" Let cynics and supersensible souls say what they will about American materialism and machine civilization. Beneath the surface are poetry, mysticism, and inspiration that the Empire State Building somehow symbolizes. In that giant shaft I see a groping toward beauty and spiritual vision. I am one of those who see and yet believe."

-Helen Keller

Fire in the Empire State Building

BY BRUCE HASSETT

"Manhattan Dispatcher to Division 1, respond to a second alarm for the Empire State Building Box 716. Chief, be advised we are receiving reports that flames can be seen from as far away as Queens County."

I acknowledged receipt of the alarm and was on my way. As I listened to the radio reports, a mental image of that great building was forming in my mind.

The Empire State Building, the symbol of New York City, is one of the most recognizable buildings in the world. Built in only a little more than a year during the Depression (completed in 1931), its art deco design adorns the famous city skyline. Although replaced as the tallest building in the world, its power, style, and height epitomize the term "skyscraper." The Empire State Building's colorful history includes an "assault" by King Kong and the real-life 1945 crash of a B-25 bomber into its 79th floor. The impact of that crash left 14 dead and caused extensive damage to the building, but the stability of this massive structure was never jeopardized. It is hard to imagine how a modern high-rise would react in a similar disaster.

Box 716 was transmitted at 1830 hours on July 16th, 1990 for a fire on the 51st floor of the Empire State Building. The 51st floor is serviced by two stairways, one a conventional stairway (designated "S") and the other a fire tower ("T"). The fire tower was an important feature in old high-rise construction because it improved the occupants' chances of leaving combustion products behind and escaping the building. In most cases it was an exterior feature accessed by a bridge. In the Empire State Building it is an interior stairway separated from the occupied areas by a vestibule that creates a space through which smoke and fire gases are vented into a nearby air shaft, thereby preventing smoke contamination of the stairway. The vestibule is enclosed by thick masonry walls and self-closing fire doors. This design is excellent for evacuation purposes but, as events would later show, is a dangerous avenue of attack.

The first-arriving engine and ladder companies were directed to the "T" stairway by building personnel since firefighters requested the closest avenue to the fire occupancy. The building's fire safety director was not present at the fire alarm control panel as required. Members found an advanced fire in Suite 5105. There was evidence that building personnel wasted precious minutes trying to fight the fire before alerting the fire department: Apparently extinguishers and a house line were applied through holes punched in the occupancy's thick, ornamental glass doors. Suite 5105 was occupied by Japra Industries, a fence material importer, and consisted of a reception area, two offices, and a conference room.

The first engine team connected a

■ **BRUCE HASSETT** is a deputy chief of the City of New York Fire Department, in command of lower Manhattan. A 27-year FDNY veteran, Hassett has been a chief for 15 years.

2½-inch line to the standpipe in the "T" stairway and stretched 25 feet down the corridor to the ornamental glass doors of Suite 5105. Fire was visible behind the doors. Ladder company members prepared to force the doors as soon as the line was charged.

Suddenly the doors shattered and dropped like a curtain; the fire blowtorched into the hallway and the members were engulfed in a wave of searing heat. The firefighters scrambled for the safety of the stairway. The truck company officer, convinced that some of his personnel were trapped or badly burned, transmitted a Mayday and a request for a second alarm. Deputy Chief Vincent Dunn, the incident commander (FDNY places a deputy chief on-scene for both first and second alarms at high-rise fires), transmitted the alarm and assigned a rescue company to assist trapped or injured firefighters. A quick accountability check by company officers on the fire floor confirmed that all members had made it to safety; however, six members were burned, two severely enough to need hospitalization.

