HIGH RISE
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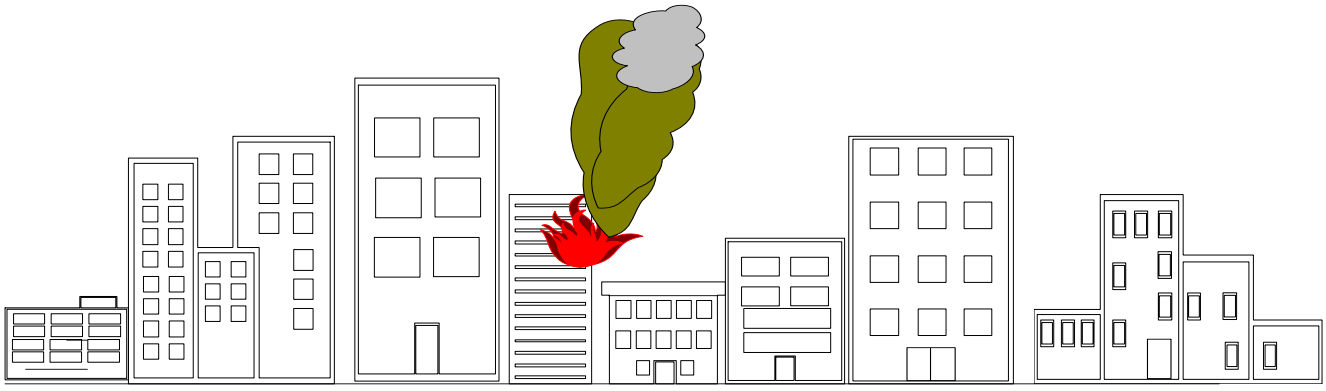
INTRODUCTION

One of the greatest building feats ever accomplished has been the development of the high-rise building. The American version of the high-rise began in the late 1880's and has prospered ever since. However, through the years, high-rise buildings have also provided as much tragedy as revolutionary excitement.

In 1929 Francisco Mujica wrote in his book "History of the Skyscraper": "Behind the skyscraper stand the leading parts of the nation... Those who advocate its abolition will certainly have no success." As history has shown, we can see that Mujica's perception was quite accurate. In the same context, we can also say that fire departments that do not respond to the growing change of their skyline will have no success when called on to handle an emergency incident in a high-rise building. High-rise buildings present new fire and rescue problems that smaller fire departments may not normally be used to handling. It is for this reason that the High-rise Training Program has been written. The program has been divided into 5 sections and includes training activities that can be completed by companies on there own, away from the classroom. The program also includes several case histories and a recommended list of audiovisual materials that can be utilized by the instructor. The format is easy to follow and read. Companies using this training program should work through the company activities and answer the review questions at the end of each section.



DEVELOPMENT OF THE HIGH RISE BUILDING

Objectives

The objective of this section is to provide the firefighter information on the history and development of the high-rise building. By the end of Section 1001.00 the firefighter should be able to:

- Explain the evolution of the high-rise building.
- *Understand the steps necessary for planning and designing a high-rise building , including how the construction is organized.*
- Understand the definition of a high-rise building.
- Understand the lessons learned from the first high-rise fires.

Company Activities

- *Identify buildings in your first in area that may have historical significance or play an integral part in San Marcos. List the potential problems you may encounter if the building was to catch fire.*
- *If you were given the opportunity to participate on a high-rise design team, what important design features would you want to have in the building?*
- *Identify a list of some of your personal concerns if you were called on to respond to a high-rise building fire. What can you do to help alleviate your concerns?*

The Evolution of the High-rise Building

Before the nineteenth century, tall buildings were generally designed around and motivated by political or religious reasons. Large structures stood as a symbol of power or faith. Buildings of this type included temples, pyramids, city halls, cathedrals and towers of various types and design. Other multi-story buildings were three to four story residential urban housing, with some type of commercial use at the base.

The first tall buildings were mostly masonry structures, although the Romans had built with concrete as early as the second century B.C. The Romans were the first to bring the use of concrete to a high level of sophistication. This is demonstrated by the famous Panetheon in Rome (123 A.D.). In these early buildings, a brick veneer was used on the outside of the building rather than exposed concrete.

In cities like Babylon and Athens, four story apartment buildings were common. They were built with the use of mud-brick with timber floors. The Romans also built ten story tenement buildings; however, they were later limited to 70 feet to reduce the risk of fire by the Emperor Augustus. Here in the southwest, Anasazi Indians built ten story cliff dwellings between 1000 and 1200 A.D.

Through the Middle Ages, the common building materials used were stone, brick, timber and timber framing with a masonry fill. Another structural element used in combination with these materials was stone arches supported by posts.

Although these basic construction techniques may seem primitive when compared to today's' modern construction methods, the traditional method of constructing a high-rise is still used. Saudi Arabia, North and South Yemen are still constructing high-rise buildings with the use of sun dried clay brick.

Technical Improvements

Modern high-rise construction techniques, which include the use of iron, steel and other technical components necessary for tall buildings were first introduced in the nineteenth century. These early technological improvements paved the way for the first high-rise buildings of the 1920s and 30s.

The steel I Beam construction was developed simply out of necessity. The traditional tall buildings that were constructed out of concrete were massive structures. Since loads increased with building volume and height, a limit to height was rapidly reached. The continued use of concrete would have required a larger base. This would have defeated one of the main reasons for constructing the building in the first place. Additionally, it would have become impossible for the base to support the load. Typical brick masonry construction can support about 200 psi. In comparison, the steel column has an average supporting capacity of 16,000 psi. Obviously, if masonry construction would

have continued, walls of the building would have become very thick, and more property would have been needed for the footprint of the building.

The main highlight of the technical evolution of the high-rise occurred in the second half of the nineteenth century. This was the development of essential high-rise building components. These components are:

Structure: All-skeleton metal construction, with the ability to provide lateral stability.

Curtain Wall: Separation of building support structure from its enclosure. Wall: enclosure becomes cladding.

Fireproofing: Safety.

Elevators: Exiting.

Mechanical Systems and Sanitation: Plumbing, heating, artificial lighting, ventilation.

Time Line of Major Events

1880 to 1900 - The early development of the high-rise occurs in Chicago. Block, slab like. building forms reach 20 stories. Also during this period the soaring towers of New York are beginning to take shape. The high-rise becomes the symbol of many American Cities. This period in time represents the “First Skyscraper Period” which was highlighted by the construction of the Home Life Insurance Company Building in Chicago. During this period most architects were struggling with the formal values of the past and also having to respond to the new conditions presented to them with high-rise and the explosive urban environment. Cities like Chicago and New York set the pace in high-rise construction.

1895 to World War II - The “Second Skyscraper Period” was known as, “a time for the race of height”. During this period, high-rise activity moved from Chicago to New York. It was the state of technology that set limits to the growth of the buildings. The beginning of the “Second Skyscraper Period” is marked by the Singer (1908) and Metropolitan Life Insurance (1909) buildings. Other notable buildings during this period included the 50 story Metropolitan Life Insurance Tower (1909), the 57 story Woolworth Building (1913), the 77 story Chrysler Building (1914), and the 102 story Empire State Building, (1931), at an incredible height of 1250 feet.

World War II to 1970s’ - This period is marked by modernism. The high-rise buildings that are now being built in San Marcos derive their roots from this construction period.

Planning and Design Steps

A great deal of planning and design work must go into constructing a high-rise building. In some cases, the plans can be so in-depth that the building foundation may be under. construction while the roof assemblies are still being designed. Activities often take place simultaneously, and once construction starts, decisions that will affect the overall design are made daily. However, there are some basic steps that must be undertaken when a high-rise building is constructed. These steps are:

- Site selection and feasibility of need are completed.

