around the country. A serious fire in a high-rise building can easily require up to three alarms or more.

Every alarm after the first will bring at least three engines, one truck, and one Battalion Chief. Additional alarms may also include deputy or assistant chiefs, light and air units, and other special response units as needed. These additional units may be used for relieving first alarm units or filling essential roles on the fireground, including:

- Rapid Intervention Team(s)
- Search and Evacuation
- Stairway Support
- Base
- Staging
- EMS Branch or Group
- Safety
- Rehabilitation
- Logistics
- Planning
- Reconnaissance for fire extension and smoke migration
Additional Engines

The base area is to be established by the sixth due engine, typically the first engine on the second alarm. In a high-rise fire situation, this area will be designated as “Base” and will simply become a parking area for fire apparatus. If not already identified, that officer should announce this location.

The driver of the sixth due engine should become the Base Officer. It is expected that Command will later assign an officer to this position as the Command structure is built. The officer should check in with the Incident Commander for assignment. The remaining personnel of the sixth due engine company should be prepared to set up staging two floors below the fire floor unless otherwise directed to perform a different assignment by command. Subsequent engines should park at the designated Base location and be prepared to take additional equipment to Staging when called for. Staging will be set up at least two floors below the fire floor. A detailed explanation of staging and base operations is contained in the Other Considerations section.

Given the critical importance of air supply in highrise firefighting operations, each engine company on the second alarm and greater shall bring two spare air cylinders per unit to the staging area.

Additional engine companies shall report to Staging, unless otherwise directed by the Incident Commander, with a 100-foot, 2½-inch highrise pack and a 100-foot, 1¾-inch highrise pack at a minimum. Based on the minimum complement of a second alarm in the NOVA region, this will result in the resources available at Staging having at least 300 feet of 2½-inch hoseline available for large-flow firefighting and 300 feet of 1¾-inch hoseline available for overhaul and small fire knockdown.

Greater Alarm Trucks and Rescue Squads

Type of occupancy, fire conditions, and severity of the evacuation problem will dictate the assignment of these later arriving companies. Trucks or rescue squads may be assigned to cover the floors above the fire for search and evacuation operations. Checking for further fire extension is required, as is control and direction for occupants who are being protected in place. If large-scale evacuation is indicated, multiple units will be required.

Given the critical importance of air supply in highrise firefighting operations, truck and/or rescue company on the second alarm and greater shall bring two spare air cylinders per unit to the staging area.

Light and Air Unit

The light and air unit is included with the second alarm and will need to be positioned at a forward position (close to the building) with stairwell access to Staging. Most of these units are equipped with a 250-foot air hose, as well as extra air cylinders that will be required at Staging. Incident Commanders should consider calling for multiple light and air units, as well as other sources of spare cylinders, if a major operation is underway.
OTHER CONSIDERATIONS

This chapter identifies additional considerations specific to high-rise operations.

Lobby Control Operations

Lobby control is responsible for a variety of critical tasks, as described below.

- Unit tracking and recording, inclusive of:
  - Unit identification
  - Task assigned and location
  - Time entered and air level
  - Number of personnel

- Elevator operations.

- Building systems control.
  - HVAC/pressurization systems
  - Fire pump and fire suppression systems
  - Fire alarm
  - Fire phone
  - Building speaker system

- Stairwell identification (attack/evacuation).

- Coordinating civilian evacuation of building. Due to the possibility of displaced civilians congregating in the lobby area, personnel may have to designate an alternate area to which civilians are evacuated.

Given the number of tasks required, the engine crew will generally need to split up to accomplish them in a timely manner. The following is a suggested procedure for splitting a crew of four personnel.