Meanwhile, a second engine team stretched an additional line from the "T" stairway and members attempted to advance on the fire with both hoselines. A third 2½-inch line was connected to the standpipe in the "S" stairway and members there awaited instructions from Battalion Chief John McDermott, commander of the operations post, to advance on the fire from that position. (The operations post is established one floor below the fire floor in most high-rise operations and is responsible for the attack, search, and evacuation of both the fire floor and the floor above.) Chief McDermott denied the third attack team's request to move on the fire for two reasons: He wanted to avoid a situation in which lines would oppose

Fortunately the building's heavy, fire-resistive construction features and floor area compartmentation contained the fire long enough for suppression forces to extinguish it. However, convection currents blown from the oven-like fire suite, through an interior corridor, and into the fire tower air shaft made advance on the fire extremely difficult. Communication to occupants above the fire floor was impeded because the building's public address system was inoperable. A painstaking search of the 35 floors above was a long and arduous process. (Photos by Dave Cantor.)

each other, and he wanted to maintain the "S" stairway as an evacuation channel since attack operations were already committed to the "T" stairway, which meant that the door to stairway "S" had to remain closed to prevent contamination.

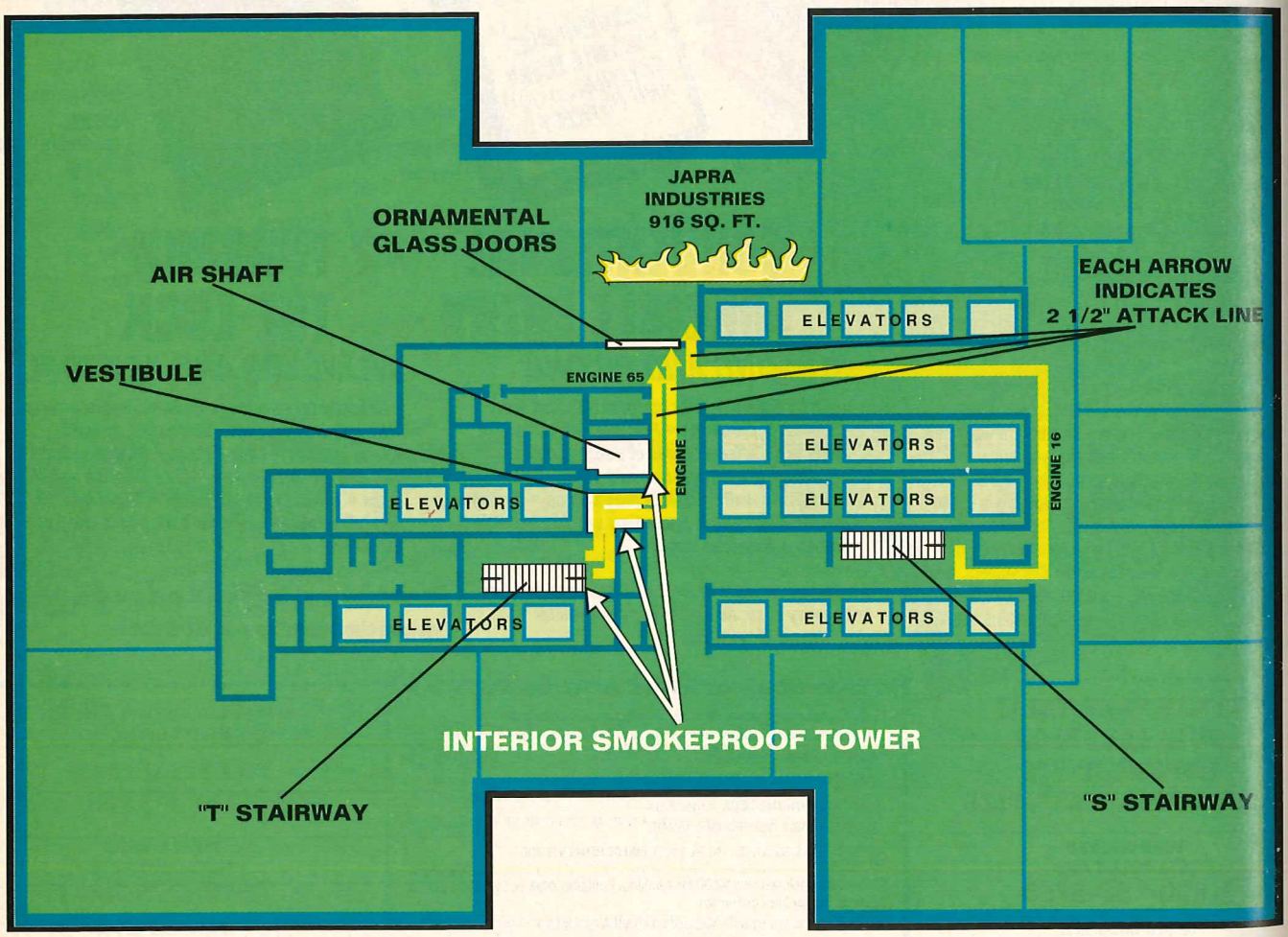
In a few minutes it was evident that no progress was being made from the "T" stairway. The combination of a 6-mph wind blowing through the fire area's failed exterior windows, the failure of the suite's glass doors, and an open pathway to the building's air shaft created a horizontal chimney, and members at the "T" stairway were opposed by a draft of convection currents and combustion products of wind-tunnel proportions. Chief McDermott therefore decided to attack from the "S" stairway. Battalion Chief Robert Marsh was assigned attack chief and the "S" stairway team progressed to the entrance of the fire suite in a flanking maneuver via an adjoining corridor. Their attack diverted the stream of convection currents long enough for members of the "T" stairway teams to join the attack and together overwhelm the fire.