- Rough sketches for the basic idea are produced. These rough sketches are followed by more detailed drawings and gradually a design concept emerges.

- Once the detailed drawings are completed problems are identified which could cause a complete re-design. For example wind pressures are particularly complicated and special research may have to be carried out. Seismic studies are also conducted to assure that the building will hold up to an earthquake. Rarely are two high-rises ever identical. Their use, the site, and the need of the people who will be working in them will vary.

- Once construction begins, it is organized in a logical step starting with the foundation and working up to the top. When the steel frame has been completed, Iron Workers will celebrate the event with a topping out party. A Christmas tree will be placed on the top floor, thus symbolizing all the steel has been erected. Most high-rise building construction is done in phases. To help speed up the process many components are prefabricated off site and then are brought to the job for installation.

Defining the Modern High-rise

Through the years, the definition for a high-rise building has been associated with the. height of the building. However, the firefighter cannot rely on instituting high-rise fire fighting procedures solely because the building is extraordinarily high. With this thought in mind, the firefighter should be familiar with the following definition.

"A HIGH-RISE BUILDING IS ANY BUILDING THAT LACKS VIABLE ACCESS TO THE UPPER FLOORS FOR FIREFIGHTING, AND IN WHICH FIREFIGHTERS MUST PLACE ALMOST COMPLETE RELIANCE ON THE BUILDING'S SYSTEMS AND COMPONENTS FOR FIRE SUPPRESSION.

THESE BUILDINGS MAY PRESENT PROBLEMS SUCH AS DIFFICULT ACCESS, COMPLEX CONSTRUCTION OR A NUMBER OF OCCUPANTS WITHIN THE STRUCTURE. A HIGH-RISE BUILDING WILL NORMALLY BE 75 FEET HIGH, BUT ANY BUILDING THAT COULD OVER POWER NORMAL FIREFIGHTING PROCEDURES SHOULD BE CONSIDERED A HIGH-RISE. WHEN FACED WITH THIS TYPE OF SITUATION, HIGH-RISE FIREFIGHTING OPERATIONS SHOULD BE INSTITUTED."

Lessons Learned from the first High-rise Fires

Early on, it became apparent that no building could be considered fireproof. Although a damage will be severe due to high temperature and the time it takes to mobilize an effective interior attack. The first high-rise fires occurred in the late 1800s and, as we all know, are still occurring in todays' modern buildings. In each of these fires, new lessons are learned on how they could have been prevented. The following list identifies some of the major building code changes that have occurred due to past high-rise fires.

- Improvements in window design, moving away from standard glass and installing thicker pane, tempered, or in some cases wire glass.
- Improved exiting and division of area requirements.
- Automatic sprinklers and standpipe systems.
- Identifying daily shut down procedures such as assuring filing cabinets are closed and trash is removed.
- Enclosing pipe shafts and vertical access.
- Installing smoke detection and heat detection equipment.
- Installing firefighters access in elevator cars with automatic return to first floor.
- Protecting gas lines with fireproofing.
- Installing emergency lighting and back up power equipment.
- Installing internal communications.

Review Questions

1. What were the reasons behind the first tall buildings?

2. What were the first tall buildings constructed of?

3. Identify some of the common building materials that were used in the first high-rise buildings?

4. When were modern high-rise construction techniques first introduced?

5. Why did architects move away from masonry construction and start using the Steel I beam?

6. Identify the main components of a high-rise building?

7. What were some of the concerns architects had during the “First Skyscraper Period”?

8. What was the “Second Skyscraper Period” known for?

9. What are some of the major design and planning issues that must be researched before a modern high-rise building is constructed?

10. What does a “Topping Out Party” Signify?

11. Explain why you feel the definition of a high-rise has been expanded from the traditional definition based on height?

12. Identify some of the lessons learned from past high-rise fires. If you were in charge of a building under construction, what would you do to make it more fire safe.

HIGH RISE BUILDING CONSTRUCTION

Objectives

The objective of this section is to provide the firefighter information on how a high-rise building is constructed. By the end of Section 1002.00 the firefighter should be able to:

- Explain the purpose of a central core building.
- Understand how floor and ceiling systems are built.
- Understand the basic concepts behind steel structures.
- Understand what a curtain wall is.
- Be able to identify basic fire problems associated with high-rise construction.

Company Activities

- *Visit buildings in your area that are under construction. Try to identify the construction methods being used.*
- *Compare high-rise construction methods to other types of construction methods that are commonly used. Would there be any similar fire problems?*
- *Review your pre-fire plans. Do they provide adequate building construction information to help you contain a fire?*
- *Pre-plan how you would respond to a heavy rescue problem in a high-rise building.*

General Characteristics of High-rise Construction

In Section 1001.00, we learned that high-rise buildings have evolved over hundreds of years. We also learned that a variety of construction materials and methods are used to construct high rise buildings and a great deal of planning must be done. As these buildings become more complex, it becomes very important for every firefighter to understand how a high-rise is constructed. To put this in a different context, imagine you are responding to a wildland fire. As you respond, your mind will be thinking a variety of thoughts. More than likely you will be concerned with the fuel type, height and arrangement. You will be evaluating the weather including the wind direction. You also may consider if there are people in the area that could be injured or you may consider your own personal safety, quickly checking your safety gear.

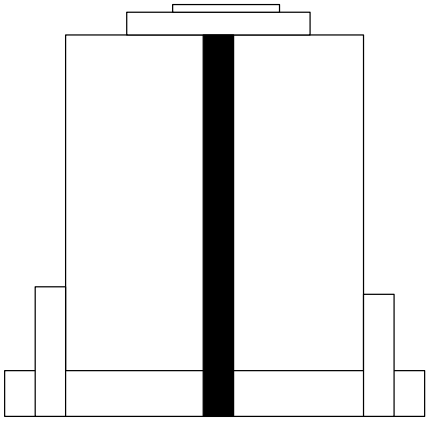
Now imagine yourself responding to a high-rise fire. Will your thoughts be the same? Will you still have the same concerns as you did when you imagined you were going to the wildland fire? The answer is yes! You will have many concerns as you respond to a high rise incident, and rightfully so. Fires in large buildings are very difficult to handle.

In 1908 David Knickerbocker Boyd, stated in the American Architect and Building News, *"Aside from all the aesthetic considerations, the continued erection of the so-called skyscraper, the excessively tall building, constitutes a menace to public health and safety and an offense which must be stopped."* Probably most firefighters would agree with Mr. Boyds' statement. Many of the concerns you may have about handling incidents in high-rise buildings can be alleviated by simply understanding what you are responding to.

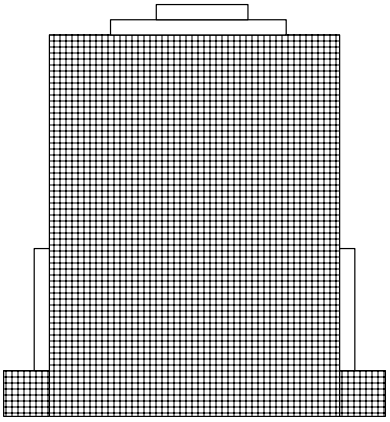
There is a wide variety of high-rise buildings. However, all high-rise buildings have some similar characteristics the firefighter should be familiar with. Specifically, firefighters should know what a central core building is. They should also understand floor and ceiling systems. Finally, they should have an understanding of how the curtain wall, and the structural steel frame is constructed.

