The High Rise Hand Book

Presented by

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HIGH RISE OPERATIONS

High-rise Operations poses a tremendous challenge to the fire service. Our responsibilities are to protect life and property in buildings, which have construction features that place great physical demands upon our firefighters and severely limit the strategies and tactics that can be utilized successfully.

A High-Rise building may be defined as any building above the reach of ladders. It can also be a building that lacks practicable exterior access to the upper floors for fire operations, and or that which the fire service and each Incident Commander must depend upon the building's systems and components for fire suppression and smoke removal. From a fire-fighting viewpoint, the distinguishing characteristic of a High-Rise is its excess height, which removes the option of exterior access, egress, attack and controlled ventilation. At the same time confines the strategy to interior attack operations from locations that are dictated by the building design.

The threat to life and property loss is high. Major fires have caused losses running into the tens of millions of dollars, taken many lives, and posed potentials for disaster that go beyond the limits of reason.

We in the fire service are challenged with the fact that developers and the architects of today have now created a lightweight type of High-Rise construction with less fire-resistivity then the generations of buildings built during the mid 1900's.

Today’s design of lightweight, core construction includes enclosed stairs that are particularly vulnerable to heat and smoke contamination, depriving occupants of their use as a means of egress and also providing an artery for the distribution of smoke and toxic gases.

The following will review the Strategy of operations in the open floor design of High-Rise, which has the potential for larger fires. We must also consider the fact that we are operating in a much better insulated building with maximum heat retention, and one with complex systems that add to the hazards of firefighting.
The current generations of high-rise building being built have floor areas that are as great as 30,000 to 40,000 square feet. The Buildings total occupiable space may equal square footage in the millions. The occupant load may be greater than 20,000 people during the peak of any workday.

A plan for total evacuation before the commencement of fire operations for many buildings is not practical. Should fire operations occur on a lower floor, many people may be forced to remain in place. The Fire Service is then charged with the responsibility to secure and protect their position and means of egress.

The threat to life can be great at any time of the day for the occupants of a High-Rise building. The daytime occupant load of a High-Rise building can reach the thousands, while nighttime hours may place that number near a hundred. The maintenance of these buildings may require a substantial work force present after what is considered normal working hours. These workers may not speak the local language, which creates difficulty-announcing instructions for evacuation if it is to be carried out efficiently. Some tenants may employ workers who work around the clock, especially those utilizing large computer installations.

The strategies to control fires in high-rise buildings with minimum loss to life and property must include the use of the following:

- Fire department staffing and equipment
- Building management and service personnel
- The building components, and systems
  - Fire (Alarm- i.e., detection, Standpipe/Sprinkler - i.e., suppression)
  - Communication
  - HVAC (The environmental systems)
  - Elevators

The fact that we are restricted to interior operations that limits our attack options places heavy reliance on the integrity of the building, its design and its systems. For these reasons we must have the understanding and knowledge of the design features and systems that are built into these buildings so that they may be used in the strategy of operations.
THE HIGH RISE BUILDING

In the earliest High-Rise structures built in the early 1900’s a single stairway often provided the only means of egress from the interior. This singular stairway may or may not have been enclosed with a fire rated wall. Many structures were built with large open stairway that served the height of the building. The enclosed stairs were constructed with metal clad wooden doors and metal jambs at each stair landing for the attempt to offer a fire rating.

Elevator shafts were not constructed in protected shafts but unenclosed and interior standpipe outlets were not located in the stair enclosures, they were located within the occupancies, placing them in areas vulnerable to the effects of fire. In the years since the first high-risers began being built, there has been a gradual evolution in their construction from cast iron and wood to steel frame and re-enforced concrete. This evolution was a slow to change and became a trial-and-error process. The fires experienced throughout the world offered its own lesson and resulted in improvements in the building codes of today.

High-Rise Evolution

It was after World War II, when developers, architects and construction firms began to protest that the fire protection requirements were increasing the cost of construction beyond that which was reasonable and affordable. Inflation of the times added to the problem; and union contracts were increasing in cost. Employment to stimulate economy was needed and cities needed to revitalize older sections of there cities. All of these pressures were directed toward a relaxation of the fire-safety requirements contained in building codes. As a result, a new generation of High-Rise buildings appeared in the 1950s and 1960s with a new generation of fire problems. This new generation of building has as its primary component a central core which contains most of the building's services and utilities such as power, plumbing for water and waste, elevators, air supply and return shafts, stair shafts and lavatories. The concept of compartmentalization was now being revolutionized into the open space design.

In high-rise buildings built primarily of steel the columns at the core are connected to the columns at the exterior walls of the building by steel girders. These long girders eliminate the need for intermediate columns. This design concept allows for a completely unobstructed floor space providing an individual tenant or building owner versatility of floor layout that best meets their needs.
In the older cities throughout these United States, the structural features, utility and environmental systems that are found in various High-Rise buildings will generally be determined by the age of the building and requirements according to the authority having jurisdiction and building codes in effect at the time of their construction.

In order to be an effective Incident Commander and strategist, it is imperative that we become familiar with the features and systems of High-Rise buildings. The firefighters of line units must also become familiar with these buildings, since they are not all built the same. Familiarization with construction features and building systems will permit decisions and actions in the early stages of fires to be made with some intelligence and proficiency. It is vitally important that all responding units to a High-Rise building operate efficiently and safely. This is a valid reason for effective and thorough pre-fire planning. This planning should begin when first ground is broke to commence the construction of a new building and what will become yet another challenge to the fire service.

At times our operations are in areas High in the Sky in these buildings, which are certainly difficult, and time consuming to reach, which extends the reflex time of operations. (Reflex Time, is the definition of the time interval from the initial receipt of the alarm to the first application of water on the fire). The environments that we must operate can be extremely punishing on the firefighting forces, and the ability to communicate and coordinate operations at times is difficult or non-existent.

The realities also include the fact that property loss and economic loss may prove to be staggering as a result of even a relatively small fire. There is direct damage by fire, the damage made from overhauling, and smoke contamination throughout the building and at times extensive water damage. After a fire the tenant space and other areas of the building that were effected will incur an interruption in business, either to clean up or rebuild what was lost or damaged.

Because fires in High-Rise structures occur in areas with open floor designs, involving sophisticated building systems, the well-insulated characteristics and highly combustible contents create an environment that is not always controllable and frequently not well understood.

The Incident Commander to effectively plan a Strategy must have a complete picture or plan of the building and the particular fire area of concern. The IC must also have an understanding of all its systems and an appreciation of their effect or potential effect on the fire. This plan should have detailed information regarding the construction, alterations and occupancies. This will provide information regarding the manner in which they will influence the fire, and finally, up-to-date intelligence regarding the status of the fire, its level of extent and potential.
STRUCTURAL FEATURES OF A HIGH-RISE

The Backbone of a High-Rise – The Frame

The high-rise structure is considered a framed structure, which means that the building is supported by a structural frame as that of the human body, supported by its skeletal make up of spine and connecting bones. A building considered an unframed structure, is one that is supported by bearing walls. This frame not only supports the dead load of the building itself, but also all superimposed live loads such as the contents of the building and people within.

The most common framing systems used for High-Rise buildings utilize either concrete or structural steel as the basis for forming the building skeleton. Both types of construction use vertical interior and exterior columns to which the horizontal support, girders are attached. The girders span the horizontal distance between the columns and are used to support structural beams. These girders and beams will in turn support the floors. Although there is a difference in the materials used for the structural elements in a reinforced concrete or steel structural frame, they perform the same function of support.

High-Rise buildings of today are generally built of Class 1 construction. In New York City that classification according to our 1938 code was classified as fireproof construction. The current NYC Code's classifications would be Class 1, non-combustible with a Rating of protection to withstand exposure to fire for a period of time. Components performing different functions require different ratings. A column may require a fire rating from 3 to 4 hours, whereas floors and walls may only require ratings from 1 to 2 hours. One of the greatest misconceptions ever offered regarding modern high-rise buildings is that they are "fireproof". The fires that have occurred in high-rise structures throughout the world have disproved this repeatedly. To meet the requirements of fireproof construction, exposed steel will be insulated with a sprayed on insulation and/or concrete to provide a fire rating.

Construction designs for High-Rise buildings are usually based on the concept that structural integrity of the building must be sufficiently maintained through any potential fire. In keeping with this concept the principal components that comprise a High-Rise structural frame are required to have a high degree of fire resistiveness, but under prolonged exposure to sufficient heat, it is possible that failure of components could occur. The seriousness of such a failure increases with the relative function of the component. For example, failure of a floor beam is somewhat serious, but the failure may only be localized. Failure of a girder, which may support a number of floor beams, would be far more critical because it affects a significantly larger area. The failure of one or two girders can cause instability of a column, potentially leading to a progressive collapse of the framing system.
These girders provide strength to columns by decreasing the height with which they are required to support loads. The removal of these girders increases the height of a column and decreases its ability to support loads when subjected to high temperatures during uncontrolled fires. Column failure results in serious structural instability and depending on the location of the column could trigger extensive collapse damage to the structure. This was of major concern to the Incident Commander at the One Meridian Plaza fire in Philadelphia, when upon the inspection and advice of engineers, a decision was made to evacuate the structure before that fire was brought under control.

After the bombing of the World Trade Center in 1993, a major priority was given to installing lateral supports to the vertical columns in the lower levels of the complex, because of the damage created by the blast. The floors that were heavily damaged or missing provided horizontal support. The attack upon the World Trade Center on 9-11 not only weakened the structure by damaging floor and walls, but created a fire that involved the contents that ultimately caused the connections of the horizontal supports to fail increasing the load on the remaining vertical supports beyond their ability to hold up the structure. Thus within hours both towers of the World Trade Center failed completely resulting in the greatest loss of life for the city of New York and the FDNY. Three Hundred and forty three heroes were killed that day performing their duty including our Chaplin Father Mychal Judge.

In many of the older High-rise, to achieve the fire protection required by building codes for Class 1, fireproof structures, with steel frame members. They were "fireproofed" with the use and protection of concrete, terra cotta tiles, metal lath and plaster, brick, or gypsum boards (sheet rock). This method is called encasement. You will see variations of the method in new construction. Concrete has the advantage of being the most permanent type of fireproofing, whereas at the other end of the spectrum, gypsum boards can be compromised in many ways. Another method includes fireproofing that is directly applied to the steel usually by spraying with a protective coating. In today’s lightweight design, the common method of protection for columns, girders and beams is by applications of spray insulation consisting of an intumescent coating containing non-combustible fibers, which swell and char when exposed to flame and also cementitious coatings. Asbestos insulation was used extensively in years past, and is present in many High-Rise buildings. This now poses the compounded problem of the contamination and spread of a hazardous substance during and after fires have been brought under control.