"Manhattan Dispatcher to Division 1, be advised that we are receiving numerous reports of trapped occupants. We will give you specific locations as we receive them."

"Division 1, 10-4."

The Empire State Building, besides having 850 tenants that employ 20,000 people, is one of New York City's most popular tourist attractions. People from all over the world come to enjoy the breathtaking view from the observation deck on the 86th floor—as many as 30,000 on

High-rise operations are exhausting. Lack of ventilation opportunities, heavy construction in older buildings, and the proliferation of synthetic furnishings and combustibles make high-rise fires burn hot. The logistics required to fight the fire and search and evacuate the building place great physical demands on the firefighters. Continuous relief and rotation are absolute musts for safety and success.



weekends. It is said that on a clear day one can see for 80 miles. A darker side to the observatory was its attraction to those who wanted to commit suicide. Hundreds of people have tried to fling themselves to their deaths and 16 were successful, which prompted the erection of a seven-foot-high, mesh and steel spiked fence that now surrounds the deck.

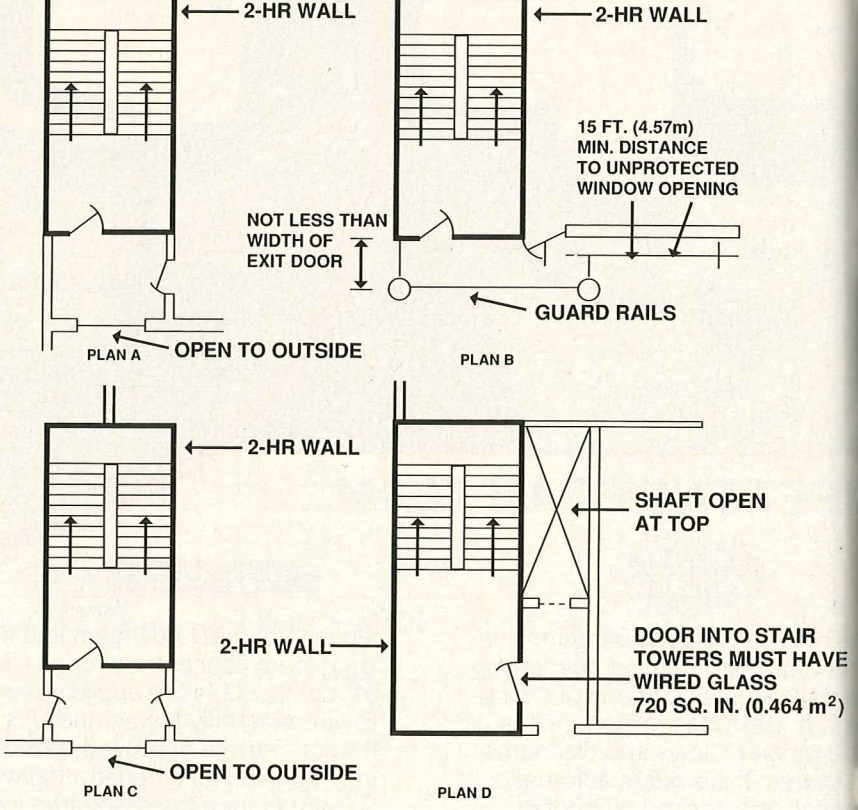
But even with spiked bars, the observatory is an impressive place. As one would expect on a sunny summer evening, there were many people on the observation deck, and they could see and feel the smoke drifting upward from 35 floors below. Although it was after business hours, there were still several thousand occupants in the building at the time of the fire.