The most common type of high-rise building is built with a central core of reinforced facilities such as power and water lines, elevator shafts and air supply and return shafts. Additionally, stairwells and restrooms will be located in the central core. The central core building helps provide a place for all of the service lines to be located. It also helps strengthen the structure. A central core can be compared to a mast on a ship. As the mast runs up the center of the ship, the sails are hung from it. In a high-rise building, the central core serves the same function, except that the floors are hung from the core. The outside walls then become very light, and receive the wind forces transferring them to the central core.
Another way the building can be constructed is like a steel tube. This tube would receive the forces of the wind, transmitting them along the steel beams and columns down to the foundation. For an office building, this is a more practical construction method since more rent able floor space would be available. The firefighter should be aware that some buildings could be constructed using both methods. This could mean that service

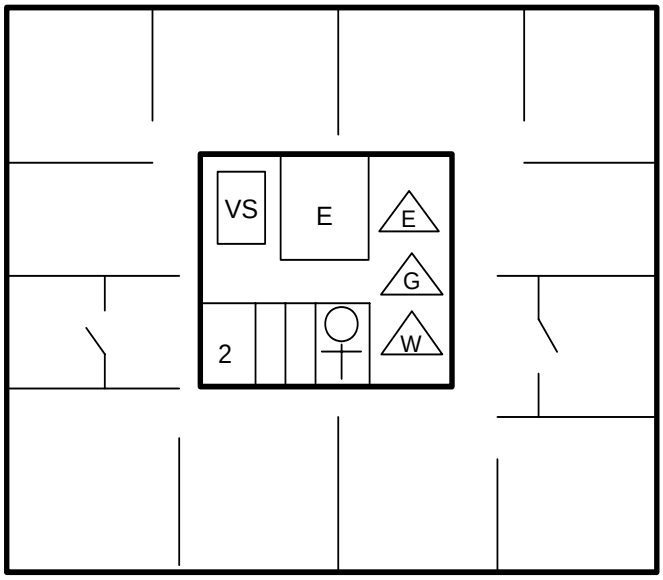
lines and elevators could run up the building in a central core and then move throughout the building in the tube.



Central Core



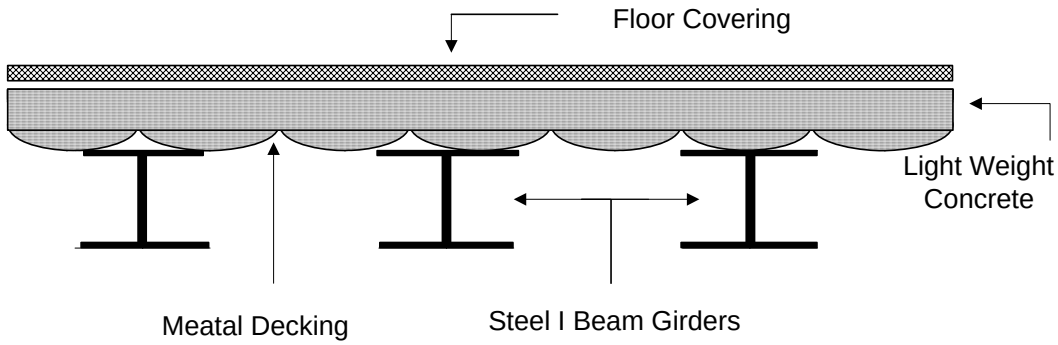
Tube

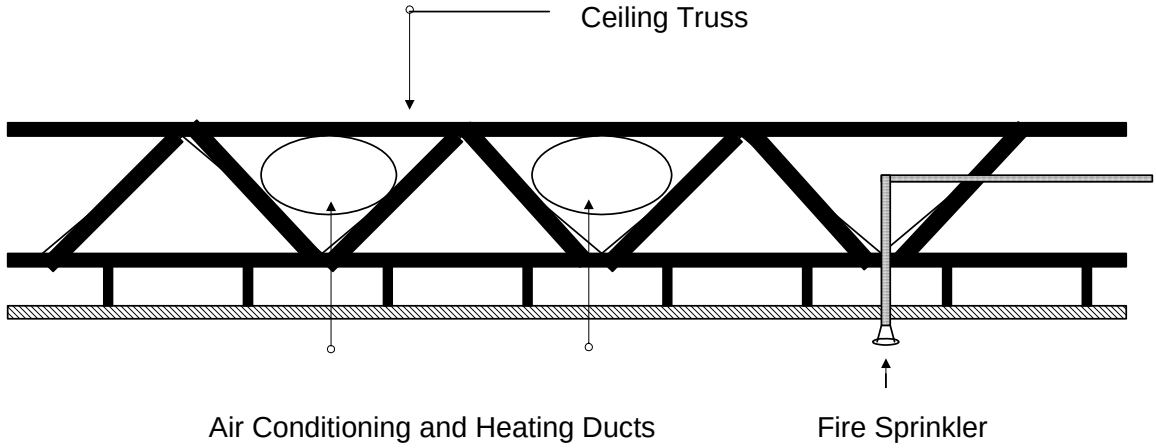


Central Core

The central core contains most of the building services including elevators, stairs, utilities, air-conditioning shafts and rest rooms. This diagram is looking from the top down. You can see the foot print of the building.
The floors of a high-rise building use a combination of materials. The standard floor system for a high-rise building is called Q - Deck or metal deck. This floor system consists of a metal panel that is attached to the floor beams or girders. The metal

panels provide the support for lightweight concrete, which becomes the base of the floor. The lightweight concrete is then covered with carpet or tile.





Ceilings are of noncombustible acoustical tile hung from hangers or roof trusses supported from the floor above. This construction creates a void space, which is then used to install supply ducts. Firefighters need to be aware of fire in this overhead area. Make sure you constantly check this void space for fire extension.

The steel frame of a high-rise building is sometimes called the skeleton. A typical steel framed building will weigh around 100,000 tons. Depending on the design of the building, columns may have to be emitted from the floor area. Many different structural designs can be used in place of these columns. Sometimes the facade is braced with diagonal beams. Or an umbrella frame may be used high in the building suspending the columns. When an umbrella frame is used, the columns act as hangers for carrying the floors.

Steel is very strong. Each piece of steel in a high-rise frame is typically 1-1/4” thick. In a fire, steel can heat up very quickly. Without protection it can reach temperatures of about 2,120 F. Firefighters should understand that when steel reaches this temperature,