There are different fire resistance ratings required for structural members and assemblies based upon their function of support. Exterior walls, interior bearing walls and partitions that are not required to support loads other than their own weight, would have a lower fire resistance rating then, the structural components of columns, girders, beams or trusses which make up the framing that may support one or more floors. They would be required to be provided with and have a protective rating of longer duration.
Spray insulation has been tested to offer different ratings for columns, beams and girders. Columns are generally given a four-hour test rating and three-hour rating for beams and girders. The thickness of the spray insulation will depict the fire resistiveness.

The degree of thickness has been determined through prior testing to meet the ASTM 119E Standard. Unfortunately the test conditions do not duplicate the actual conditions encountered in the field when these structural components are subjected to extreme heat developed in high-rise fires, fed by strong wind currents and the pounded by the force and pressure of hose streams. As a result, the adhesion of the insulation is often less than effective. It is frequently placed on rusted metal that has not been properly processed prior to the application of the insulation. The consistency of the insulation can vary and its application is sometimes uneven. During the course of construction, members of different trades working on the building frequently dislodge this insulation while installing their equipment and it is seldom replaced. The result has been that this type of insulation process has been found to be deficient at fires encountered. This sprayed-on coating when improperly applied can spall during a fire, thus leaving the steel structural member exposed and subject to failure from excessive heat.

**NEW DANGERS WITH BUILDINGS UNDER CONSTRUCTION**

In New York City there has been a trend of building owners requesting and the City administration approving Temporary Certificates of Occupancy (TCO), allowing part of a building to be occupied while construction work is still in progress. This poses a severe challenge to the fire service. Buildings under construction will not begin to receive a return on the cost of construction until a positive cash flow begins with the renting of space within the building. Consequently, there is a great pressure to have tenants move in and start paying rent as soon as possible. The construction and patterns, which the structure begins to become occupied, are subject to shortcomings. While the upper floors of a structure may be the last to be built, they are often the first to be rented. These upper floor spaces offer the best views of the city and there is the impression that offices or occupancies at the upper levels indicate power and prestige. The middle and lower floors often remain unoccupied until a later date, with the result that these lower floors become storage areas for construction materials being used to finish the remaining floors, creating a heavy fire load. The first floor level of some structures may be designed to provide space for commercial retail occupancies, which will be rented before the structure is complete. Work shanties that were located on the first floor level will be relocated either in the basement or to an upper floor.
The Standards of protection required as a minimum before a Temporary Certificate of Occupancy can be issued are suggested to be:

- **Standpipe** and/or required **Sprinkler sys**, complete and operational
- **Stair shafts** complete with **fire rated door assemblies** (fireproof and self closing) Identified with letter designation and floor numbers
- **Elevators** to be equipped with **Fireman Service Recall** feature
  Programmed **not** to stop on the construction floors and the vise/verse
- **All shafts** to have proper fire stopping
- **Unoccupied floors** to be **Sprinkler protected (Core only)**
- **Fire protection system of Detection** (Tested and approved)
  Smoke detectors
  Water flow alarms

**FLOORS**

Individual floors can be reinforced concrete poured in forms supported by reinforced concrete columns or they may be floors described as ‘Q’ deck or metal decking consisting of metal panels attached to the floor beams supported by girders. When vertical columns pierce the floors of metal decks they may not be properly fire stopped which will allow the intrusion of fire in the form of a pilot flame to extend to the floor above or ignite the accumulation of combustible gases. The metal panels provide the support for a 3” to 5-inch or greater layer of concrete, which becomes the floor. Electrical "raceways" may be placed in the floors for distribution of power. These raceways and their complement of wire and insulation are subject to ignition from the high temperatures from the fire below contributing to the accumulation of heavy concentrations of smoke and extension of fire.

**Fire Extension**

Because of the failure of floor beams, when they expand and distort, they cause the floors to heave and buckle. This will allow the introduction of a pilot flame. Some designs have the floor end at the mid-point of the exterior column. The exterior finish wall is attached to the outside surface of the exterior columns, thus creating a vertical void between the edge of the floor and the interior of the curtain wall. This space is fire-stopped with varying degrees of effectiveness that depend upon the building design and specifications. The contractor must have the knowledge of its purpose for fire stopping and employ the proper workmanship in its installation. This workmanship can vary from very good to very bad. When it is bad, it can become a primary artery for vertical fire travel. Synthetic insulation has been used in this space. It is placed between the exterior finish wall and the floor edge. When heat or fire penetrates these voids this synthetic insulation can be expected to burn and add to vertical extension and intensity of the fire.
POKE-THROUGH CONSTRUCTION

While the fire resistive rating of concrete floors is quite high, modern High-Rise buildings utilize a construction concept referred to as "poke-through" construction that can lower the fire resistiveness of a floor considerably. Poke-through construction provides penetrations of various sizes in floor slabs for vertical travel of utility services such as electrical power, telephone cables and plumbing lines. Frequently, the fire-stopping material that is required by building codes for sealing these openings is either lacking or poorly installed. This condition can provide an unwanted path for the vertical travel of fire and smoke, as well as allowing water from the fire floor to spread to floors below. Vertical fire travel must be curtailed by protective construction features around vertical shafts and above windows, and adequate firestopping of all "poke-through" openings between floors.

EXTERIOR WALLS

The building “Skin” is considered the exterior walls and windows. In the course of construction once the frame and floors of a structure are complete the skin is now mounted to protect the spaces from the elements and weather conditions. As the structure comes together it will now contain the products of combustion should a fire break out within the confines of its spaces. The exterior walls of modern High-Rise buildings are usually lightweight, prefabricated walls. They are non-loadbearing and referred too as curtain walls. A complete curtain wall consists of a panel with finished surfaces and a means of attaching it to the building frame. The most common method of attaching curtain walls to the building is by bolting them to clips that are attached to the structural frame or floor slab. This method of attaching walls often leaves a space of several inches between the end of the floor slab and the exterior wall. Unless this space is adequately protected, it can provide a path for fire spread to floors above and allow water to penetrate floor below as already mentioned. This outside finish or "skin" as it is often referred to may consist of may variations decorative material using metals such as aluminum, stainless steel, copper. Many buildings use decorative stonework using limestone, granite, marble, brick and lightweight concrete with window areas of glass or synthetic materials. There are those buildings that an exterior wall is erected at each level from the perimeter edge of the building. These are also a non-load bearing walls constructed in cement block and are referred to as (URM) unreinforced masonry. They only extend to the ceiling of the floor above. A wall with more esthetic qualities may then be added on the out side of that wall. It will be supported vertically by a metal shelf or angle Iron tied into the structure at the spandrel wall and laterally by masonry tabs inserted into the inner block wall.
Glass Walls

Many new office buildings utilize a skin constructed almost entirely of plain, tempered or decorative glass that is held in place with metal-alloy frames and supported with conventional construction and caulking. Glass walls and windows of High-Rise buildings will pose a danger during firefighting operations. Heavy pieces of razor-sharp broken glass falling into the street from 10 or 20 stories above can cause injury and death. When a fire in the outer perimeter of a High-Rise building has gained in proportions the heat from the fire will eventually cause the glass to fail and fall to the street below. This falling glass not only poses a danger to the public and firefighters, but may also effect fire operations should the glass sever any hose lines augmenting the supply of water to the standpipe system. Under such intense fire conditions, the failure of these windows also allows the rapid vertical extension of the fire on the exterior of the building.

Stone Walls

Exterior stonewalls are also susceptible to failure should the mounting assemblies be subject to excessive heat or flame. At the One Meridian Plaza fire in Philadelphia, sections of the granite wall collapsed. Flames spreading upward from window to window on the outside of the structure heated the granite facade. Large chunks of heated granite weighing 20 to 30 pounds came crashing down on the sidewalk, narrowly missing firefighters.

The Exterior walls are designed to be Energy Efficient creating "The Sealed Building concept" or what is also referred to as "Tight Building Syndrome". We can expect when entering fire floors in the new generations of high-rise that because of the energy efficient design and the fire loads that can be present we will be encountering fires that may have been smoldering for some time creating tremendous amounts of heat and smoke. This fact also insures that, in the initial stages of a fire, virtually all of the heat generated by the fire is contained within the building.
VERTICAL ARTERIES

Vertical arteries include the shafts built for stairwells, elevators, utilities and the air handling systems. They may be built of reinforced concrete, concrete block or tile and gypsum board.

Stairwells

Generally stairwells in High-Rise buildings are usually built into the core and may be supplemented with additional stairwells on the outer perimeter of the structure, based upon the requirement setting limits for a specific distance of travel to each exit. This will vary depending on the occupancy type of the building. Stairwells and exits in High-Rise buildings are not designed to handle the total occupant load simultaneously. Additionally, the number of useable stairwells may be reduced by heat, smoke or fire department operations. This is one of the main reasons that total evacuation of building occupants during a High-Rise fire is impractical.

Types of stairwell range from open stairwells, which can be found in the older High-Rise buildings to pressurized stairshafts, found in many newly constructed High-Rise structures. Pressurized enclosed stairwells operate on the principle that air forced into the bottom of the shaft and removed at the top at a controlled rate will create a positive pressure in the stairwell, thus preventing smoke entering from the fire floor. This concept was first tested in New York City in 1972 at a 22-story office building located at 30 Church Street known as the Hudson Terminal Building.

THE FIRE TOWER OR "PHILADELPHIA TOWER"

The design of the fire tower or smoke-proof stairwell is to maintain a completely smoke-free stair under fire conditions, with persons entering the stairwell from the fire area. They have also been referred to as the "Philadelphia tower". This design is accomplished by constructing a stairwell that is separated from the occupied floor by a vestibule, which is either an enclosed shaft that is open at the top or an outside balcony. When a door is opened from a fire floor the heat and fire gases are drawn up into the enclosed shaft or to the open air if it were an open balcony, thus not contaminating the stairwell. Fire towers are probably one of the safest forms of stairwell exit systems from the standpoint of protection to building occupants and fire control personnel. This is because they do not depend on mechanical ventilation equipment to provide smoke-free atmospheres. In spite of the effectiveness of fire tower systems, they are not commonly found in the new High-Rise construction of today. This is due to the square footage of floor space they require. Space in these buildings is sold or rented by the square foot and that space now becomes a premium segment.
There are two different stair design types commonly used in High-Rise buildings. They are referred to as "return type" and "scissor type".