Crew 1 (Officer and Firefighter)

Unit tracking and recording – The officer and firefighter should be located in a position highly visible to incoming units. Units will check in with the officer and the firefighter will record pertinent information on the command board or tracking sheet, Figure 42. As an example:

- Unit identification – Engine 208
- Task assigned and location – 10th floor, backup line
- Time entered and air level – 1930 hrs, all SCBAs @ 4500 psi
- Number of personnel – 3 personnel
Crew 2 (Left Bucket Firefighter)

Building system control – The firefighter should attempt to make contact with the building engineer who will have a strong knowledge of the building system controls. The firefighter should proceed, with the building engineer, to the fire control room to take control of the following:

- Fire pump – Determine if operating and if not, activate via remote switch and notify Command.
- Fire alarm system – Continually monitor for changing activations and relay to Command (e.g., multiple floors go into alarm after suppression efforts are commenced).
- Sprinkler system – Monitor where sprinkler heads have activated (floor and location). Additionally, notify Command that the sprinkler system is in trouble or indicating water flow.
- Prepare to deliver messages to building occupants or firefighters via the building’s public address (PA) system. The PA system can be used to direct occupants on specific floors to evacuate or stay in place. These systems can also be used to communicate with firefighters operating throughout the building.
- Constantly monitor and answer the fire phones. The respective floor should illuminate on the panel when a fire phone is lifted off the receiver.
- HVAC – The HVAC shall be shut down initially to limit smoke migration and fire travel. Upon coordination between the building engineer and Incident Commander, the HVAC may be activated using the “exhaust” function.
- Pressurization system status and control – Monitor and prepare to control any pressurization systems. Due to the amount of smoke and environmental conditions, the pressurization system may be used in conjunction with PPV.
- Elevator status and location, if applicable. The status and location of all elevators shall be known. If all cars were not recalled to the lobby, this must be communicated to Command so the car can be located and searched.
- Notify Command if the building representative has a list of non-ambulatory residents.
- Retrieve the sets of keys for fire service operations and give them to the officer for dissemination among incoming companies

Crew 3 (Driver/Operator)

Elevator operations – Elevators can be used to deliver personnel and equipment to Staging and/or the fire floor. They can also be used to remove patients quickly from upper floors. To be effective, efficient, and safe, the firefighter assigned to elevator operations must:

- Obtain a set of keys, inclusive of the elevator recall key, from the Fire Control Room.
- Proceed to the elevator lobby and attempt to recall all of the elevators, if not done already.
- Determine which elevators have Firefighter’s Service.
- Check the shaft for any fire, smoke, or water. If clear, enter the car and take control of the car operations.
- Based on direction from Command and/or Lobby Control, the firefighter will deliver companies to the appropriate floors.
• The firefighter must be aware of the fire floor. Personnel should not take the elevator above the fire floor.
• The elevator firefighter must also be familiar with the location of the attack and evacuation stairwells, as he/she may have to advise incoming companies of their locations.

<table>
<thead>
<tr>
<th>Unit Identification</th>
<th>Task and Location</th>
<th>Time Entered</th>
<th># of Personnel</th>
<th>Air Level @ Entry</th>
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Figure 42: Example of a Lobby Control Worksheet

Staging

Staging is the area for assembling resources close to the operations on the fire floor, ideally two floors below the confirmed fire floor. An officer should be designated as the Staging Officer by Command. As the incident escalates, it is likely that companies will be put to work quickly. However, the need for establishing Staging cannot be ignored and must be assigned. This may be delayed until a unit from the second or third alarm can be assigned, but does not diminish its importance.

The Staging area will be a point of significant activity, where air cylinders, hose, tools, and equipment will need to be assembled. To ensure a clean air environment, an air monitor/meter capable of registering carbon monoxide should be present and working properly.

The Staging officer will need to assemble and maintain a pool of available firefighting crews. Once Staging is established, a minimum amount of resources, as determined by the Incident Commander, shall be maintained and ready at this location.

Base

*Base is the area where incoming fire apparatus and other vehicles park.* The first person coordinating activity in Base may be the driver of the first engine that arrives at Base. Using the driver for this job keeps the officer and the rest of the crew available for other duties.
The Base Manager should begin organizing units by function, and parking them in an orderly fashion. This would include parking units on diagonals along one side of the street to allow for easy egress and to keep a travel lane open. Parking all the engines, trucks, medics, and rescue squads in groups of like vehicles helps facilitate the operation. Equipment should be taken from the apparatus, particularly air cylinders, and assembled for movement up to the fire building as needed.

Once Logistics is established crews working in the Logistics Section may be sent to retrieve tools and equipment from the apparatus parked in Base.