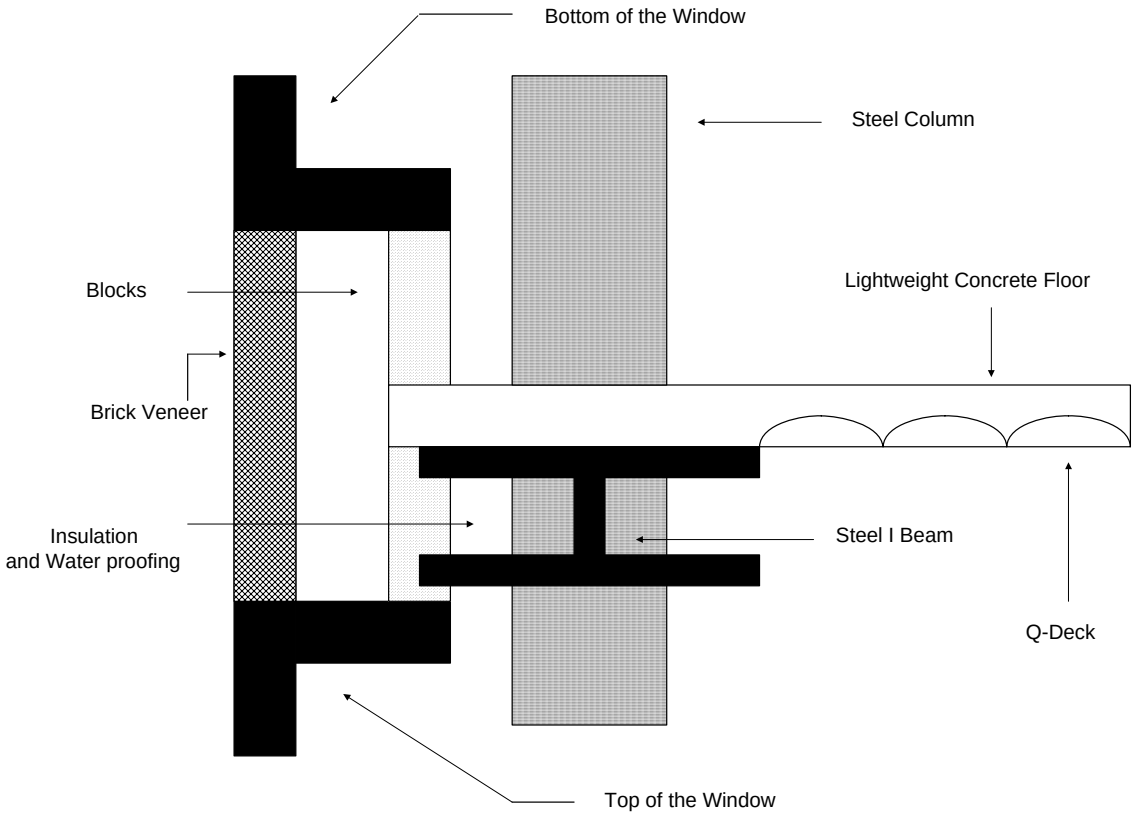
it will have little strength and will expand considerably. This means that upper floors could collapse or partially collapse. For this reason, steel framing is fire proofed with a sprayed on insulation. This fireproofing cannot always be counted on by firefighters. In some instances, it is sprayed to rusted metal and will fall off easily if bumped by workers during construction. Firefighters working above floors should pay close attention to the surroundings. Ceilings hanging unusually low or groaning and creaking sounds could be a tip to a possible building collapse. Building collapses in steel framed buildings will occur for other reasons besides fire.

An example of this is the disaster of the Kansas City Hyatt Regency Sky walkways in 1981. Due to a building design error, 113 persons were killed and 186 people were injured. Firefighters spent days at the site removing the dead and injured and had to rely on assistance from heavy equipment contractors to remove the walkways. One of the worst construction accidents occurred in 1987 at the L'Ambiance Plaza Apartment Building, Bridgeport CT. Using a technique called lift slab, a failed support detail triggered a chain reaction and progressive collapse that killed 28 workers and injured many others. Remember, high-rise buildings not only present a new type of fire problem, they also present new types of rescue problems.

The walls of a high-rise building are probably one of the most complex parts of the building. The walls of a high-rise building are called "Curtain Walls". The main functions of the curtain wall are to keep the water out, prevent air leaks, and insulate the building. It is also the public face of the building. A Cladding system refers to the type of Curtain Wall. The most common type of cladding systems are:

- Metal curtain walls
- Glass curtain walls
- Stone cladding
- Precast concrete panels
- Brick veneers

An important point about a curtain wall is that it does not bear any of the buildings weight. Curtain walls do not hang from the exterior of a building, rather they sit upon a shelf with their weight carried by the steel frame. Curtain walls should not be used for rope anchoring points. Remember the curtain wall is the buildings skin and will usually be very light. Curtain walls are required to be fire resistive and will have a fire resistive rating as specified by the building code. Thin metal curtain walls may require back up walls of noncombustible or fireproof material. Gaps between the exterior wall and slab must be closed so a flue cannot be created. Curtain walls are installed in a variety of ways. In the picture on the next page, a basic curtain wall design is shown.



The main functions of the curtain wall are to keep water out, prevent air leaks, and insulate the building. It is also the public face of the building. A Cladding system refers to the type of Curtain Wall. Curtain walls do not carry the load of the building.

Fire Problems Associated with High-rise Construction

Each high-rise construction feature that you have learned about has a fire problem associated with it. High-rise buildings are designed as a self-contained operating structure. This is the firefighters first enemy. The first obstacle you will encounter is extreme heat. Fire resistive construction has always contained heat. This is compounded in a building that has been designed with climate control and heat transfer in mind. If you consider forced ventilation, large open spaces and highly flammable contents, the effective work time for a firefighter will be 5 to 10 minutes.

Another fire problem associated with high-rise construction lies with a central core building. In a central core, return airshafts will move air back to the center of the core. This will heat the center of the building. Even with breaking out windows, firefighters will feel little relief from the heat. Remember, it is this high heat zone area that you will be entering to attack the fire.

The Q deck construction method for flooring is economical and easy to install. Its' lightweight feature is an important part of the overall design feature of the building. However, to the firefighter, lightweight flooring means faster heat travel to upper floors and possible breaches from electrical conduit.

Anytime you have a void space, you have a place for fire to travel. This is the case with ceiling areas and between the curtain walls. Most of the building services will be located between the ceiling and the floor. Firefighters have to be ready for fire traveling in this space. Especially when you are advancing in a hallway or corridor. The curtain walls are very light and are required to be fire stopped. If the fire does breach this area, it is possible for fire to travel vertically without you ever knowing. The fire can also lap on the outside of the curtain wall and breach the upper floors.

I beams that are exposed to high heat could lose their strength and cause a partial collapse of the structure. I beams are fastened to each other or to main girders. A beam under heat will move downward since there is no support below them.

Glass windows can be difficult to breach. The glass that is used in high-rise buildings can be tempered, heat strengthened, laminated with a plastic coat or wired.

Finally, fire loading will be of major importance to the firefighter. When you take a fire resistive building and load it with highly combustible contents, you have the potential for a disaster. Materials made of plastics and synthetics contribute to the heat and smoke problem. In offices, filing drawers and office storage areas will also contribute to the flammability of the structure. Firefighters need to be familiar with the occupancies in their first in area and have an idea where most of the fire loading is located in the building.

All of these problems add up to either a rapid vertical or horizontal spread of the fire. The only way to counteract these problems is to make a quick, aggressive interior attack, holding the fire to the origin.

Review Questions

1. What is a central core building used for?
2. Explain how a Q-deck floor is built?
3. What is another name for the frame of a steel building?
4. What is the purpose of an umbrella frame?
5. What happens to steel when it is exposed to extreme heat?
6. Besides fires, what are some other ways high-rise buildings can collapse?
7. What does a cladding system refer to?
8. Why should a firefighter not anchor a lifeline to a curtain wall?
9. What is a firefighters first enemy in a high-rise fire?
10. What are the main fire problems that are associated with high-rise construction?

HIGH RISE FIREFIGHTING STRATEGY

Objectives

The objective of this section is to provide the firefighter information on high-rise firefighting strategy. By the end of Section 1003.00 the Firefighter should be able to:

- Define the term “firefighting strategy” as it relates to high-rise.
- Understand basic tactical priorities for developing an effective strategy.
- Understand the term “Stack Action” and what it means to the firefighter.
- *Understand what a direct frontal attack, flanking attack, and defensive attack are.*

Company Activities

- *Visit buildings in your first in area that could be capable of creating a “stack effect”.*
- *Discuss with your crew the firefighting strategies that are deployed in a high-rise building. Do they differ from standard structural firefighting strategies?*
- *Review your pre-fire plans. Do they provide adequate information on how the building is laid out to help you develop an effective strategy?*
- *Discuss with your crew, safety measures you could take to keep yourself from becoming lost during a high-rise fire attack.*

Firefighting Strategy

A combination of resources will be needed to combat and control a fire in a high-rise building. How well these resources come together will be the deciding factor if there is to be a positive outcome. High-rise firefighting strategy is a plan to assist the Incident Commander in achieving the ultimate goal of final extinguishment. Put another way, it is the art of utilizing resources, such as personnel, built in building systems, and equipment to control the fire. An effective high-rise strategy will mobilize resources to the staging area for tactical use by the Operations Officer. The Operations Officer can then provide an aggressive coordinated attack. The Incident Commander will have several immediate concerns which will affect strategy. These concerns are:

- Is there a rescue problem?
- Is there an adequate supply of water?
- Are there adequate fire personnel?
- Is there adequate overhead personnel to fill vital ICS positions?
- Are support functions being established?