**Return Stairs**

These stairs used in the majority of High-Rise buildings are similar to stairs found in conventional structures. In return type stairs, entry to, and exit from the stairwell is made at the same relative location on each floor level.

**Scissor Stairs**

These types of stairs consist of two separate sets of stairs, which cross each other within a common shaft. In this type of stair arrangement, the stair access point for each set of stairs in the shaft is at opposite locations on adjacent floors. Some scissor type stair arrangements will only service alternate floors with each set of stairs in the same stairshaft. (E.g., one set of stairs serves odd numbered floors only; the other set serves even numbered floors only.)

Doors that provide access to the stairwell from individual floor areas are required to offer a degree of fire protection that is comparable to the construction of the stairwell shaft. They are usually metal-clad, solid core, rated fire doors with metal jambs. The metal door assemblies that are used in High-Rise stairwell shafts can make forcible entry operations very difficult and are subject to becoming tightly wedged due to heat warpege under fire conditions.

Since stairwells in High-Rise buildings are required exits, doors leading to the stairwells at each floor level and from the stairwells at terminal exit points should be openable without a key. However, for security reasons, doors are usually locked on the stairwell side to prevent passage from the stairwell into the floor area of those floors above the exit level. You may encounter exit doors with some sort of security or locking device installed because building owners and tenants are more concerned with security than they are with fire safety and are installing various locking devices on exit doors to add security to their space and inventory. Some security devices are of the ID "Swipe Card" or Bar Code reading type. Entrance and exit from the space requires an ID of some fashion for the locking devices to operate. Their inventory includes vast amounts of computer information, which has high value to the corporations of ownership, and other concerns that can use the information for economic benefit.
The location of terminal exit points from stairwells in High-Rise buildings will vary greatly. All stairwells do not provide access to the roof area. Some may terminate in a machinery room area. Their are stairwells that exit at ground level directly into the lobby area from center core design or they may exit to the perimeter of the building in some fashion, hallways, corridors, etc., with no access to the interior lobby area. All stairwells in High-Rise buildings should be provided with signs on doors at each floor landing which identify the stairwell by letter and floor number. This information is provided to assist building occupants who may be forced to use the stairs under fire conditions and vital to the operations of firefighting personnel. It is from these stairwells that our access is made into fire areas and our attack is mounted. The use of stairwells is vital for the evacuation and rescue of persons endangered. Standpipes are either located within or in close proximity. Pre-fire plans should include their location. FDNY includes in its Alarm response, information on recall referred to as CIDS-Critical Information Dispatch System.

Access Stairs

Sometimes referred to as convenience or tenant stairs, they are not considered a means of egress. Usually added as a convenience for an individual tenant who may occupy many floors and use of the exit stairwell with the fireproof self-closing doors or use of elevators becomes time consuming. These open stairs provide quick assent or descent between floors. They also become an avenue for fire and smoke to travel uninhibited up or down. These types of stairs can be used at times to access a fire floor from below for search or launch an alternate strategy such as a flanking attack.

Utility shafts

They include chase ways for electric conduit, plumbing and communication lines. They are shafts for the supply and return of conditioned air in the HVAC system. During construction they may be open for the height of the building prior to fire stopping or pouring of concrete once all conduits lines and plumbing are in place. Fires originating in electric equipment are common to the fire service. Transformer fires have been a frequent response for the New York City Fire Department. The transformer fires encountered have been those located on the exterior of the building. They are then connected to the service supply of the building through conduit piping. There may be many other transformers located throughout the building. The service supply transformers may be handling voltages in the range of thousands of volts, while those within the building step down voltages for the supply needs of a given area, in ranges of 440 or 220 volts, etc. Until the equipment is isolated and de-energized, the tactic employed is to protect exposures and limit or channel smoke contamination awaiting the arrival of utility company personnel or building engineers. Until that time, fire extension can be expected within the electrical system contained in the utility shafts, service panels and rooms. Electrical short circuits may start fires at remote locations in the structure. It is important that these utility shafts are properly protected with fire stopping to alleviate the extension of fire that may break out from conduits and panels.
During firefighting operations water may find its way to shaft openings. Water entering shafts may cause electrical short circuits and water damage to areas below fire operations. Carbon Monoxide levels throughout the building must be monitored at these types of fires.

**Elevator shafts**

These shafts also provide an avenue for the extension of fire and smoke. These shafts are subject to the natural phenomena of stack effect, which creates a draft of air towards the shaft. This draft will draw smoke and heat to the upper reaches of the shaft when subject to positive stack. The movements of the elevator cars in the shaft push air (piston effect) in the direction of travel creating drafts and pressures. Elevator components may incorporate mechanisms that are activated by the use of light beam or laser capturing devices. They may certainly be affected by smoke entering the shaft and cause erratic operation of the elevator. Water entering the shaft may affect the electrical circuits causing unreliable operation or loss of elevator use altogether. Be aware when experiencing or responding to smoke from an elevator shaft it may be a fire originating in the base of a shaft involving refuse or improper storage.

**Air handling shafts**

The return and supply airshafts have become arteries for the extension of fire and smoke at high-rise fires. At the First Interstate Bank fire in Los Angeles in 1988, one major avenue of fire spread was up through a return airshaft from the 12th floor to as far as the 27th floor.

**Mail shafts**

Buildings built prior to the 70's may have been designed with a shaft that was used for the conveyance of mail to the various floors. These mail shafts are now being converted to supplement the increased needs of communication and electrical supply or they are lying dormant. With the technology of today, business and corporations are utilizing communication lines with fax equipment and computer links, rather than rely in the slow process of the US mail system. Shafts become points for extension of fire from its origin should a fire originate in equipment housed in or connected to the shaft. Fire will seek an avenue for extension and these shafts have allowed fire to extend from floor to floor.
COMPACTOR SHAFTS

Shafts for the removal of refuse in residential buildings have become a location for a common fire for the fire service. Some of the older residential structures were built with an incinerator. The shaft used to deliver refuse to the incinerator was fire rated for the temperatures that were to develop by burning this material. Many of these old incinerators and shafts were converted into compactor systems. The shafts of these converted systems withstand fire well and the problems facing the fire service are that of smoke travel and contamination and not that of fire extension. The systems and shafts built originally, as compactors may be deficient in terms of withstanding and containing fire within the shaft or compactor unit. Smoke can be encountered on many floors and fire has extended from improperly constructed compactor shafts and broken or dislodged access panels on the various floors.

LAUNDRY CHUTES

These type shafts are common to Hotels. Laundry and linens contaminated with organic oils and compounds have ignited spontaneously to cause fire as well as the careless discarding of cigarettes and acts of arson.
BUILDING SYSTEMS

HVAC (Heating, Ventilation & Air Conditioning)
To effectively manage a fire in a modern high rise office building with central air conditioning and sealed windows, the Incident Commander must have a functional knowledge of the heating, ventilating, and air conditioning (HVAC) system. Lack of such knowledge, or the failure to use the HVAC system correctly during a fire, can create problems for the occupants and the firefighting forces.

HVAC systems are designed to process and treat air controlling the temperature, humidity, and cleanliness. The system will then distribute this processed air to meet the requirements of the conditioned spaces. Another function is to collect the air from the conditioned spaces and return it for reprocessing and reuse. The HVAC systems found in high rise office buildings fall into two categories: Central air conditioning systems, where the processing equipment supplies air to more than one floor, and non-central air conditioning systems which supply air only to the floor on which the processing equipment is located. Central air conditioning systems are the most common, and they create the most problems during a fire.

The Strategy of Operations or plan should have goals in the effective management of the HVAC system.
• Use the HVAC system to limit the spread of smoke and fire to as small as area of the building as possible.
• Prevent the HVAC system from intensifying the fire and spreading it beyond the initial area of involvement.
• Provide the operating forces the greatest assistance in reaching the seat of the fire.
• Prevent the components of the HVAC system from becoming avenues for the spread of smoke throughout the building.

The use of HVAC systems to exhaust smoke will be covered in Venting. (See page 33)

FUELS THAT GENERATE SMOKE

Combustible finishes are still used in new buildings and modern furnishings as a rule sustain combustion more readily, then old-style furnishings and they usually generate more toxic smoke. Even carpeting adds to the fire load and can contribute to fire spread to other rooms or corridors. The use of plastics for some structural items and in many furnishings has a very pronounced effect on fire spread and smoke generation when these materials are exposed to high heat and flame.
Elevators

In past history there have been many cases of persons trapped in elevators during fires in high-rise buildings, as there have been many fatalities. It is essential to account for all elevators at a high-rise fire and verify their being void of occupants. Initial operations upon arrival are to gain control and operation of those elevator banks that will provide the safest means of transport to the reported fire area if available. It is imperative that all elevators be accounted for and confirmed void of people.

The use of elevators must always be with caution because fire, heat, smoke and water entering the shaft will effect their operation. Firefighters entering elevator cars must be equipped with a means of communication and forcible entry tools to be used in an emergency for evacuation, should they become trapped if power is lost or the operation of the elevator fails. The Incident Commander in that case shall be notified immediately.

The use of elevators to reach the point of operation in the early stages of a fire on an upper floor of a high rise will reduce the time of ascending by foot to a fraction of the time. The fatigue of transporting equipment required for the support operations is also reduced. It is obvious that reliable elevator service is a necessity for effective fire fighting and rescue operations. Should their use be negated and interfere with efficient operation it will result in a delay on the attack to extinguish a fire and increase the likelihood of the loss of life and property.

Fire Pumps

When required by NFPA standard 20, they are generally located in the lower levels of a high-rise building. They may be started manually or function automatically upon a drop in pressure of whatever system they supply. The New York City Fire Department considers the primary water supply or augmentation to be that of a fire department pumper supplying a standpipe, sprinkler system or one that is a combination of both. This ensures water and proper pressures to the system regardless of the operation of pumps on site.

Should hose lines be operated from standpipes a qualified motor pump operator will be assigned to locate the pump room and verify the pumps to be operating and supplying volume and pressures required that are proper for the location and height of the fire operations. This firefighter should have training to enable him/her to start the pump(s) and have them operate at the required pressures. The training should include the knowledge and awareness to view the system and design to determine if the bypass valve is in the open position reducing the volume of water being supplied. These valves may have been left in the open position after the pumps have undergone testing. Should the FD connection on the exterior of the building be damaged or inoperative, stretch a supply hose line into the building and supply the system via the 1st floor outlet. If a PRD (Pressure restricting device) is present, unthread and remove it before connecting the supply hose. Be aware of PRV's, (Pressure reducing valves) they cannot be removed and are designed only to flow water in one direction, outward as an outlet. Once water is introduced, pumped into the valve outlet, the device shuts down, acting similar to a clapper valve. They cannot be back flowed!
Communications

The systems of communications within high-rise buildings may include public address systems, hard wire phones to stations on each floor of the building, mechanical equipment rooms, pump rooms connected to an alarm panel or command station on the lower level of the building. The commercial phones throughout the building may also be used to establish a communication link.