**Search Considerations and Procedures**

Typically, the population in commercial high-rises is highest during regular work hours. Residential high-rises will normally have higher occupancy during the evening and nighttime hours. However, it is not uncommon to find occupants in commercial occupancies after hours or in residential occupancies during the day.

Searching smoke-filled floors above the fire can be time consuming and will require multiple crews per floor. Crews operating on the floor above must search for signs of life as well as vertical extension and communicate these findings.

Personnel must be aware of the location of the evacuation stairwell for both ambulatory and non-ambulatory occupants that must be removed.

Taglines shall be used in commercial occupancies, regardless of how small the fire might be, as conditions can change rapidly.

It is extremely important that all areas compromised by smoke are searched. The following system shall be utilized to avoid duplication of effort. All personnel shall be equipped with chalk or a crayon in order to apply this search identification system.

- An “X” shall be used to indicate that a search has been conducted in an apartment, room, office, etc.
- When a crew enters an office or apartment off a central corridor, or enters a room in an apartment or office, a single slash (“ / ”) shall be made, either on the door or adjacent to the door, upon entry for search.
- After the search is complete, the crew shall make another slash, completing an “X” upon exiting the room.
- As the entire apartment, office, or room search is complete, the “X” will be completed and the unit designator (T411, R418, etc.) written next to the “X”.

**Ventilation**

Ventilation in a high-rise building is particularly challenging. However, it is critical that personnel find ways to remove the heat, smoke, and gases that build up during a fire. These operations must be coordinated with attack, search, and evacuation activities. Communication with the Incident Commander is the key.
There are several tactical options available to accomplish this task. In choosing one of these options, fire officers must consider the impact that wind and stack effect will have on the operation.

The three basic ventilation tactics include:

1. Horizontal through the windows.
2. Vertical through stairwells.
3. Use of the building’s HVAC system.

*Generally, horizontal ventilation in a commercial high-rise is not a prudent tactic. Window size and construction, the square footage of the fire floor, unpredictability of the wind, and the likelihood of increasing the intensity of the fire makes this a poor option. Therefore, while the fire is active, horizontal ventilation should not be used in a commercial high-rise.*

Wind direction must be known and units must limit the number of windows that are taken out. It is extremely important that the basic guidelines associated with horizontal ventilation be observed; opening windows on the leeward side first and windward side last. Isolation of any areas that are not contaminated with smoke should also be achieved during the operation.

Wind at the upper levels of a high-rise can be very strong. Venting windows on the windward side can have a disastrous effect. The only way to accurately determine wind direction and its effect is by having a truck or rescue squad duplicate the situation on the floor above or below the fire. The truck or rescue squad operating on the floor above the fire will open the window, assess wind conditions, and communicate conditions to the attack crew prior to ventilation.

Where possible, windows should be opened rather than broken. Breaking windows is dangerous for crews and occupants entering and exiting the building, due to falling glass. This operation shall not be initiated until the IC has been contacted and has taken the appropriate measures to evacuate the area below. Ideally, the glass should be struck from the outside with a tool, which will help direct the glass inward. If the area is out of reach of the aerial devices on scene, truck and rescue squads should vent from the floor above when conditions permit.

Crews must be aware that wind currents may create strong drafts in or out of the opening. Personnel need to back each other up or secure each other with tag lines.

Horizontal ventilation can be affected by the stack effect. In a normal stack effect situation, the heated smoke and gases escaping into a stairwell will proceed up and out. If windows have been opened, this effect may violently blow fire toward the stairwell without smoke going out the vented window. Nothing is gained in this situation.

The preferred method is to use horizontal ventilation by pressurizing the attack stairwell with the intention of forcing the smoke out the fire apartment window, Figure 43. Additionally, a positive pressure fan should be placed in the other stairwells to pressurize the stairwells and preclude smoke from entering. This operation is contingent on the coordinated and timely placement of positive pressure fans along with venting the windows in the fire apartment. If smoke has already polluted the attack stairwell and is not contained and venting out the fire apartment, the exhaust opening (bulkhead, scuttle, etc.) at the top of the stairwell must be opened.
Personnel must remain vigilant in monitoring smoke movement and ensure that smoke is venting out of the fire apartment windows and not collecting in the common hallway and attack stairwell.