It is easy to see how quickly a first alarm assignment can become over taxed. To keep from losing control of the situation, the Incident Commander needs to call for additional help and to keep basic fire ground priorities in mind. The tactical priorities for the San Marcos Fire Department are:

- RESCUE
- FIRE CONTROL
- PROPERTY CONSERVATION

REMEMBER: *The best way to save lives will be through a prompt aggressive attack on the fire and adequate ventilation.*

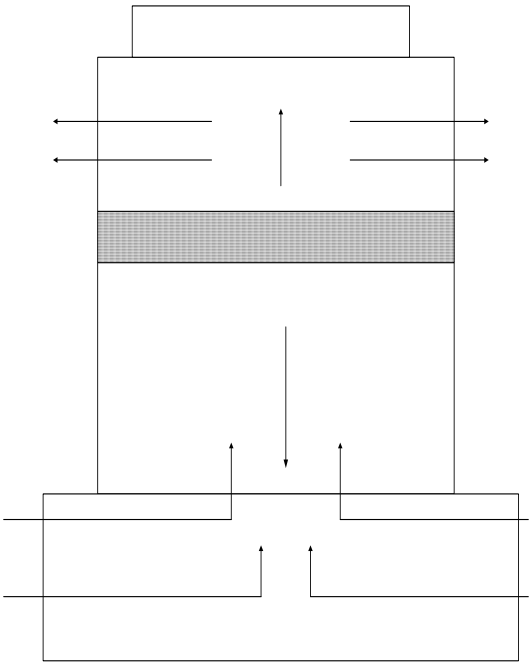
Officers finding themselves in a command role at a high-rise incident should not forget that the building is a complex structure. As discussed in Section 2, how the building is constructed will create a wide variety of problems for firefighters. For this reason, the plan of attack at a high-rise fire will have to be based upon the design of the building. The number and location of the stairs, location and design of the core, and location of return airshafts are factors in determining where personnel will be able to operate from. A floor plan should be available to assist the Operations Officer in planning his fire attack. Once the attack has begun, firefighters will be faced with an assortment of challenges.

The floors of a high-rise building will be heavily partitioned and will resemble a maze. This will make it difficult to advance to the seat of the fire. Partitions will obstruct the direction of fire streams and inhibit the advancement of lines. When faced with this condition, a truck company should be assigned with the fire attack team to assist in moving the partitions.

A phenomenon occurring in high-rise buildings that firefighters may not be familiar with is called “stack action”. Stack action can be defined as the upward flow of air in the vertical shafts. Stack action is created by the difference in the air densities and pressures on the outside of the building as opposed to those on the inside of the building. Cold air from the outside will move to the lower parts of the building. It displaces the warmer air, which will rise. This causes the upward flow of air or stack action. As the cold air is heated it will also rise and will keep the upward flow of air moving in the shaft. This upward flow creates a pressure in the building. In theory there will be a neutral plane. This is when pressures on the floor and in the shaft are equal and there is no flow of air.

There are also ambient pressures on all floors. If the pressure on the floor is greater than the pressure in the shaft, the airflow will be from the floor to the shaft. Normally, the air below the neutral plane will be from the shaft to the floor, and above the plane, from the floor to the shaft.

This constant upward movement of air will cause the fire to spread much faster than in low rise buildings. Most people in a high-rise building are trapped by smoke and are injured or killed by toxic gases. To help combat this, the Systems Officer with coordination from the fire attack team will need to utilize the buildings HVAC system to help direct smoke movement. Smoke zone venting or smoke control zones may have to be activated. Certain floors may have to be pressurized to keep the flow of smoke away from building occupants. Examples of this are the pressurization of the vertical stairwell and elevator pressurizing the floors above and below the smoke zone. In any case, how the systems are operated will have to be known by any firefighter who may be fulfilling the role as a Systems Officer. This information should be located on the pre-plan and be readily accessible at the systems control area.



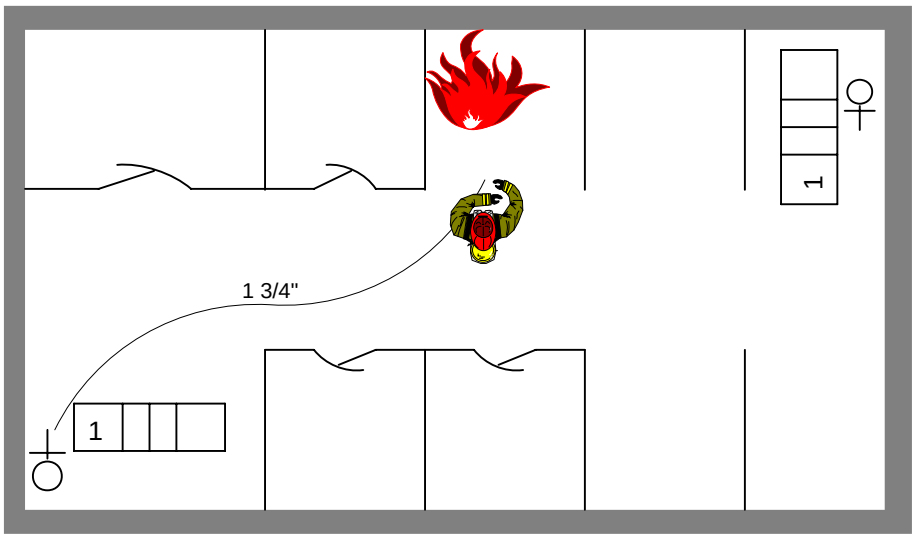
Stack Action

Arrows indicate stack action - the upward flow of air in vertical shafts that is created by the, difference in the air densities and pressures on the outside of a building as opposed to those on the inside. Shaded bar indicates the neutral plane. This is where pressures on the floor and in the shaft are equal and theoretically there is no flow of air.

As complicated as the problems may be, there are no fancy attack options available to the firefighter. Firefighting will be limited to interior operations and will rely heavily on built in building systems. However, basic fire attack guidelines can be categorized:

- Direct frontal attack
- Flanking attack
- Defensive attack

The direct frontal attack is the most common. The direct frontal attack is when the fire attack team locates the closest stairwell to the fire, hooks to a standpipe system and. advances to the seat of the fire. Additional lines are committed to support the first line with the intent of reducing heat. This type of attack is mandated when a fire has obstructed the means of egress for building occupants. Standpipe connections are to be made one floor below the fire floor.