Building engineers, security and fire safety personnel may be equipped with hand held radios which have been customized for efficient operation in their particular building. All of these systems and methods can and should be utilized as a means of coordinating and effecting notification and instructions to building occupants. The public address system is the most efficient means to institute the safe and controlled evacuation of people from those floors that require vacating.

These systems can also be used when there is a break down, deficiency or overload in the equipment used by the fire service. Utilization of these alternate systems may relieve the traffic load on the fire department frequencies.

Alarm Systems

Members of the fire service should become familiar with the difference between trouble signals and actual alarms of detection. The types of alarm detecting devises include, smoke, heat, water flow and manual alarms. Before deployment is made to investigate a report of smoke, double-check that information with the alarm panel. A detection device activated from other areas or a lower floor from the original activation may now give indication of the actual location and origin of the fire. The status of Alarm panels should be constantly monitored.
STACK EFFECT

A natural phenomena associated with High-Rise buildings is called "stack effect". Which is best described as the vertical natural air movement through the arteries of the building caused by differences in temperatures and densities between the atmospheres both inside and outside the building. Positive stack effect is characterized by a draft from the ground floor to the upper floors and roof. Positive stack effect is more significant in cold climates because of the greater differences in temperature between the inside and the outside of the building. The colder the weather and the taller the building, the draft of air or movement will be greater (the stack effect). Negative stack effect can also occur in the reverse direction in hot climates, but is not as dramatic because the differences in temperature are not as great. The fire does not cause stack effect, but it creates the smoke that will spread throughout the building during a fire.

Stack effect is responsible for the wide distribution of smoke and toxic gases in a High-Rise building fire. The magnitude of stack effect is a function of:

- Building height
- Air tightness of exterior walls
- Air leakage between floors
- Temperature difference between inside air and outside air

The smoke and heat from a fire originating on a lower floor of a high-rise building will be drawn to the vertical arteries of the core and be spread to the uppermost floors, where it will mushroom and bank down until top ventilation or other means of ventilation of the building is provided. Efforts to reach the seat of the fire in a high-rise building are often difficult because the flow of heat and fire is usually toward the natural draft in the center core area where stairshafts and elevators are located. This natural movement of air not only increases the speed with which a fire will spread horizontally; it also can create untenable conditions at the access point on that floor where the attack is launched.

ATRIUMS

Atriums are also subject to the Stack effect. They would be subject to smoke contamination from spaces that adjoin the large open space. The controls to vent the space may not be automatic. They may be controlled remotely or operated manually by dispatching members to the roof area of the atrium to open vent hatches.
SPACE AND OCCUPANCY SEPARATIONS

Partitions & Walls
The requirements for compartmentalization of floor areas in New York City is predicated upon whether the space is sprinkler protected or not and also the lack or presence of smoke detectors. Any new construction exceeding 75’ in height must now be fully protected with a sprinkler system, thus allowing no limit to a floor space or a requirement for fire divisions. The most common design used in today’s High-Rise is of the "open-space" concept. The open-space concept is usually utilized in office buildings where many office and clerical functions for one tenant are performed on the same floor. Under these conditions the tenant does not wish to divide the floor area with walls or partitions. The open-space floor concept poses significant problems under fire conditions in terms of horizontal fire spread and amounts of exposed combustibles creating the potential for large areas of involvement and tremendous heat development. The lack of fire division walls will make it possible for a fire burning unchecked by sprinkler protection to quickly spread throughout the entire floor. One advantage for the fire service would be the unobstructed reach for our hose streams.

Dwarf partitions
The open space design of modern High-Rise buildings offers the flexibility to erect interior partitions that can be installed at any location that is convenient to the tenant. These partitions are not to be confused with cubical separations between workers. Dwarf partitions are usually made of steel studs and gypsum board, and quite often are covered with combustible surfaces such as wood paneling. Normally, they extend only from the floor to just above the topside of the ceiling; their effectiveness is negated by the common plenum between the dropped ceiling and the upper floor slab. This provides a means of communicating highly heated convected air and fire gases from the seat of the fire to remote spaces on the same floor and also to adjacent floors, through "poke-through" construction. This type of partition does very little to stop the spread of fire and depending on the type of material they are constructed from, can even add to the fire load. Even where permanent partitions are used to divide office floors, their fire protection efficiency can be greatly reduced if the partition stops at the dropped ceiling line. The breaching of these partitions may afford access for the rescue of persons trapped or that of hose lines to reach the seat of a fire. Compartmentation commonly used in older High-Rise buildings was based on the concept that small-protected areas will allow the fuel within them to burn out and keep the fire from spreading beyond the separated or protected area and it worked well. Compartmentation is an essential design consideration in the limitation of the size of High-Rise fire, but it is not valid unless it is maintained. Compartment separations must offer adequate fire restiveness and must divide plenum areas above dropped ceilings. Today compartmentation design of High-Rise buildings is often dictated by the basic building functions. For example, a typical High-Rise apartment building is well compartmented compared to a typical High-Rise office building.
Ceiling Assemblies

Ceilings in High-Rise buildings are usually suspended from the floor slab above by steel wires or rods attached to a grid of metal channels that hold acoustical tiles. The open space between the suspended ceiling and the floor above is normally used for horizontal distribution of utility services (air conditioning ducts, electrical conduits, plumbing lines, etc.) and often serves as a common exhaust plenum for the (HVAC) air handling system. Under prolonged exposure to sufficient heat, suspension wires will weaken, often causing ceiling assemblies, light fixtures and any other suspended appliance to crash down on to the floor that may be the cause of serious injury to firefighters. Concrete exposed to extremes of heat may spall, dropping down on our operating forces.

The Plenum

This open space allows the heat and fire gases to spread throughout this space above the heads of firefighters operating below. Removal of a tile may offer indication of the heat and smoke conditions in the plenum. When the HVAC equipment is left running in the Return Mode, it will draw the products of combustion through the plenum area and extend the fire in the direction of the return airshaft opening.
STRATEGIES

The success of high-rise firefighting operations and that of the initial strategy and actions of extinguishment by fire service units is very dependent upon the information, coordination and actions of the building staff, first to arrive fire service units and the Incident Commander.

The information received initially from building personnel and that which is relayed from the units on the fire floor to the Incident Commander must provide an accurate description of the fire and overall situation.

This information must be interpreted intelligently and correctly. Then it must be incorporated into an effective strategy and plan. If the first to arrive units’ deployment is consistent with an accurate size up and assessment of the fire situation and conditions, a successful operation is possible. The strategies of most operations are very well structured on the initial positions established by those first arriving units and the tactics they choose to employ. The old saying “The fire goes as the first line goes”

Upon arrival these first in units would establish contact with a Fire Safety Director and/or the responsible person in charge. The first question would be the location of the fire, source of reported smoke or the location of the alarm detection device. Check the Alarm or Annunciator panel for verification and note any additional devices having been activated. Next the status of elevators, evacuation, and the presence of access stairs in the vicinity of the reported location of operations would be ascertained. A safe means of access would then be sought out, either via the stairs or elevators dependent upon the location and elevation of destination. Some departments have the first to arrive unit establish Lobby Command to glean this information and implement the System of Incident Command. Other departments prefer having these first to arrive units proceed to the location of the fire more important to reduce the time involved in placing the first line in operation.

A team should be deployed to cause an investigation of the reported alarm. If the information were that there was a confirmed fire, members of the first Ladder and first two Engine Units would proceed to the target floor below the fire floor. The Ladder would ascertain and confirm the closest stairwell and standpipe to the fire area. That information would be conveyed to the Engine Units and Incident Commander. The investigation team must be equipped with a means of communication and forcible entry tools to gain access to area that otherwise may be locked and secured.
STRATEGIC OPERATING PLAN

The basic strategic operating plan for an *Incident Commander* to use at major High-Rise fires is as follows; (listed in order of importance)

**Determine specific Fire Floor** (if possible) or the floors on which smoke is reported from any information that is available upon arrival to the building.

1. Frequently, especially during off business hours, specific information regarding a fire floor will not be available other than a report of smoke on numerous floors (i.e., 30th to 35th floors).

**Verify fire floor** – review the information gleaned from responsible occupants/building management personnel. Then contact the first arriving units performing the investigation and request their current status and result of their survey.

1. The fire floor location must be determined as rapidly as possible.

   *All future actions* hinge on this vital piece of information.

**Control Evacuation** - simultaneously, or as soon as possible, begin the process of controlling evacuation. This can be accomplished with the use of an in-house public address system or intercom. Announcements should be made to ALL floors and evacuation of only selected floors or those that are affected by smoke.

1. Occupants of numerous floors may have begun self-evacuation. This may cause an almost a mob scene or near panic in stair shafts or building lobby.
2. Due to large floor areas or maze like corridors, occupants on the fire floor may be unaware of the fire until it is too late to evacuate. The **fire floor** must be totally evacuated as soon as possible.
3. Search and evacuation of the floor above the fire will also be required as soon as possible. This can only be accomplished as the resources of firefighter’s available permit.
4. The presence of Fire Apparatus being observed by building occupants may begin a phenomenon of self evacuation, when announcements have not been made, for even a minor fire or emergency.
Gain control of Building Systems

- Fire Pumps
- Air handling equip (HVAC)
- Communications
- Elevators

Confine and Extinguish the FIRE

Experience has shown that any serious fire will require a large commitment of personnel and equipment to control and address the numerous responsibilities and support the extensive logistic problems and also the need for early and frequent relief of members. During the initial stages of major operations in a high-rise, the Incident Commander is faced with more problems than the available resources to solve them. It is a time when difficult decisions must be made. To make correct decisions the IC must have experience and good judgment to process and evaluate the information received and to determine its accuracy. The experience level of the members offering the information will be a factor in this determination.

IMPLEMENTING THE STRATEGIC OPERATING PLAN

To achieve the outlined Strategic-operating plan, the suggested position for the first arriving Chief Officer, who will act as Incident Commander, would be a location in the lobby. Some departments utilize a command vehicle positioned distant from the building to coordinate operations. This requires additional communications from a Lobby Control team that can already overload the radio traffic on the operational frequency if a command channel is not established or available.