The management of vast numbers of people and information is critical at a high-rise fire. Unfortunately, the building's alarm system did not operate in all areas of the building and electrical failure of the building's public address system took away our ability to communicate immediately with occupants above the fire. To accomplish the monumental task of searching the floors above the fire, command established a search and evacuation post on the 56th floor early into the operation. Four chiefs and 10 units were positioned there; each report of trapped or distressed occupants was checked while a systematic search of all floors was conducted. Members were sent to the observation deck to assure the tourists, many of them foreigners, that the fire department was present and that they were safe. The most time-consuming search was for a cleaning woman who was seen on the 51st floor just before the fire was reported. It took dozens of firefighters more than an hour to locate Olga, standing in the crowd—completely unaware that this five-alarm operation, which required 18 chief officers and 34 units manned by more than 175 firefighters, could not be concluded until she was accounted for. At 10:08 p.m., 3 hours and 38 minutes after it was reported, Chief of Department Joseph DeMeo placed the fire under control.

Interestingly, during the search for Olga, one of our rookie firefighters expressed his surprise that the fire could burn so long and so intensely with so few combustibles in the suite—the office appeared vacant. Of course, the ashes he was stepping on were the remnants of desks, chairs, metal filing cabinets, and other items in an active office—totally incinerated.

LESSONS LEARNED AND REINFORCED

- A fire tower should not be used as an attack stair. The attack lines block open the doors and the negative pressure created by the air shaft invites a severe draft that opposes advancing forces. This tactic is unwise from both an operational and a safety standpoint and it's especially dangerous if the fire is suddenly vented from the fire area to the outer air. Use of the fire tower for attack negates its purpose: to be the safest means of evacuation.
- When a Mayday is received the incident commander must immediately assign a unit to investigate. Progress reports are extremely important, especially an order to cancel the Mayday.
- Generally it's necessary to evacuate only the fire floor and the floor above the fire during the initial stages



Four variations of smokeproof towers. Plan A has a vestibule opening from a corridor. Plan B shows an entrance by way of an outside balcony. Plan C could provide a stair tower entrance common to two buildings. In Plan D smoke and gases entering the vestibule would be exhausted by natural or induced draft in the open air shaft. In each case a double entrance to the stair tower with at least one side open or vented is characteristic of this type of construction. Pressurization of the stair tower in the event of fire provides an attractive alternate for tall buildings and is a means of eliminating the entrance vestibule.

ESCAPE FROM LARGE BURNING BUILDINGS

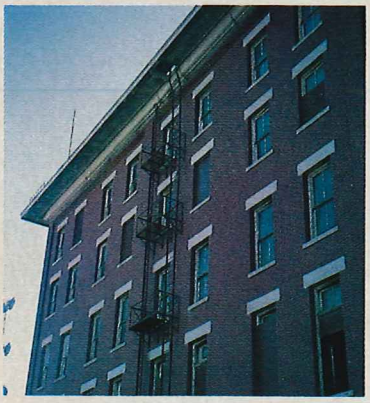
Most 19th-century cities experienced a great influx of immigrants. Housing abandoned by the rich served as residential housing for the poor. New York City, for one, required a huge number of multiple dwellings. No consideration was given to the fire hazards of these buildings. Hundreds of people lived in what were essentially enlarged private dwellings divided up into many apartments. Terrible multiple fire deaths occurred in these buildings.