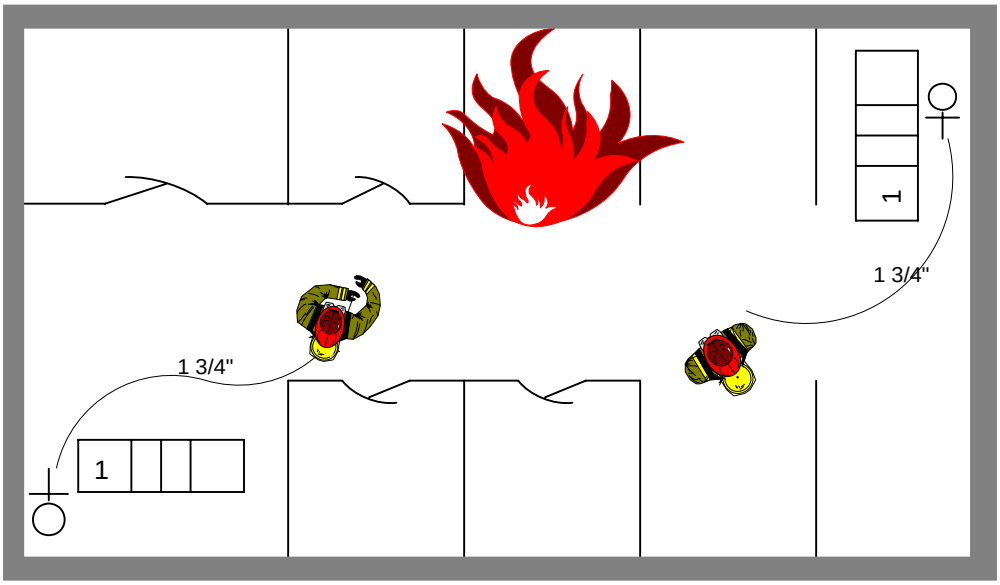


Direct Frontal Attack

A direct frontal attack is the most common. It is also the attack that will expose firefighters to more direct heat. This attack option should be used when there are

occupants trapped or when the fire is relatively small. The potential for fire in the overhead should be carefully examined.

Most initial attacks will begin as a frontal attack. When a frontal attack fails, a flanking attack should be instituted. A flanking attack should also be considered whenever there is a chance for fire to wrap around behind the fire attack team. Flanking attacks will start as a frontal attack and then will be reinforced from a second or even third stairwell to cut off the spread of fire. Coordination is needed to keep nozzles from opposing each other.



Flanking Attack

In this example, the fire has the potential of wrapping around the first attack team. When this occurs, a flanking attack should be used. Communication will be needed to avoid opposing lines.

When the magnitude of the fire completely overwhelms the resources available, a defensive attack should be deployed. Another example of when a defensive attack should be used is when access or egress is so poor firefighters are unable to establish areas to operate from. When a defensive attack is deployed unmanned monitors and large master streams should be used in a holding action. A defensive mode of operation usually means that the advancement of an offensive attack has not been successful. A defensive mode of operation would normally be operated from the outside of the building. However, in the case of a high-rise, master streams may have to be set up inside the building.

“IN ALL CASES, THE BEST WAY TO CONFINE A FIRE IS THROUGH A PROMPT AGGRESSIVE INTERIOR ATTACK. FIREFIGHTERS NEED TO BE ON THE LOOK OUT FOR FIRE IN THE OVERHEAD AND FIRE BURNING BEHIND THEM.”

Review Questions

1. Explain the term “firefighting strategy” as it relates to high-rise.

2. What are the main concerns that an Incident Commander will have at a high-rise fire?

3. What are the 3 tactical priorities?

4. What is the best way to save lives when a high-rise fire occurs?

5. Explain what “stack action” is and how it could effect firefighting operations.

6. Explain some of the problems that are associated with partitions?

7. Explain what a direct frontal attack, flanking attack, and defensive attack are?

8. What are the major safety concerns for fire attack teams?

9. What are some of the methods available that can be used to control smoke movement ?

10. What are some of the reasons that fire travels faster in high-rise buildings?

HIGH RISE FIRE ON SCENE

Objectives

The objective of this section is to explain the responsibilities of first alarm companies arriving at the scene of a high-rise fire. By the end of Section 1004.00, the Firefighter should be able to:

- Clearly state the objective of the first alarm companies.
- Define the responsibilities of the first in officer.
- Understand the main ICS positions that will be needed at a high-rise incident.
- Understand the types of communication systems available to the firefighter.

Company Activities

- Review high-rise procedures listed in the emergency operations manual with your crew. Make sure everyone on your crew is familiar with the procedure?
- *Hold a tabletop exercise with your shift. Discuss strategies and responsibilities.*
- Review past case histories. What lessons can be learned from these fires?
- *Visit buildings in your first in area. Practice making size ups, connecting to standpipes and hooking to sprinkler connections*

On Scene

All firefighters who respond to any type of fire should understand the overall objective of the first alarm assignment. In a high-rise fire, the objective is to locate and extinguish the fire, if possible, while establishing the basis for operations if the fire develops into a multiple-alarm situation. This will include establishing a fire attack team, command post, and a base location, staging area and maintaining lobby control.

The first arriving officer must set up a command post in a high-rise situation. The fire control room or the alarm panel are desirable command post locations in most high-rise buildings. The first in officer needs to size up the situation from the outside of the building and transmit a brief report to dispatch. The firefighters from the first in company should be designated as the fire attack team and should be sent to extinguish the fire. Before entering the building, which will normally be through the lobby, the officer is to assure that the crew has the proper equipment. The attack team should have an idea of where the fire is located. If an annunciator panel is available, it should be checked. The first in officer should also make contact with building security or maintenance if they are available.

The fire attack team will be responsible for reporting back on fire conditions. If a working fire is found, the Incident Commander should request additional alarms and staff support. Strike teams may have to be called for additional personnel and equipment.

The next arriving engine company reports to the IC. If the building has a dry standpipe system, pumping the standpipe will be the first priority of the driver operator. The rest of the company should be prepared to ascend to the fire floor after reporting to the IC. The second company officer at the scene will meet with the original attack team and become the Operations Officer.

The third arriving engine company should prepare to supplement the sprinkler system. The company officer will report to the IC, and should be prepared to assume a staff position (e.g., Lobby, Staging or Base).

The truck company or fourth arriving engine company must also report to the IC and should be prepared for assignment to the fire floor with forcible entry tools and additional firefighting equipment. If needed, this company can also be used to handle lobby control and systems. The first in chief officer will assume command after transfer of command procedures have been completed. A command post should be located outside the building at least 200 feet away. The original company officer can be used as the chief officers aid or in another command function. Certain ICS positions within high-rise incident organization will have modified responsibilities.

The following list identifies ICS positions that have modified responsibilities and other staff functions that will be needed at a high-rise incident:

- Base. Responsibilities: Establish and maintain an assembly area for incoming resources and disperse by priorities. Reports to Logistics.

- Lobby Control. Responsibilities: Provide for personnel accountability. Control and direct personnel to entry and exits points. Also will control building systems when no System Control Unit Leader exsists. Reports to Logistics.