This Chief Officer is now designated “Command” for all communications from units operating. The Lobby Control team’s location should give access to the Fire Alarm panel. This location should provide a means of observing and/or possibly controlling the building systems referred to in the plan. Responsible building personnel should perform the control of these systems. It is at this location that information may be received first hand about other problems that may develop on floors above the fire through the building communications networks. It is suggested to establish a liaison with the local Police Department for control of the lobby and the streets in the vicinity of the fire building. The continuity of Command by an informed and knowledgeable Chief Officer, at the Command Post position is of prime importance. To provide continuity of operations, it is essential that the first arriving Chief Officer remain at the Command location to assist the next ranking Chief Officer who will take charge of operations as Incident Commander. This first arriving Chief can assume the duties of the Planning Officer and shall remain at the Command Post.
The first arriving Chief Officer performing the initial size up will be required to determine the adequacy of the response and the need for additional equipment and resource of personnel. This Chief or Lobby Control team would be required to establish a liaison with building/management personnel present to determine and verify the following:

1. Has the fire floor definitely been determined, if feedback has not been received from the first arriving units as yet?
2. What is the extent of the evacuation that has been implemented, if any, from information received from floor wardens? *
3. Have there been any reports of severe life hazards.
4. Are there any handicapped individuals located on the fire floor or floor immediately above?
5. What is the status of the elevators and the HVAC system?
6. Are there any access stairs in the vicinity of the reported fire floor?
7. What communications have been or can be established between the fire floor and Lobby command?
8. What communications have been or can be established between the Lobby Command and the occupants of the entire building?

* A fire warden is a selected individual from a tenant on each floor who has been trained to begin and effect evacuation of their tenant space/floor area.

This Chief Officer should ensure that announcements are made, if not already given, over the PA system or Intercom system.

Sample “The Fire Department is on the scene to extinguish a fire on the ____ floor. Please remain calm at your place of employment. If your assistance is required, a request will be made in an announcement. As information is received it will be passed along to you. Thank you for your cooperation.”

An announcement to those occupying the fire floor and floor above can be made and would instruct them to use the stair designated and the “Evacuation Stair”

Sample “Everyone on floors __ and ___ Please evacuate using the “B” stairwell.

Fire Safety Director/Responsible person

The responsible building/management contact MUST be informed to remain in the lobby where their assistance will be available during the entire operation. Copies of floor plans are to be obtained from this person. As soon as possible, the first arriving Chief Officer shall start obtaining the additional information required and it would be suggested to devise a High-Rise Check List of vital information to ensure nothing is overlooked.
TO ACHIEVE THE BASIC STRATEGIC OPERATING PLAN
This first arriving Chief Officer would contact those units on the scene to verify their location, fire conditions and the operations they have implemented. This Chief may be advised that they are still proceeding to the reported location of operations, or attempting to gain access by means of forcible entry. The operation may have progressed to advancing onto the fire or still searching for the fire or the report of trapped occupants?
The tactical placement of the responding High-Rise fire assignment in New York City is as follows: A Radio Code Signal for a fire in a Commercial high rise structure is transmitted and will provide, 4 engines, 4 ladders, 1 Rescue company, 1 Squad company, 4 Battalion Chiefs and 1 Deputy Chief including special units.

1. The **first** and **second** arriving Engine companies shall be teamed to stretch and operate the first attack hose line.
2. The **third** and **fourth** arriving Engine companies shall be teamed to stretch and operate the second hose line. (Most commonly the Back up line)
3. The **first** arriving Ladder Company shall be assigned to search and evacuate the fire floor.
4. The **second** arriving Ladder Company shall be assigned to augment the search and evacuation of the fire floor.
5. The **third** arriving Ladder Company shall be assigned to search and evacuate the floor above the fire.
6. The **fourth** arriving Ladder Company shall be assigned similarly to operate on the upper floors.
7. The Rescue Company shall be used to perform special tasks as determined by the Incident Commander.
8. The Squad Company shall also be used to perform special tasks as determined by the Incident Commander.
9. The second arriving battalion chief shall be assigned to establish and operate the Operations Post in proximity to the fire floor which may be the floor below.
10. The third and fourth arriving battalion chiefs will be assigned as needed. As the operation expands, they can be assigned as Staging Area, Search & Evacuation, etc.

LOGISTIC SUPPORT
It is important for the Incident Commander to establish a logistics support system early in the operation and maintain it throughout the entire operation. Those fires requiring a sustained attack or prolonged operation, an Incident Commander shall order a Staging Area established two floors below the Operations Post.
It is suggested that the staging Area is to be supervised by a Chief Officer. The Staging Area shall be supplied with Staffing for relief and rotation. A minimum of (3) three Engine Companies and (2) two Ladder support units is recommended. A supply of SCBA bottles should be made available, enough to maintain the sustained attack and overhauling stage, or until the atmosphere is considered non-contaminated.
A triage area can also be set up below the Staging area for the treatment of injured civilians and firefighters as well as a Rehab area for firefighters.
Rapid Accent Teams
Some department have adopted the concept of assigning Units/Teams of members to transport the resources of equipment needed to support continued operations up stairwells to the Fire Operations area or Staging area. These members are allowed to be dressed in work duty clothing and shoes to reduce fatigue. This concept allows those members wearing full PPE to ascend to the upper floors without carrying heavy equipment requiring an extended recovery period to resume physically demanding performance. Large departments with adequate staffing can support this concept.

SEARCH & EVACUATION POST
A Search and Evacuation (SAE) Post can be established above the fire operations based upon the scope of the search effort that must be launched. This post shall also be supervised by a Chief Officer, with the support of an adequate assignment of personnel to meet the demands of search. One team of 4 or 5 members is adequate to search every five floors on an average, depending of course of the complexity of the areas to be entered and searched. The SAE Post should be located on a floor that is above the bank of elevators serving the fire floor. If that is not possible then is should be located at least (5) five floors above the fire floor.

On the Fire Floor
One of the prime considerations of ladder units, performing the initial reconnaissance on the fire floor is of course the protection of life that may be endangered by the fire and the location of the fire in relation to the means of egress for any occupants present. After locating the fire and reporting this information and conditions to the Incident Commander and Engine Units, the next determination would be to select the stairways to be designated as Evacuation and Attack stairways. Other considerations in determining these two stairways would include the number of stairways serving the fire floor and what stairway(s) the occupants of the building are already using to evacuate?

The Evacuation stairway if possible should be one that is remote from the fire area. The type of stairwell preferred are those designed as a fire tower, smoke proof stairs or one that is pressurized.

The Attack stair selected for the advance of the hose line should be in a location that is most favorable in terms of providing the shortest distance from the standpipe connection to the seat of the fire if possible. When wind conditions are a factor choose a stairwell that provides the least punishing conditions while launching a direct aggressive attack, even if it is not the adjoining stairwell? The Incident Commander must be advised of the conditions and reason for this decision. Generally the tactics of the first arriving units are similar to those employed upon arrival at ordinary conventional fires. Basically the first Engine Company will initiate a direct attack on the fire from the stairway containing the standpipe closest to the fire.
Attack Strategies

THE DIRECT (FRONTAL) ATTACK
The objective of the first engine company is to advance as aggressively as conditions permit and at the same time with intelligence to reduce the volume of the fire or to completely extinguish it. Firefighters cannot be expected to launch an aggressive attack into a large fire area of a central core type high-rise building without a thorough understanding of the buildings design and what to expect of the behavior the fire, heat and smoke will take. We must understand the problems posed by the common plenum, the HVAC system, the corridors that may encircle the central core and the other structural features that contribute to the complexity of the fire problem. 
As an Incident Commander you would expect that an aggressive attack launched from an efficient location and the end result extinguishes the fire in the shortest time will solve the problem. We have to understand that our firefighters are a precious resource and are not expendable. It is unconscionable to expect our members to press an aggressive direct attack if we would place them at risk of having fire or tremendous heat overwhelm them or cut off their escape.

If the tactical deployment of the first companies are successful and the fire is being knocked down and contained, through the efforts of the direct attack then the Incident Commander should continue and support that plan of strategy. Continue to reinforce the tactic and effort in place and relieve those units that were involved in the initial attack and search. Confirm the accountability of all units and members and their condition. Now the focus can be trained on ventilation and secondary searches of the entire structure and exposures.

If a direct attack on the fire with the first hose line is not possible, because of floor layout or heat conditions, then this first hose line should work in cooperation with the ladder units on the fire floor to cover their effort and attempts at search and rescue if persons were reported to be in that location? The Incident commander then could alter his strategy based on the information received back from these units. Based upon the progress, conditions while advancing a decision can be made to deploy two hose lines simultaneously in an effort to reduce the effects of heat and provide backup protection. This strategy may then prove successful. The success will be measured by the true grit and push of the attacking unit and the volume of the fire or heat encountered. The positive encouragement and supervision of unit officers, the Operations officer or that of a sector supervisor will also add to the success and drive of these attack lines. The deployment of a second hose line to be used as a back up protection line should be standard procedure. Launching an attack from an enclosed stair into the fire area with a super heated atmosphere may be the only option available. When this situation is encountered, it is doubtful that you will be able to launch an immediate attack.
When you encounter extreme conditions and are placed on the defense immediately and the option of the direct frontal attack proves futile. An Incident Commander can request that a ladder or other special unit on the floor, under the supervision of a sector chief, make a concentrated effort to explore the area and attempt to find an alternative approach for a more favorable attack from another stairwell or access stair.

**REVISION IN STRATEGY**

If the initial strategy must be revised and an alternate approach will prove less punishing and more effective, before relocating lines from one stairway to another, critical time could be wasted attempting to move a charged line or disconnecting and draining it to be repositioned. Leave the initial line in its original position as its use and function may prove to be useful later in the operation. If the standpipe outlet is needed for another line then it can be disconnected after being shut down and drained of pressure. Subsequent lines can then be attached and stretched to locations less punishing. In the absence of remote stairs for this approach, the Incident Commander may order the tactic of using massed lines (up to three) in a frontal attack. This can be launched from one location (stair) in an aggressive attack possibly to reach a remote location where lives are endangered or where the location or arrangement of stairs has isolated occupants on the fire floor. This may be the only option. Before this tactic is launched, instructions must be given to each unit controlling the attack hose lines. Their attack must be coordinated so that the hose lines do not become entangled and advance with assistance from members supporting the stretch. The instruction can be one unit advance along the left wall, one in the center of the hall and last along the right wall. The hose streams should be trained so that its delivery of water is directed at the source and area of fire. To be effective, the stream may have to be directed into the ceiling and plenum area over dwarf partitions to be deflected into the fire.