Finally, new laws requiring fire escapes were enacted. Some were balconies across the front of adjacent buildings, or horizontal escapes. Others were steel balconies connected by a vertical ladder that passed through an opening in the balconies. As escapes these were fit only for acrobats.

New York's Tenement House Act of 1903 pioneered many code requirements designed to make combustible multiple dwellings safe enough for occupants to escape. Until World War II there was no loss of life from fire in such buildings. Probably the most important requirement was for enclosed, noncombustible stairways with self-closing metal doors on all apartments. Fire escapes of the stairway type, rather than the traditional vertical ladder, were required from each apartment.

Fire escapes also were provided on industrial and commercial buildings and hotels. Until recently, Texas had a very detailed fire escape law that provided outside fire escapes on 30-plus-story high-rises, such as the Texas Building in Fort Worth. A trip down such a fire escape would no doubt be terrifying but still would be preferable to an interior stairway polluted with toxic smoke. In some cases chutes and circular slides were provided. Hotels often had a rope in each room.

As it became clear that firefighters could not operate from the same stairway that was being used by escaping occupants, a series of platforms up the face of the building connected by a vertical ladder was equipped with a dry standpipe. This was for fire attack. A separate fire escape was provided for evacuation.



Balconies, a ladder, and a standpipe were built into this Salt Lake City factory for firefighter use. (All photos by author.)

Unfortunately this excellent concept was lost. Firefighters coming up a stairway to a high-rise fire often are blocked by occupants coming down.

Some intelligent person came up with the idea of placing the exterior fire escape in a fire-resistive enclosure accessible by a balcony or bridge that provided an atmospheric break between the exit door from the floor and the entrance door to the stairway. This came to be called the New York or Philadelphia fire tower, or the smokeproof fire tower. Unfortunately the fire tower was not used for ordinary movement from floor to floor so was often ignored when evacuation was necessary. It usually was not used for fire department attack.

Many developers soon realized that the exterior of the building was premium rent space and the smokeproof fire tower did not fit into their plans. However, some buildings were built with an interior fire tower in which a smoke shaft was situated adjacent to a stairway, with an enclosed vestibule between the two. The theory was that the smoke entering the vestibule air space would go up the shaft, leaving the stairway free. However, smoke and heat cannot be separated. The shaft can become a chimney. At a spectacular high-rise fire on Park Avenue in New York City, the aluminum guard railings on the shaft melted, exposing firefighters to the hazard of falling into the shaft. Check shaft rails in your high-rises for aluminum.

A California university installed this excellent exterior fire tower on dormitories.

The evolution of high-rise evacuation methods continues. In some cases the stairways are simply enclosed, with no ventilation. In the worst cases scissor stairs (two stairways in the same shaft) are provided as alleged "separate exits." As the extreme danger of these stairways was recognized, forced ventilation was provided for some stairways. The overpressurization of the stairway is supposed to keep smoke from the fire floor from entering the stairway. The pressurized stairway should be reserved for evacuation.

The best exits are horizontal. Once people pass through the barrier wall, they can evacuate at leisure. A real problem with such exits is that the integrity of the divisions and the operation of the barrier doors are both liable to be compromised. All levels of management must understand the function and be alert to any compromise, no matter how temporary that compromise may be. The absolute ideal would be high-rise towers in pairs with bridges open to

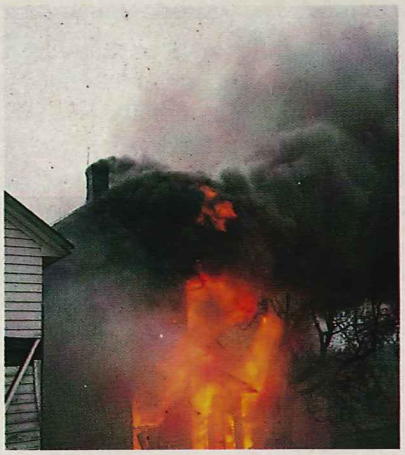
the atmosphere connecting the two structures.