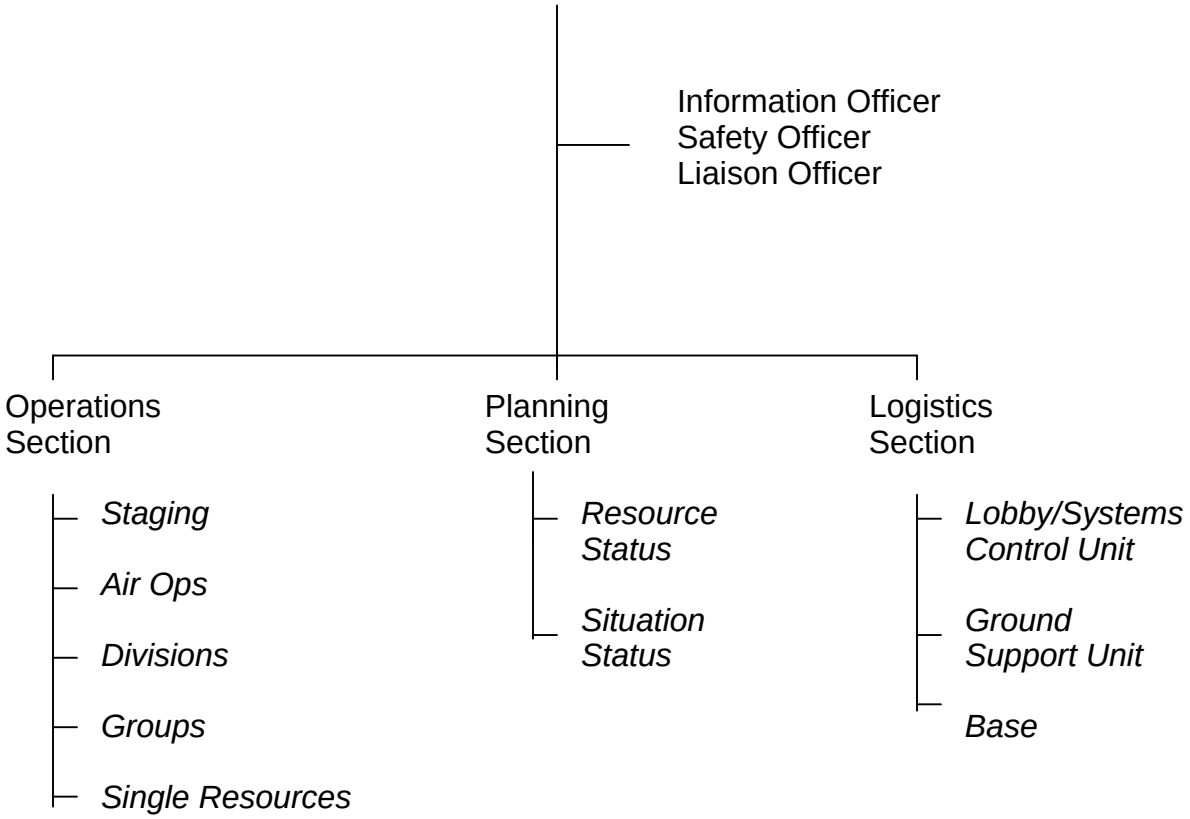
- Staging. Responsibilities: Provide an organized area for crews to assemble. Establish a check-in. Designate areas for: RIC (Rapid Intervention Crew), Rehab, air exchange, ect. Reports to Operations.

- Systems. Responsibilities: Maintain control over ventilation, elevators and fire control room, air conditioning, and enunciator panel systems within a building. Reports to Logistics.

- Ground Support. Responsibilities: Provide transportation for personnel and equipment. Implement traffic/movement plan. Provide service for all equipment eg; SCBA's, portable equipment, and vehicles.
  Reports to Logistics.

High Rise Fire Incident
Incident Command System Organizational Chart

Basic



As a minimum, high-rise incident communications should be established between stairwells and floors. However, it is highly recommended that communications also be established between:

- Floors
- Stairwells
- Elevators
- Roof
- Lobby
- Certain command functions that may be located outside the building

There are several different types of communication systems available for use during a high-rise incident. Communication systems available could include:

- Portable radios
- Public/business telephones available throughout the building
- Built-in emergency telephone systems
- Built-in public address/intercom systems
- A messenger or relay system

Maintaining portable radio communications inside of high-rise structures is often difficult since the masses of steel and concrete act as barriers to radio waves. Moving a few feet in one direction or another sometimes improves reception. However, radio communications vertically in the building is practically impossible. If the fire is on one of the top floors, transmitting from the roof may be necessary.

If a reliable portable radio contact between the fire area and the IC Post cannot be maintained, officers can telephone dispatch and have them maintain a communication phone line. Built-in emergency telephone or intercom systems can also be used.

When radio or telephone communications cannot be established, messengers should be used. Firefighters operating elevators can often be used for this.

It is absolutely essential that ALL radio traffic be acknowledged. If acknowledgement is not received, assume that the message did not get through.

Review Questions

1. What is the overall objective of the first alarm assignment?

2. What are the responsibilities of the first alarm officer?

3. What are the responsibilities of the fire attack team?

4. Why do you think the standpipe system should be pumped before the sprinkler system?

5. What ICS staff functions should be filled first?

6. Explain the types of communication systems that are available to you in a high rise fire?

7. Why are portable radio communications difficult to maintain?

8. How can communications be maintained if portable radios will not work?

RESCUE

Objectives

The objective of this section is to provide the firefighter information on search and rescue operations as they relate to a high-rise building. By the end of Section 1005.00, the firefighter should be able to:

- *Identify problems that could be encountered when accessing a high-rise building.*
- Explain why smoke is the greatest threat to building occupants.
- *Understand how to conduct a search in a high-rise building including basic search guidelines.*

Company Activities

- *Practice removing injured persons from buildings using carries, drags, and stretchers.*
- Practice conducting an interior search with your crew.
- *Identify a list of the safety points that should be addressed when conducting an interior search.*
- *Visit buildings in your first in area that may present rescue problems. Identify exits and safe refuge areas you can use during an actual emergency.*

Rescue Operations

Gaining Access

When called to a high-rise incident, firefighters will have to first gain access to the complex and then to the structure. Complexes like CSU San Marcos will present new access challenges for firefighters. For example, fire apparatus may not have access to all 4 sides of the buildings. Common areas may be crowded with people, and trees used to enhance the college atmosphere may block driving access. Buildings that present complex access problems need to be pre-planned. Areas to spot and stage apparatus need to be well known. Company officers may find themselves backing into incidents and hand-jacking lines over long distances. Apparatus operators may find hydrants concealed by shrubbery or blocked by parked cars. They may also find standpipe and sprinkler connections hard to access, requiring hose to be hand-jacked from the engine. Apparatus placement will play an important part on how fast the incident can be handled.

Firefighters may find that gaining access to the physical structure will be easier than most commercial buildings. Since high-rise buildings are usually self contained structures, occupants could be in the building at any hour. In the case of CSU San Marcos, research and other educational activities will be occurring around the clock. In many instances, a security force will also be available to assist firefighters in gaining entrance. However, there will be times when the building is locked and no one is on the premises to meet incoming units. When this occurs, firefighters should use the keys in the Knox box for gaining access. If no keys are available, forcible entry may have to be undertaken. If forcible entry is necessary, it should be accomplished in a manner that will result in the least amount of damage. Once inside the building, firefighters may encounter further access problems. Individual rooms may be locked which would require forced entry. In some cases, firefighters may find that breaching an interior wall will do less damage than prying a doorjamb.

Rescue operations in a high-rise building are inherently different from the rescue problems faced in other types of buildings. Large numbers of occupants above the ground will require more firefighters to be committed to rescue efforts. Occupants in a high-rise building can be placed in danger by three primary elements. These elements are:

- Flame
- Smoke
- Panic

Those in the immediate vicinity of a fire will be exposed to the flame and heat. The greatest danger is exposure to smoke or other products of combustion. Smoke will travel upward exposing a greater number of occupants. Smoke may also travel through air handling ducts, stairwells and other unprotected openings. Firefighters have to be prepared to move occupants to safe refuge areas and to control the buildings HVAC

system. The final threat to occupants is panic. Even though the fire may not be a threat to all occupants, knowing that a fire is in the building will cause people to act irrationally.