**THE FLANKING STRATEGY**

Should the frontal, direct attack not be possible or prove unsuccessful or beyond the control of two hand lines then the strategy to employ or consider should be that of a flanking strategy (pincer) or a combination of frontal and flanking strategy. The physical layout of the floor or area will have to provide the means to accomplish this method. Remote stairways either enclosed or even that of an access stair approached from below may allow this approach. A review of the floor plan may show an area and walls that may be breached to accomplish the flanking strategy. All of these decisions will require the resources to affect the outcome. The logistics of supplying the equipment and personnel to the area of operations and the time required must be considered to achieve the success of this strategy. If these strategies fail, or cannot be implemented in a timely fashion then a defensive strategy must be anticipated and the call for additional resources must be made.
You must realize that if the effort remains committed to a frontal attack for an extended period, you may be forced into a defensive tactic by not formulating a timely decision. The Operations Chief or the Attack/Sector Officer must provide the Incident Commander with progress reports that will allow a sensible decision and successful result. The Incident Commander must maintain sufficient resources in reserve to maintain the sustained offense against the fire, and to support the efforts of search on all the floors above.

**DEFENSIVE STRATEGY**

Initially a decision may have to be made for an attack engine company to place an effective defense against the spread of the fire. This decision may be because of the initial availability of resources of firefighters and equipment or to protect the objectives and search efforts of ladder support units. Should the fire floor be designed with fire partitions, you must ascertain the location of these partitions. Attack lines can position and attempt to use one side of the partitions as a defense. The concept would be to operate the hose stream from a doorway or breach in the wall as a second line of defense or as conditions diminish advance as a flanking tactic or extinguish direct. Other options of strategy in defense can be, to identify the point where the fire is spreading most rapidly. Then maybe through the combination of actions such as closing doors and removing some ceiling tiles for access to the plenum or breaching selected walls to direct hose lines into these areas, the fire may be retarded significantly.

Encountering major advanced fires where the forward advance is slow due to the extremes of heat, the Operations Post Officer will be faced with the responsibility to provide relief for the attack forces. Standing in reserve at the Operations Post should be at least 1 Engine and 1 Ladder support unit. As rotations in relief are made units from the Staging area should replace these units at the Operations Post. Large fire departments like New York, Chicago and Los Angeles with strong staffing reserves can afford to augment the attack if it will bring about success in the strategic objective. Those departments that have limited reserves must be more cautious with their commitment of firefighters. The fact that the operational time for firefighters exposed to the extreme environment and the physical stress of attack has to be considered. These smaller departments may adopt through necessity a more defensive strategy initially from positions that are not directly exposed.

The operation of a master stream device that can deliver large volumes of water should be considered and evolution prepared to accomplish the tactic. These streams will have a longer range to allow them to be effective without the close approach and exposure to the operating forces. Their delivery will have a greater capacity to absorb the tremendous amount of BTU's generated by the fire, thus providing a reduction in heat at the point of attack and protection for the firefighters. They can also be used a demolition tool to expose an avenue of approach or reach the seat of the fire.
A Defensive Strategy could also include cutting holes in ceilings from the floor below to extend water appliances into the fire area. This is an extremely time consuming endeavor to set up and it will have a limited effect and coverage. A similar Strategy can be attempted from the floor above, but this may have to be performed in a highly heated, contaminated atmosphere. The FDNY is currently testing a nozzle similar to the 10’ NAVY fog applicator. It is designed to accommodate smooth bore tips to flow either 180 or 250 gpm. A hook is provided to counter act the back pressure. It is deployed from a window directly below and directed into the fire area. It can direct water back and forth or up and down with hand movements of the nozzle shaft from the floor below.

**Ventilation**

Venting of the fire floor in conjunction with fire operations and extinguishment is difficult and can prove positive or extremely detrimental! Should wind currents change at your level of operations the effects on the attack teams or other members on the floor could be devastating. Windows intact should not be broken and top floor ventilation by opening up doors at roof level of stairwell shall not be implemented without the Incident Commanders authorization. To learn what affect the wind would have on the area or side of the building operations are being conducted, it is suggested to go to the floor or two floors below the fire and remove glass (inward) when it is safe to do so. The observation the fact of wind blowing inward or being drawn outward will give you an idea of its effect on the fire floor. This information must be transmitted to the Incident Commander who ultimately makes the decision if this venting will be beneficial or negative to the operation.

**High-Rise Commercial (office building)**

**Vertical Ventilation**

The initial response assignment for a fire in a High Rise commercial (office building) should have a unit designated to gain access to the upper floors of the building and report conditions from that area and the roof. They would attempt to gain access via an elevator that is located in a blind shaft (no openings) to the fire floor. When a blind shaft elevator is not available, then this unit would ascend a stairway on foot that was being maintained clear of smoke, other than the attack stair. The report would include the conditions of smoke, people in danger, and the designation of those stairways that served the roof area. Ventilation of these stairways would not be performed until the Incident Commander designated which stairs to vent. Premature ventilation of a stairway may cause conditions on the fire floor to be detrimental to the attack forces. Opening the door at roof level of a stairwell will increase the draft of that stair shaft. It will draw the fire, heat and smoke in the direction of that stairwell. When conditions are favorable and authorization is given to vent, this top ventilation should improve conditions on the upper floors. This unit would then begin a search of these upper floors.
Once the fire is extinguished the Incident Commander may have to make a decision regarding further ventilation of smoke from the fire floor and/or other areas of the building. A decision may be made to use the HVAC system depending upon its capability and the availability of an engineer who understands the system. If its operation is not sufficient or capable of removing smoke, a decision can be made to channel the smoke into a stair shaft that is confirmed void of people and opened at the top for the smoke to vent efficiently.

Climate conditions may require this ventilation to be augmented by forced mechanical means to insure the smoke is removed in a positive mode. If the use of just the attack stairway for ventilation was insufficient than other stairways may have to be used. Again these stairways must be void of members and people, while smoke removal is to be conducted. Fans can be placed into operation at the base of these stair shafts to increase the positive stack or the method of cross ventilation can be set up. See Positive Pressure Ventilation on page 36.

The method of cross ventilation as previously mentioned, entails having the top of one stairway (Evacuation stair) closed at the top and only the door to the fire floor or other selected floor open with fans blowing in at the bottom. The other stairway (Attack) would have a fan or fans at angle operating into the base; the top door open and the door to the selected floor would also be open. The positive pressure from the Evacuation stairway would be forced onto and across the selected floor, and the decreased pressure in the Attack stairway would draw off the smoke, out and up. With the fire extinguished and no threat to reignition, the evacuation stair can be positively charged with forced fresh air from fans at the base, and the top door closed. This method of cross ventilation can be used to vent any floor into the attack stair and out the top. The height of the building may require a fan at the stair landing of the floor being vented with the fan blowing in to increase the pressure and flow across the floor into the shaft being used to vent out.

**Horizontal Ventilation**

Fires that have gone undetected and have achieved great proportions have caused windows to fail prior to the arrival of fire service units. These type fires are very punishing and difficult to extinguish. Horizontal ventilation is not normally undertaken at High Rise commercial (office buildings), until the fire is extinguished.

The Incident Commander would try to use the stairway(s), and at times the HVAC system to improve conditions within the building, once the fire was extinguished. The Incident Commander must authorize the operations of horizontal ventilation. Horizontal venting can be evaluated and if it were to be authorized on the fire floor, it would have to be under the control and direction of a Chief Officer. This officer would insure that it was performed on the correct (side of the building) exposure wall. The conditions must be favorable with the wind being drawn away from the building on that exposure, in order for the smoke to be vented away from the building. Otherwise the smoke may be pushed back into the building compounding the conditions of contamination and search effort. The wind conditions can be checked from a floor below the fire.
The sidewalk area below the windows being vented and the exposures to the sides must be clear of bystanders and firefighters and that hose lines on those exposures are protected against puncture from falling glass. This task is not easily accomplished, even with the staffing available. It will take time and cooperation. Assistance from the local police department will be required.

Remember that venting a window at a high-rise building fire without the approval of the Incident Commander can kill a passerby or a firefighter and cut the main supply hoseline to the building.

**Guidelines**

**Exposure**
The side (exposure) of the building that will be vented must be established and confirmed. That information can be gained from the Ladder Company officers on the fire floor or the Chief in charge of the Operations Post.

**Danger Zone**
The Incident Commander should designate a team or unit to clear the street of pedestrians, warn firefighters to withdraw from the collapse danger zone and protect hoselines from punctures. The officer of this team or unit will be designated the *Street Vent Coordinator*. Two members shall be stationed to clear that area below the windows being vented. They will then stand and position themselves on the sides of the building to the exposure being vented. They would insure these exposures were clear also. Another member should be stationed in the lobby or exit point to that side of the building to prevent anyone from leaving the fire building and being struck by glass. Ideally try to have members stationed at all doors leading to all exposures, to prevent members entering the danger zone.

**Hose lines**
Obtain a protective covering for the supply hose line(s). Plywood lumber from nearby construction sites would expedite the task long boards used to transport medical emergencies, etc.

**Street Vent Coordinator**
Takes a position across from the fire building in a sheltered area and advises the Incident Commander when the street is clear for venting to begin. When venting is terminated this officer would open up the street only after the Operations Post Chief and or Incident Commander gave confirmation.

**Ops Post**
When the street is clear of pedestrians and personnel and secured, the Operations Post Chief would order members to remove glass into the building, rather than to push out. Small pieces of glass may still fall to the street. Wide rolls of adhesive can be applied to the windows from the inside to help in the process of pulling in the glass. This helps to keep the glass from falling to the street.
**Positive Pressure Ventilation**

The FDNY has developed a partnership with the National Institute of Standards and Technology in the research of utilizing portable fans to pressurize stairwells during fire operations. Other partners included in the project are the Ottawa Fire Services of Canada, Toledo Ohio and Chicago Fire departments. The purpose of the research was to establish what equipment was most efficient and versatile to achieve adequate pressures to maintain stairwells smoke free during fire operations where stairwell doors must be opened or remain open.