Figure 43: Use of Pressurized Stairwells and PPV to Accomplish Horizontal Ventilation

It is possible that the attack stairwell may be needed for ventilation efforts. This will hinge on the stage and volume of fire. This must be coordinated with the attack officer to avoid fire coming back onto advancing crews. However, personnel must remember that a stairwell that is still in
use as an evacuation stairwell cannot be used for ventilation. The use of PPV in the evacuation stairwell is solely used for pressurization, since the bulkhead is closed.

Crews advancing to the top floor(s) must assess the stairwells for the presence of occupants. That will help to determine which stairwells will be suitable for pressurization, ventilation, and evacuation.

The ventilation stairwell must have a suitable opening (bulkhead, scuttle, exhaust fan, etc.) at the top that must be secured in the open position.

HVAC in the affected area should be shut down initially and not actuated until coordinated with Command and the crews operating in the IDLH (fire attack, vent, etc.)

All crews operating in the building must be made aware of the ventilation strategy, and the location of both the ventilation and pressurization stairwells.

Only doors to the stairwells on the affected floors should be open.

**Vertical ventilation using elevator shafts is the least desirable option.** The openings at the top of the shaft are typically inadequate, and on higher buildings, the shaft may not extend to the top of the building. Additionally, the mechanical room for the elevators is typically located at the top of the shaft, and the smoke will have to be moved up and through this room to get out of the building. Open shaft doors on affected floors create an additional hazard for firefighters and occupants.

If this method is used, ensure that there is an adequate opening(s) at the top, move the elevator car below the floors to be vented, open and secure the hoist way door(s) on the floor(s) to be vented, and secure ladders across the front of all open hoist way doors.

Some buildings contain sophisticated HVAC systems, which should shut down in the area under alarm (if the systems are set in the “auto” mode in the fire control room). The HVAC settings and status should be noted by the first due truck officer prior to ascending to the fire area. These systems can be placed in the exhaust mode to remove smoke on one or more floors. If the Incident Commander has elected to use the system in this manner, it would be wise to receive assistance from the building engineer. Truck and rescue squads in the building must be advised when the systems are placed in service for this method of ventilation. Conditions must be monitored and Command informed.

If any company on the fire floor or floor above detects that the system has remained on, this must be communicated back to Command so the system can be shut down. Otherwise, the rate of smoke and fire extension is greatly increased.

**Search and Evacuation**

The purpose of the search and evacuation operation is to control occupants. To do so, personnel operating in this assignment are responsible for preventing panic, controlling evacuation, and ensuring that primary and secondary searches are properly completed. Additionally, changes in
conditions regarding smoke, heat, or fire must be monitored and reported through the Search and Evacuation supervisor to Command.

The evacuation process in itself can present hazards to the building occupants. Fire department supervision of the movement of evacuees down the stairwells is imperative. Firm and clear direction must be given all the way to the point of assembly. Personnel must be aware that excited building occupants, particularly those in a residential setting, may stop and talk while exiting a stairwell into the lobby or other point of exit. This must not be allowed to occur. Occupants must be continually guided to a safe place of assembly as directed by the group supervisor.

**A Search and Evacuation Branch or Group should be activated if there are more than two floors above the fire that still contain building occupants.** A chief officer, if available, should be assigned as the group supervisor. This officer should set up the Search and Evacuation post at least two floors above the highest fire floor. This should be located inside the floor, and near the evacuation stairwell. The location of the Search and Evacuation group shall be announced once it is established. The location must be specific as to what floor it is on and near what stairwell, for example, “Battalion 401 to Command, the Search and Evacuation group is located on floor 15 at stairwell Charlie.” Items such as portable radios, extra air cylinders, handlights, pens and paper, grease pencils or markers, and a command board, should be available.

At least one company must be assigned to thoroughly inspect each floor, the stairwells, and the top floor to assess smoke and heat conditions, size of the floor area, and the potential number of occupants. Based on the assessment of the first company, additional units may be needed to carry out proper search and evacuation.