Short of adequate horizontal exits the exterior, smokeproof tower with an atmospheric break remains by far the best exit from a high-rise.

There have been numerous attempts at finding the best way to keep the smoke and heat away from the occupants long enough for them to exit the building. Smoke control using the air-conditioning system was advanced as a cheap and sophisticated method of controlling the smoke. One advocate declaimed, "You may ask, What are the problems? Let it burn, but let it burn clean. Get the people out, then worry about the smoke control systems. When the fire department arrives on the scene they can take over manual control of these systems but these systems are conceived to operate automatically upon detection in the return air ducts and this system is primarily designed to provide life safety in the first five minutes." (J. Brooks Semple, "Smoke, the Unseen Killer," IAFC Metropolitan Workshop; Cleveland, Ohio, September 12, 1972.)

Note the catch phrase, "Let the fire burn clean," as if toxic smoke is not produced by a "clean-burning" fire and the heat is to be disregarded. There is no such thing as a clean-burning fire in ordinary combustibles. All around the fire combustible materials are being degraded into toxic gases. Elmer Chapman, a former division commander in New York City's high-rise-loaded midtown and a recognized expert on smoke control and HVAC systems, tells about a high-rise on Seventh Avenue in 1974. (See "Fire Department Perspective on Smoke Control, Part 1," *Fire Engineering*, September 1985. Part 2 was published in *Fire Engineering* the following month.) The automatic smoke control system drew the smoke and fire through the return plenum, a void above the ceramic tile ceiling. The ceramic tiles became red hot, fell, and spread the fire for 200 feet. Despite this, NFPA Standard 92A permits the supply and exhaust of air before the application of any extinguishing agent. This can be extremely dangerous.

This outside fire escape was added to a New Orleans hospital when interior exits were found to be inadequate.



This fire is "free-burning" on the first floor. Directly above, huge quantities of toxic smoke are being generated from the degradation of heated material.

The way to solve the smoke problem is not to let it be generated in quantity. This is accomplished by full automatic sprinkler protection, which suppresses the fire shortly after it starts. No arguments can overcome this proven fact. Any unsprinklered high-rise office building is a potential mass death trap. ■

—FRANCIS L. BRANNIGAN, SFPE

of a high-rise fire operation. Every report of distressed occupants must be investigated and a search of all floors above and several below the fire must be conducted, with special attention given to exit stairways and elevators.

● The heavy, old-style construction was a major factor in confining the fire to the area of origin. The Empire State Building, at 23 pounds per cubic foot, weighs about three times more than the typical skyscraper of today. Built on a steel skeleton, its exterior walls are constructed of eight inches of brickwork; its wall columns are eight inches of limestone backed with eight inches of brick; its floors are three inches of cinder fill on four inches of concrete topped with a cement finish; and its steel beams and interior columns are protected with thick concrete fireproofing. Although the fire melted the exterior windows and there was some smoke damage to the floor above, vertical extension via autoexposure was not a serious problem because of the integrity of the outer walls and building facade.

Furthermore, horizontal extension was inhibited because the fire floor was compartmentized. Office spaces were enclosed by the solid masonry walls. Although this creates oven-like conditions within the fire area itself, it certainly is preferable to the rapid fire extension that occurs in large, open floor spaces such as are found in many of today's high-rises. The 51st floor contained 11 occupancies, the largest of which was 5,205 square feet. Compartmentation is particularly important in high-rise buildings due to the limited opportunities for horizontal ventilation and the practically nonexistent opportunities for vertical ventilation.

Confinement to the fire area also was aided by the fact that each floor has its own air handling system to control climate. There is no central HVAC system in the Empire State Building; subsequently there's less

chance for a fire to spread through ducts or an air return plenum.