Fans with a capacity to introduce air flows of 20,000 cfm or greater gave the best results in tests conducted in a 30 story commercial office building and research that included live fire in a 16 story residential building. A fan placed at the ground floor and directed into the stairwell will achieved pressures that negate the movement of smoke and heat into stairwell. Structures taller then 20 stories should utilize an additional fan three floors below the fire area. The fan would be located in the hall or occupancy with the force of air directed into the stairwell. This will enhance the pressure needed to maintain a pressure throughout the height of the stairwell with doors other than the door opened to the fire attack being opened momentarily for firefighter access to other floors.

Ideally fans should be set up to introduce stairwell pressurization into the attack and evacuations stairs. If the stairwells are contaminated before your arrival a team can be assigned to the top floor and roof area. They can be instructed to open the hatch or roof door and the fan(s) at the base of the stairwell activated. All other doors to the stairwell shall remain closed during this smoke removal period. The roof team will confirm when the stairwell is clear and then confirm when the door or hatch is now closed. The stairwell will now become pressurized.
HVAC Ventilation

Correct use of the HVAC system in a high-rise office building can limit the spread of smoke throughout the building, and improve conditions within the building for the occupants and the operating forces.

1st Chief Officer to Arrive
The first to arrive Chief Officer is to assume command as the Incident Commander (Lobby Command) at a High Rise office building fire. This chief would establish contact with those units on the scene and gain information regarding their status and any information confirming a fire. They may be enroute or just arriving to the reported location of the fire.

The Incident Commanders size up includes obtaining information in the lobby as to the characteristics of the fire area, is it an open office area, cafeteria or mechanical equipment room, etc. Establish a liaison with the building engineer to initiate Phase 1 of the HVAC Tactical guidelines, and obtain information that would determine:

1. The location of the MER (Mechanical Equipment Room) floors and the zones that they serve.
2. If there are any special HVAC systems, within the building. (E.g., atriums, public assembly spaces, restaurants, computer rooms, etc.)
3. If there is a central control of the HVAC system, and where it is located.
4. The number of return airshafts, and their locations.
5. If the return air shafts are common to more than one HVAC zone.
6. If the supply and return dampers that are on each floor are controllable from a central location or do they close upon the melting of a fusible link?
7. If there is a periphery air supply system, and how it is zoned.
8. If the system is protected from freeze-up when the outside air temperature is below freezing while being drawn into the system.
HVAC Tactical guidelines

Phase I

- **Determine the status of the HVAC systems in the building.**
  Any system that has not been automatically shut down should be manually shut down. This must include both supply and return fans.

- **Confirm the floor and location of the fire**
  The HVAC system shall remain shut down until the location of the fire has been accurately determined and verified.

- **All HVAC systems in "Full Dump" non-re-circulating mode.**
  All the systems shall be placed in the non-re-circulating mode, by opening all outside air supply dampers. Closing all mixing dampers and opening all exhaust dampers.

- **Pressurize non-fire Zones**
  After the fire floor has been accurately determined, all HVAC zones, which do not include the fire area, should have their supply fans activated. This will supply fresh outside air to these zones. It will pressurize these zones, and limit the spread of smoke to these areas. This will also supply fresh outside air to any of the occupants that are in these zones.

Phase II

**Exhausting the Fire Floor**

Upon the completion of Phase I, the Incident Commander can now consider the use of the return fans to exhaust the fire floor. The Incident Commander must have knowledge of the following information before this can be ordered:

- Where is the exact location of the fire on the fire floor?
- What is the location of all the return airshafts?
- What is the location of the attack stairs?

Having this information the following can be evaluated:

- Will the use of the return fans intensify or spread the fire?
- Will the use of the return fans pull the fire towards, or away from, the operating forces?
- Will the temperature reaching the fire dampers cause them to close?
- Has all visible fire been knocked down?
Before an IC orders any activation of the HVAC system or its components to the fire area, it is recommended that an engineer be consulted and if the conditions are favorable and system capabilities can perform the task, all units operating in the building are to be notified of its activation, weather exhaust, supply or both.

All units in the fire operations area must be withdrawn from the floors and backed out into the stairwell before the exhaust operation is implemented. When the Incident Commander has been assured that this has been accomplished, have the building engineer turn on the return fans for the zone that is serving the fire floor. The operating forces on the fire floor shall be alert to report any adverse effects. When conditions on the fire floor have stabilized and the smoke and heat are being drawn off, the operating forces shall re-establish their operations on the fire floor. The building engineer shall remain at the controls, and in contact with the Incident Commander. A firefighter with radio communications should be assigned to the building engineer.

**The High Rise Challenge**

I am sure that we can all agree that the loss of life and economic loss to all involved both in business and the community cannot justify the lack of Sprinkler Protection with in High-Rise buildings. The building design features and systems are major factors in the Strategy of operations at High-Rise fires. It is important to establish the Incident Command system and systems of Logistic support early in the operation if it is to be successful. Maintaining that support until the conclusion will achieve success. The building staff, their expertise of the building and its systems, their knowledge of our needs and that of fire safety and evacuation will add to the successful outcome of our operations. They are part of the team that supports the enormous demands placed on the fire service.

Pre-fire planning and drills in training will familiarize all those involved in the operation. The scope of training can expand to include other agencies such as Police, Emergency Medical service personnel, including Hospitals. Utility companies can be involved. This type of training will work out the kinks and expose problem situations so they do not occur during an actual incidence.

It will also give Incident Commanders and the firefighters an idea of the physical stress and demands required at these types of operations. The FDNY had conducted research on this subject. The facts are that firefighters require a rest and relief. Firefighters must be allowed to replace fluids lost through sweating by re-hydrating and a time period for recovery to reduce body core temperatures, stabilize heart rates and blood pressures. They must also be located away from any exposure to smoke with its added toxins. We all know that this is a dangerous job. Never let down your guard. In the areas of High-Rise, alarm detection devices become sensitive and faulty, causing nuisance alarms, which affect our attitude in response. You must never allow complacency to set in, maintain your disciplines. Treat every response as legitimate and professional. Every response regardless of purpose can be treated as a training experience, for the firefighters and the building staff.
Standpipe Systems
“The Basics”

Standpipe Systems have been a part of our firefighting arsenal for over 100 years. Not long after the founding of the FDNY, New York City witnessed the beginnings of its high-rise revolution spurred on by great improvements in technology. It was the invention of the elevator that sparked this revolution making it possible for people to occupy spaces at greater heights without facing an arduous climb. However other systems such as plumbing, heating and fire protection had to grow with these buildings to meet the other needs of the occupants in the buildings. These early standpipe systems were a new technology that experienced a trial and error period around the turn of the 20th century. Several system failures led to changes in the installation requirements, many of which can still be found in today's version of established codes. Some problems evolved for the requirement for qualified building personnel to be assigned the task of maintaining these systems to insure their reliability. Systems were soon required by the code not only in high-rise structures but also in large area buildings such as department stores, piers, factories etc. where firefighting operations would require long, difficult hand stretches. Today there are over 22,000 systems throughout the five boroughs of NYC in all types of buildings. With a few exceptions these systems have served us well. When they do fail however our safety as well as the successful outcome of the fire is jeopardized. Our proficiency in the use of these systems will be increased if we expand our knowledge and training with them.

To understand the operation of these systems we must be aware of its many parts and how they are related to the overall function. Although standpipes are one of the simplest, most basic types of water delivery systems, they have several main components such as water supplies (city water connections, gravity tanks, pressure tanks, fire pumps), siamese connections, risers, cross connections, valves (control valves, sectional valves, check valves, drain valves), and hose outlets. Figure 1 illustrates the components of a simple wet standpipe.

Wet systems are by and far the most common type of system although dry Systems will be encountered in buildings where they will be subject to freezing, such as open parking lots. Wet systems will have some type of water source and its piping will be filled with water. The Building Code specifies the pressure and volume requirements for the systems. In some cases the system will be supplied directly from a city water main when it is determined that the city main pressures are capable of meeting those requirements. As the height of the building increases it becomes more likely that the city water main will not provide the pressure and volume and a supply must be provided within the building itself. In some cases it will be an automatic fire pump, but in most cases a gravity tank will be installed on the roof. These roof tanks (Figure 11) have become a part of the city's skyline, however many buildings will have these tanks installed inside the building. These tanks may also contain water for domestic use in which case a certain amount will be held as a fire reserve. The minimum quantity of water for fire protection purposes will usually be 3500 gallons for systems with one or two risers or 5000 gallons for more than two risers.
If the building has a combined standpipe/sprinkler system, the amount of the fire reserve may be greater because it must account for the sprinkler system demand, which will increase the storage in gallons. Our standard operating procedures calls for the use of 2\(\frac{3}{4}\)" hose with 1\(\frac{1}{2}\)" open bore nozzles for standpipe operations, which will flow 250 gpm at the recommended outlet pressure in Firefighting Procedures - Engine Company Operations. With that flow capacity a 3500-gallon tank supply would only last about 14 minutes of operation for one handline.

It must be realized that the bottoms of these tanks are only required to be elevated 25 feet above the highest outlet in the building. If the tank were full to a height of 15 feet, this will only provide 40 feet of 'head pressure' at this highest outlet. This would equate to only 17.3 psi of pressure available at the outlet (40 feet of head \(0.434 \text{ psi/ft} = 17.3 \text{ psi}\)), which is obviously an inadequate amount of pressure. The limited amount of operational time for a single handline and the deficient amount of pressure available in the upper portions of these buildings would not be sufficient to sustain an attack against an advanced fire situation. This re-emphasizes the importance of augmenting the system with our pumpers as per Engines 1, which requires the system to be fed by the first supply line as soon as all connections are made. Augmenting this supply with additional supplies into the system should be done ASAP to circumvent any problems the first line may encounter, such as clogged intakes.

Pressure is a measure of force acting over an area, and we measure water pressure in terms of 'feet of head' or 'pounds per square inch'. Head pressure is derived from the fact that a column of water twelve inches high and one inch square will weigh 0.434 pounds. A one-foot column of water will therefore exert 0.434 pounds per square inch no matter what the area of the container is.

One foot of 'Head Pressure' = .434 psi
One cubic foot of water would total 1,728 cubic inches. There are 144 square inch columns of water in a cubic foot, each weighing .434 lbs e.g. 144 \times .434 = 62.496 lbs (one cubic foot = 62.5 lbs).

It is also fact that one gallon of water contains 231 cubic inches. We can now determine the total gallons of water in one cubic foot by dividing 231 cubic inches from 1,728 cubic inches e.g. 1,728 \div 231 = 7.481 gallons. If the total weight of a cubic foot of water is 62.5 lbs now divide that by 7.481 gallons and the figure will equal 8.35 pounds per gallon of water. From this we can see that delivering 250 gpm to an upper floor of a building through the standpipe system will require ‘lifting’ over a ton of water per minute from the street to the fire floor.