All units operating under the search and evacuation branch or group shall use the evacuation stairwell to ascend/descend and remove victims. The evacuation stairwell must be kept clear of as much smoke and heat as possible. This will facilitate the evacuation operation and prevent evacuees from becoming patients once they enter the stairwell. As such, the stairway door to a fire floor shall not be opened into the evacuation stairwell. The exception would be to carry out the rescue of a trapped or injured firefighter.

The establishment of a Search and Evacuation Branch or Group does not imply that a complete evacuation of the floors above the fire is imperative. Rather, the officer-in-charge of this operation is responsible for the control and safety of occupants above the fire floors. This officer shall make decisions on evacuation or protect-in-place tactics based upon conditions on each individual floor, progress being made on the fire itself, and through consultation with Command.

The Search and Evacuation Officer should use the fire service telephones to communicate with the fire control room or Lobby Officer. By doing so, information and directions can then be announced to building occupants on selected floors by personnel in the fire control room using the PA system.
Stairwell Support

Stairwell Support is a function that should not only be anticipated on the incident, but may be one of the highest priorities during the early stages of the event. If the fire occurs in a building where crews cannot use the elevators, or use of the elevators is lost, Stairwell Support becomes the “lifeline” to the operation at and above the fire.

A fire that involves more than one apartment, or one that occurs in an office high-rise, will require a large amount of resources to be moved up. At a minimum, stairwell support will need a firefighter positioned every two floors to effectively shuttle equipment.

Air cylinders are a priority. Personnel should anticipate no more than 15 to 20 minutes per air cylinder during firefighting operations. The first alarm units will not be able to take up spare cylinders. This means the Incident Commander MUST take immediate steps to begin moving air cylinders upstairs.

Personnel should expect to deliver the following to the fire area:

- Spare SCBA cylinders
- Extra SCBA packs
- Deployment of the supplied air line from the Mobile Air Unit
- Water for personnel hydration
- Standpipe packs
- Flashlight and/or portable lighting
- Portable radio batteries

EMS Branch

The EMS Branch is responsible for managing all civilian patients. An EMS supervisor should be assigned to manage the EMS Branch. If units encounter civilian patients upon arrival, that is a good indication of more patients to come. At a fire in an occupied high-rise where patients are found by the first due units, additional EMS resources should be ordered to the scene.

Medical Unit

The Medical Unit is responsible for the care and treatment of fire department personnel. An EMS supervisor should be assigned to manage the Medical Unit. The Medical Unit is responsible for the development of the Medical Plan, which should include a rehabilitation component.

The Medical Unit should be remote from staging to ensure personnel are properly evaluated; ideally the Medical Unit will be located one floor below staging. The Rehab Manager reports to the Medical Unit leader.
**Safety**

The Safety Officer reports directly to Command. Exterior safety issues include concerns such as building perimeter control. Danger from falling glass and other objects must be evaluated, and access to the danger area controlled or denied as necessary.

Safety must constantly be checking for hazardous conditions that operating crews need to know about. Examples include open elevator shafts or windows that are broken out flush with the floor.

Given the complexity and sheer size of a high-rise incident, Command should consider requesting a second Safety Officer. The two Safety Officers could be directed to interior and exterior safety.

**Planning**

The Planning Section is another Command Post function that must be staffed for serious high-rise fires. It is important to recognize that a high-rise fire is one in which the Planning Section must be implemented early.

The Battalion Aide or an EMS Supervisor will normally serve as the initial Planning Section Officer. Responsibilities include assisting with the Incident Action Plan (IAP), situation and resource status, identifying needs for specialized resources, and maintaining incident status and records using Command worksheets or boards.

**Logistics**

The Logistics Section is a Command Post function. This position must be assigned early in a high-rise incident. The logistics and planning functions might be shared by one officer initially. However, as the incident develops, they will need to be separated.

Logistics is primarily responsible for ensuring that adequate personnel and equipment are available. One of the most important tasks of this section is to establish, staff, and supervise the Stairwell Support Unit. This role is crucial to ensure that operations on the fire floor(s) and above are sustained.

In addition to supporting the operational needs of the incident, supporting services must also be addressed. Operations that are extended over several hours or more may require that meals, fuel, and additional relief personnel be provided.