Modern high-rise construction methods "trade" the massiveness of old-style construction for such lighter materials as spray-on fireproofing and gypsum board. The effectiveness of such methods is contingent on proper automatic sprinkler systems.

- To effectively deal with a high-rise fire, operations must be separated into functional sectors. This fire was made more manageable by the establishment of a command post in the lobby, an operation post one floor below the fire, a staging area three floors below the fire, and a search and evacuation post above the fire.
- The high-rise fire is an exhausting operation that demands aggressive attack. Manpower relief and rotation are vital to success. As per standard operating procedures for FDNY high-rise operations, two engine companies were assigned to each hoseline. This paid dividends when members were injured during the initial attack. Adequate backup manpower also was available for forcible entry, search, and evacuation procedures.

John T. O'Hagan, former commissioner of FDNY, writes in his book *High Rise/Fire & Life Safety*, "The primary obstacle to the fire fighter in high-rise fires is heat. . . . At the temperatures encountered, a fire fighter's effective worktime is from five to ten minutes. Further exposure reduces him to a nonambulatory casualty requiring the assistance of two or more additional firemen whose services are temporarily lost for the control of the fire."

- At high-rise operations, fire forces are almost completely dependent on the building systems; if the systems fail, firefighters will fail unless they are prepared to utilize contingency plans and improvise. Our ability to improvise became a factor in communications, water supply, elevator transportation, fire attack, and search and evacuation. ■

HIGH-RISE FIRE

New York City currently has more than 1,000 buildings of 100 feet or more in height, excluding residential or hotels. The first major high-rise fire and million-dollar loss in New York City occurred in the Home Insurance Company building on December 4, 1898. Since then, the experience and knowledge gained from these fires has provided the opportunity to study the problem in depth. Unfortunately, much of the information gathered over the years appears to have been forgotten or dismissed as outdated. The time has come to revive the material gathered from past experiences and use it to assist your high-rise suppression and protection efforts.

The protected steel-frame construction of the Home Insurance Building was considered the most advanced design of the time. The fire originated in an adjacent five-story, nonfireproof building and quickly involved the entire structure. The high-rise windows overlooking the fire building were regular unprotected glass, and they quickly failed. The failure of the windows allowed the fire to extend from the 6th to the 16th floor of the building. Subsequently the NYC building code was amended to require wired glass with a ¾-hour fire-resistive rating.

(Editor's Note: "Fireproofing" was the general term given to the practice of insulating the steel structural members with tile, plaster, or concrete. "Fire resistive" is a more accurate term for such construction techniques and refers to a building's resistance to collapse under fire conditions and resistance to vertical and horizontal spread. Refer to Frank Brannigan's *Building Construction for the Fire Service*, Chapter 11.)

On April 22, 1908, the New York City Fire Department received an alarm for the 12-story Parker Building, representative of fireproof buildings occupied for mercantile and light manufacturing purposes in New York City. Upon arrival the firefighters found both the fifth and sixth floors involved in fire and heavily charged with smoke. Fire spread quickly up the building's open stairways. Electrical conduit placed inside tile fireproofing expanded, pulling the tile off the columns and exposing the columns to the extending fire. Structural integrity was severely compromised and the building collapsed, killing several firefighters.

The New York Board of Fire Underwriters was asked to investigate and determine the cause and spread of the fire. They concluded that the large amount of combustible material in the Parker Building, its large open areas, inadequately protected stair and elevator shafts, and lack of early warning devices furnished conditions that permitted the rapid spread of fire before the fire department's arrival.

The board strongly recommended the establishment and enforcement of fire safeguards. These included more effective use of fireproofing materials and the use of automatic sprinklers, especially in high-rise buildings used to store large quantities of combustible material.

The Parker Building fire caused a stir because a supposedly "fireproof" building had failed so rapidly, yet there was no immediate reaction in the way of code amendment.

On January 9, 1912, a fire was reported in the Equitable Life Assurance Building in lower Manhattan.

■ **ARTHUR C. SMITH** is the superintendent of the New York Board of Fire Underwriters. A retired lieutenant from the City of New York Fire Department, Smith received his bachelor's degree in fire science from John Jay College.