It should be noted that these systems are required by code to provide no more than 160 psi at the outlet, in which case it is necessary that we control the pressure at the outlet by throttling the valve to avoid overpressurizing the line. This is also why the code requires pressure-reducing devices (Figure 8) to be installed on many outlets. These devices are required where houselines (hose, usually 1”\endquote") are provided for civilians and building personnel to operate. They act like a partially closed valve to limit pressure in the line when water is flowing (see Chapter Nine of Engine Operations for a further discussion of these devices).

Control valves will be installed on all supplies to allow them to be shut off. These valves are required to be 'indicating' type; that is, it will be easily discernible whether or not the valve is open or closed. The most common type of these indicating valves is the outside stem and yoke type ("OS&Y"), which has a stem that will be seen when the valve is open (see Figures 5,6,9). Any valve that controls the flow of water to the system will have to have some type of security, usually a lock and chain.

The hose outlets in the building will be supplied through ‘risers’, which are vertical, pipes installed in the stairwells. Enough outlets on each floor have to be provided so that every point on the floor is within 145 feet of an outlet. Usually the outlets in the stairwells will be sufficient to meet this criterion, however there are cases where additional outlets are required and installed outside the stairs. These outlets are referred to as “auxiliary hose stations”. At the
base of each riser there is required to be a riser control valve. It can be located in the stair enclosure 'when practicable' at the first floor, basement or cellar level. When located below the first floor, they are not always installed at heights within easy reach and may be at ceiling level. (See Figures 5 & 6). When they are installed at a height above 7 feet, a 12-inch ladder may be provided for access. They are required to be below the first floor outlet, which allows us to close them and supply the first floor outlet if there is a break in the piping below that point.

Riser sectional valves (see Figure 9) will be found on many risers at 100-foot intervals, or approximately every 10 floors. They are required on single riser systems and in buildings with multi-riser systems where a single riser serves a section of the building (e.g. a building with several risers but only one will serve the upper portions because of setbacks). They're intended use is to isolate portions of the system for maintenance and repair operations, but can be beneficial to us if we need to sectionalize the system due to a break. If for some reason riser control valves or riser sectional valves cannot be located in a stairwell, they have to be motorized and remotely controlled from either the lobby or the fire pump room. The riser control and sectional valves will also have to be indicating type valves, but many of these will be 'wafer-type' butterfly valves (see Figures 12 & 13). At the top of at least one riser there will be installed a roof manifold with three 2" outlets. If it is not inside a heated star enclosure, it will be kept dry by a closed valve inside the building. This valve will often have a long stem extending from it to the roof where there will be an operating handle. These manifolds are available for fires on the roof, exposure fires and if necessary for flowing water when the building personnel test the firepump. (See figure 10)

Siamese connections are required on all standpipe systems (Figures 3 & 4) to provide a point at which we may supply the system. One siamese connection is required for each 300 feet of building frontage. If the building fronts on 2 parallel streets, they must be installed on each streetfront. For a corner building, however, only one siamese is required if the total frontage is less than 300 feet. In this case, the siamese must be located within 15 feet of the corner on the longer street. If the building faces three streets, again one siamese is needed for each 300 feet of frontage. If only two are required they must be on the parallel streets and within 300 feet of each other. If a building fronts on four streets, at least one siamese may be installed for each streetfront, but one siamese may be installed at a corner if its within 15 feet of the corner on the longer street and within 300 feet of another siamese. In other words, a building that fronts on four streets may have only 2 siamese connections if they are located within 15 feet of a corner and within 300 feet of each other. In general, companies should be aware that because one front of a building does not have a siamese, it does not necessarily indicate that the building doesn't have a system.

Siamese connections are required to be interconnected, meaning that if there are multiple Siamese, they must all supply every outlet in the building. There are a few buildings in the city that have been given permission to have separate Siamese supply individual portions of the building. There are also buildings that have been interconnected with adjoining buildings but their standpipe systems have not been connected. And there are now buildings with siamese connections attached to them for the subway stations beneath them. In these cases, to avoid confusion there should be signs affixed to the connections indicating the area that they service.
The piping from the siamese connection after entering the building will have a check valve installed on it. This valve, also known as the 'lower check', allows us to pump water into the system but prevents water in the building from backfeeding into the siamese connection. In systems with gravity tanks, an 'upper check' will be installed at the discharge of the tank and will allow the tank to supply the system but prevent water from being pumped into the tank through the system. A ball drip valve installed on the siamese side of the lower check acts to automatically drain the piping between the check and the siamese to prevent freeze-ups. This ball drip valve closes automatically when we supply the system. Control valves are not allowed on the siamese piping. (See figure 2)

![Figure 2](image)

Having an understanding of the standpipe system and its components will assist us in uncovering and rectifying problems encountered when water is not available at the outlet or when pressures are deficient. The alternative to utilizing the system is to handstretch up through the building, which can be an extremely difficult, and time-consuming job requiring many hands.
### Problems Encountered

**Upon the commencement of Operations**

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No water at outlet</strong></td>
<td>Have the riser control valve(s) checked below. Consider your location, the height of the building and how many control valves may be between your location and the lowest supply piping. There are new type Indicating (vane type) valves being installed as control valves. It is a butterfly valve, also referred to as a “wafer valve”. (See fig’s 12 &amp; 13)</td>
</tr>
<tr>
<td><strong>No water, with loud noise of air being released</strong></td>
<td>The system was drained of water or is normally a dry system. It is now being filled with water from the pumper. The system may currently be under repair? Expect outlet valves at any level or drain valves at lowest level to be open. The system will fill faster and it is preferable to bleed the system via the hose outlet valve rather than through the hose and nozzle.</td>
</tr>
<tr>
<td><strong>Minimal water with no pressure</strong></td>
<td>The outlet valve or a riser control valve may not be fully opened or a pressure reducing/restricting device may be in place. Reducing or restricting devices should be adjusted or removed. There may be a break in the supply piping below grade. Close the riser control valve to that riser and supply the 1st floor outlet. If problem still exist then have the riser control valve(s) checked below the area of operations; you may be operating with only tank “fire reserve” water.</td>
</tr>
</tbody>
</table>
Flow Interrupted
(No water flow after operating)

If the hoseline suddenly goes limp and there is a loss of water, the investigation to uncover the cause should begin with a query report to the pump operator. A quick check of the pump panel gauges will reveal if the pumper has drawn a vacuum on the inlet side of the pump. If that is the case the hydrant may not be fully opened or the hydrant, supply hose and/or strainer of the inlet is clogged with debris. When inlet and outlet pressures readings are adequate then determine if a water flow is being recorded on the flow meter?

If a flow is being registered on the flow meter and there is still no flow or minimal flow at the outlet in the area of fire operations, there is an opening or failure of the piping. Investigation should begin at the lowest level of the system piping. Try to isolate the failure and supply the system through and outlet above the point of failure.

When inlet and outlet pressures are adequate and no flow is registered on the flow meter then possibly the outlet or nozzle has become clogged with debris. Have the 2nd line (backup) take over as the attack line. This clogged line will have to be shut down and pressure relieved from the hose to determine the location of obstruction. If the clog is located at the outlet then couple additional hose and re-connect to an outlet on a lower floor. If a clog/obstruction should develop at the nozzle, the hose will remain stiff (pressurized). Disconnect the tip and remove obstruction if possible and/or replace with a new nozzle. When not using a flow meter on the pumping apparatus, and the outlet pressures are being registered as adequate, try gating down the supply line. If there is no change in the outlet pressure reading then no water is flowing in the system.

When water problems arise at a Standpipe operation the Incident commander must consider the lapse in time required to uncover and resolve the problem. The decision to have a supply/attack line hand stretched to the area of operations can be considered a tactic to employ simultaneously while an investigation of the system is being conducted. The decision will also be based upon its feasibility, height and distance to the area of operation and method of implementation.
When a system fails to provide water these are Options to employ.

- Hand stretch up the attack stairwell from the first floor or lowest street level direct from the pumper. Consider any fire located below grade and those within the 1st and 2nd floors to be ideal situations for a hand stretch. Water pressure and flow can be regulated at the pumper, rather than at an outlet that may be subjected to the conditions of the fire area. Utilize a well hole when present.

- Drop connected sections of hose down to street level from the floor below the fire and have a supply line attached. The distance dropped should be limited to three lengths of hose. This hose shall be supported in on the floor by a hose strap or other means to insure that when charged it weight does not carry it to the street. One charged length of 2½” hose can weigh as much as 175 lbs.

- Rope stretch when the distance is greater than three lengths of hose. Have a rope dropped out of a window from the floor below the fire floor and haul in enough hose to reach and operate in the fire area. Have the hose supported for its weight as mentioned above.

When rope stretching more than three lengths of hose, have members’ open windows below at intervals every four floors and a portion of hose brought into the window. The amount of hose brought in shall be enough to take the entire weight off the hose being stretched up the height of the building. Have the hose secured in a manner that will not allow it to be draw out of the window. When a utility rope of great length is not available on the floor below, consider the use of a search rope or more than one connected together to haul in the hose line. The priority of water on the fire must be given consideration over the loss and use of a search rope. Our procedures have more than one Ladder Company operating on the fire floor. Sufficient amount of search ropes should be available for search operations.

- Have a tower ladder raised up to the floor below and have the hose connected to the waterway of the bucket. This procedure may be possible to heights up to the seventh floor or higher depending upon the close positioning of the apparatus. The ladder pipe of an aerial ladder can be used to greater heights. This method and procedure would be implemented as a resource when the need for water/extinguishment was a greater priority then the use of the ladder equipment for access/egress or ventilation.
Fig 1
Components of a Standpipe System

Standpipe Siamese Connection

Combination Standpipe/Sprinkler

Riser Control Valve (RCV)

RCV on 1st floor

Floor outlet valve
Outlet Reducer (Restricting device)

Section valve 9th floor

Roof Manifold

Water (roof gravity) Tank

Fig. 8

Fig. 9

Fig. 10

Fig. 11
New type Indicating valve
Butterfly valve also “wafer valve”

Shown as *Vane type* Open or Closed

**Fig 12**

**Fig 13**

**Outside hose stretch**
Adjoining window not available

Hose taken in every 4th floor
**Fig 14**

Adjoining window available
**Fig 14a**

Note: Stretch and position hose butts in building to relief the stress from these couplings, if possible.

References;
FDNY Firefighting Procedures High Rise Office Buildings