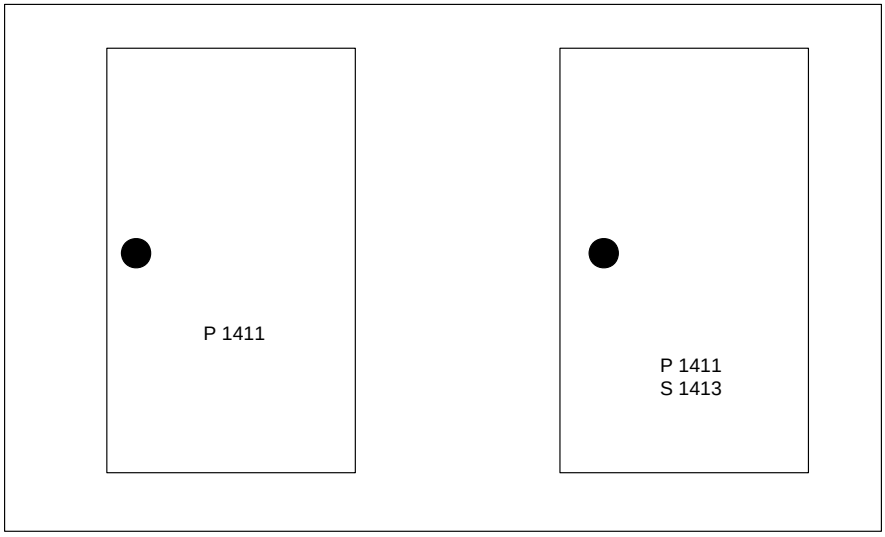
REMEMBER: *The best way to save lives will be through a prompt aggressive attack on the fire and adequate ventilation.*

People will inhabit a high-rise building at all times. It will be important for all people in the building to be accounted for. A complete search of the building may have to be conducted. Searching large buildings is a very tedious task. However, when a fire does occur, it is a task that cannot be overlooked. To speed up the process, the search should be organized in a logical fashion and based on priority.

The first search priority should be the fire floor. The second area to be searched should be the floor above the fire. The search can then continue from floor to floor both above and below the fire. Each search team should be provided with keys for access and should carry chalk to mark the doors of rooms that have been searched. A good guide for all search teams to follow would be:

- Consider most severely threatened.
- Largest number of occupants.
- Victims in the remaining fire area.
- People in other exposed areas.

In the picture below, the first door has been marked by an engine company that has completed a primary search. Shown on the second door, is an example of a second company that has given the same room a secondary search.



Review Questions

1. What are some of the exterior access problems firefighters can be faced with?

2. How should forcible entry be conducted?

3. What is the best way to save lives?

4. What are the three ways occupants can be placed in danger?

5. How should search operations be conducted?

6. What is a good guide to follow for search operations?

7. How should rooms be marked that have been searched?

GLOSSARY

BASE An assembly area for incoming resources. A Base Manager supervises this area.

CENTRAL CORE A common type of high-rise building. The central core runs up the center of the building and is where most of the building services will be located.

CLADDING SYSTEM Refers to the type of curtain wall.

COLUMN A vertical member in steel or concrete which takes the load of the building.

CURTAIN WALL The exterior wall of a high-rise building.

DEFENSIVE ATTACK A fire attack using unmanned monitors and large streams. Used when an offensive attack has been unsuccessful or when the fire overwhelms the resources available.

DIRECT FRONTAL ATTACK The most common type of attack in a high-rise building. This attack is when the fire attack team locates the stairwell closest to the fire, hooks to a standpipe and advances to extinguish the fire.

FACADE The outer face of the building.

FIRE ATTACK TEAM Firefighters that have been designated to move to the fire floor and extinguish the fire.

FLANKING ATTACK A fire attack using more than one line to cut off fire spread.

FOOT PRINT The plan - shape formed by the building on the ground.

HANGERS Rods of steel, sometimes covered in concrete, which drop from the umbrella frame to hold up the floors.

HIGH-RISE BUILDING A high-rise building is any building that lacks viable access to the upper floors for firefighting, and in which firefighters must place almost complete reliance on the building's systems and components for fire suppression. These buildings may present problems such as difficult access, complex construction or a number of occupants within the structure. A high-rise building will normally be 75 feet high but any building that could over-power normal firefighting procedures should be considered a high rise.

HIGH-RISE FIREFIGHTING STRATEGY The art of utilizing resources, such as personnel, built in building systems, and equipment to control the fire.

HVAC SYSTEM Abbreviation for heating, ventilation, and air conditioning system.

I BEAM Term used to describe a steel structural support in a high-rise building. An I beam is usually 1 1/4" thick and shaped like an I.

LOBBY CONTROL ICS position. Responsible for controlling manpower and equipment. Is stationed in the lobby area. Reports to Logistics.

Q - DECK Metal support for the floors of a high-rise building. Concrete is poured on to the Q - Deck.

SAFE REFUGE AREA A safe area to move occupants of the building to. A safe refuge area can be either inside or outside of a high-rise building.

SKELETON Word used to describe the steel frame of a high-rise building.

SKYSCRAPER A word used to describe a high-rise building.

STACK ACTION Upward flow of air in vertical shafts that is created by the difference in the air densities and pressures on the outside of the building as opposed to those on the inside.

STAGING An area located 2 floors below the fire where crews and equipment will be staged before moving to the fire floor.

STAIRWELL SUPPORT ICS position responsible for moving equipment up the stairwells from lobby to staging.

SYSTEMS ICS position that is responsible for controlling the buildings HVAC system.

TACTICAL PRIORITIES Rescue, Fire Control, Property Conservation. Operating priorities for fire attack teams.

UMBRELLA FRAME A building design where columns act as hangers for carrying the floors.

VOID SPACE A hidden space usually found between the roof and the upper floor where fire can travel.

CASE HISTORIES

The case histories listed below should be used to supplement this training program. The main points of each incident are listed and should be discussed in class.

INCIDENT	MAIN POINTS
— First Interstate Bank Fire Los Angeles, Ca.	Sprinkler systems shut down Standpipes shut off Inadequate radio system Lack of air bottles
— Jet fighter into Ramada Inn Indianapolis Ind.	Personnel not checking in.
— Atlanta Federal Building Atlanta Ga.	Benefits of a high-rise fire plan Pre-planning pays off Use of ICS
— MGM Grand Deadly smoke Las Vegas Nv.	Fire in the overhead Unprotected vertical openings.
— Westchase Hilton Hotel Houston TX.	Smoke movement through elevator shafts and HVAC system
— Fraternity House Univ. of Calif. Berkeley	Fire Exposure problems Lack of fire safety training for building Occupants

— VIDEO	American Heat Selected High-rise Incidents.
— VIDEO	American Heat Retirement Home Fires Norfolk & Roanoke Va.
— DEPARTMENT HIGH-RISE PROCEDURES	San Marcos Fire Department Emergency Operations Manual High-rise Firefighting Procedures, Use of Elevators, Equipment Aloft Guidelines, Safety procedures.
— CHARTS	High-rise ICS Charts and ICS Positions.
— SLIDES	Slides of Cal State San Marcos.
— Technical Report	FEMA, Resources on Fire Catalog # 102. Delaware and Virginia College Dormitory Fire.

— Technical Report FEMA, Resources on Fire Catalog # 102. Interstate Bank Building Fire.

— Technical Report FEMA, Resources on Fire Catalog # 102. 5 Fatality Office High Rise Fire.

— Technical Report FEMA, Resources on Fire Catalog # 102. Double Tree Hotel Fire, Louisiana.

— Technical Report FEMA, Resources on Fire Catalog # 102 La Posada Hotel Fire, Texas.

— Technical Report FEMA, Resources on Fire Catalog # 102 12 Fatality Nursing Home Fire, Virginia.

— Technical Report FEMA, Resources on Fire Catalog # 102 Shenendoah Retirement Home Fire, Virginia.

— Technical Report Fire Journal Magazine, November 1982, Fire at the MGM Grand.

— Technical Report Fire Journal Magazine, January 1983, Twelve Die in Fire at Westchase Hilton Hotel.

— Technical Report Fire Journal Magazine, July 1978, Fires on Campus.

— Technical Report Fire and Arson Investigator, September 1990, Fraternity House Fire UC Berkeley.

— Technical Report Fire Journal Magazine, July 1985, 200 Patients Evacuated in Hospital Fire.