PREAD: LEARN FROM THE PAST

Firefighters arrived at this eight-story building in the early morning hours. The fire was not declared under control until the late afternoon, hours after the building had collapsed. Again, large unprotected, undivided vertical and horizontal openings, coupled with heavy fire loading, produced rapid fire spread. Once the fire gained headway into the upper floors, fire department operations became ineffective due to the absence of standpipes and smokeproof stair towers.

The Triangle Shirtwaist fire in 1911 took 146 lives. The fire occurred in the upper three stories of the Asch Building, a factory loft building that housed several manufacturers. The fire spread rapidly through the vast amount of shirtwaist material, and the lack of adequate exits forced many young women to jump to their deaths below. Following the fire, the New York State Labor Law instituted the requirement that sprinklers be installed in factories of more than seven stories in height.

This fire, like that of the Equitable Building and Parker Building, paved the way for a number of tests on fire-resistive construction, including ASTM E-119, the National Bureau of Standards test that is still used as a standard for fire resistance.

Based on these fires, the New York and the National Board of Underwriters recommended that any building more than 50-feet or four-stories high be equipped with some or all of the following fire protection features: automatic sprinklers, smokeproof stair towers with standpipe equipment, one or more interior fire walls, and ample stairways and other approved means of exits. Fire doors should be used as corridor partitions in every office building, and any glass should be wired for reinforcement. Single offices containing large areas should be subdivided by fire partitions intended to retard the fire spread.

Moving to more recent history, on August 5, 1970, occupants of One New York Plaza pulled a fire alarm box in response to a fire on the 33rd floor. The alarm boxes were not connected to a central station or the fire department so they produced no results. A guard in an adjoining building called in the first registered alarm eight minutes after the alarm box was pulled.

When the fire department arrived, the 33rd and 34th floors were raging infernos. Smoke and heat were so intense that firefighters could stay on the floor for only short periods of time. It took five hours to control the fire, and the building sustained $10 million worth of damages. The rapid spread of fire was caused by the common ceiling plenum in the HVAC system, exterior curtain wall construction, Q-deck floors with embedded raceways, and heavy fireloading. The delayed alarm was another major contributing factor.

In the early morning of Friday, February 14, 1975 a fire was reported from the 110-story North Tower of One World Trade Center. The fire involved the ninth to 19th floors. Fire had spread through the common air-handling plenum in the ceiling. Window glass failed, which caused auto-exposure of upper floors. The main cause of fire spread was determined to have been through openings around cables in telephone closets that were not fire-stopped. The telephone closets had louvered doors and contained cable insulated with polyethylene and polyvinyl chloride. These cables passed through ceiling openings of 12″ by 18″ to the closet above and through holes in walls to other closets on the same floor.

This building had unique regulations restricting the combustibility of furnishings, drapes, curtains, and carpeting. While these restrictions did not eliminate combustible furnishings, they limited extremely rapid extension that could have worsened the situation.

These fires and many others have provided a list of basic methods to reduce fire loss and provide life safety:

- Automatic sprinklers provide important and necessary fire protection. When properly installed and maintained they are the most effective means of limiting smoke generation and fire spread.
- Openings between floors, whether access stairs, cable openings, or the HVAC system, must be protected with fire-resistive barriers.
- Reducing the amount of combustible materials available to burn and controlling the types of combustible furnishings allowed in the building will positively impact the fire spread problem.
- Early alarm is important both to help fire personnel control the fire spread and to ensure the safety of the occupants. Modern technology has provided the means to detect fires in the incipient stage, yet we still find the alarm being transmitted by people from outside the fire building.
- Large open areas allow fire to spread freely throughout a structure. Compartmentation and fire barriers are necessary. The current trend toward open office design invites rapid fire spread.
- Wire glass provides protection from external fires and autoexposure. Today's technology should be able to produce a wire glass or substitute that would satisfy asthetic requirements while restricting fire spread.

—ARTHUR C. SMITH