ELDERLY HOUSING FIRE
Johnson City, TN
December 24, 1989

NFPA INTERNATIONAL

FIRE INVESTIGATIONS

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FIRE INVESTIGATION REPORT

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Publishers of the National Fire Codes® and National Electrical Code®

A non-profit membership organization dedicated to promoting safety from fire, electricity, and related hazards through research, codes and standards, technical advisory services, and public education since 1896.

ABSTRACT

At approximately 5:10 p.m, an accidental fire occurred at the 11-story John Sevier Center in Johnson City, Tennessee. The fire damage was limited to the first floor and two second floor areas. However, smoke travelled throughout the entire building. Sixteen occupants died in this Christmas Eve fire, and at least 40 others were injured.

At the time of the fire, the center was a mixed occupancy with residential apartments on all eleven floors and supporting business facilities on the first floor only. In 1924, the building was constructed as a fire-resistive structure, and its original use was as a hotel. But, as the building was converted to its current use, the fire resistance was reduced by the use of light-weight noncombustible and combustible materials in areas on the lower floors and by unprotected penetrations for pipes and other utilities. On the other hand, some renovations were made to improve firesafety features of the building such as new enclosed stairways and detection alarm systems.

The fire, which started in a first floor apartment, was apparently caused by smoking materials. Once ignited, the fire spread into a combustible concealed space above the apartment or origin's suspended ceiling, and this fire spread horizontally over most of the first floor. In addition, the fire spread horizontally from the apartment of origin through an open apartment door. The fire also spread vertically into two areas of the second floor. The vertical fire spread occurred through unprotected utility penetrations made during a renovation. Unlike the fire damage that was limited to the lower floors, smoke spread to and caused damage on all floors.

The following factors appear to have contributed to the loss of life and property:

1) Rapid fire spread in a combustible concealed space.

2) Loss of compartmentation due to open doors, walls that did not extend slab to slab, and voids that were not sealed against smoke penetration.

3) Smoke spread into the high-rise residential tower through various vertical openings.

4) The lack of automatic sprinkler protection.

I. INTRODUCTION

The National Fire Protection Association (NFPA), with the assistance of Southern Building Code Congress International (SBCCI), investigated the Johnson City Tennessee fire in order to document and analyze significant factors that resulted in the loss of life and property.

This study was funded by the NFPA as part of its ongoing program to investigate technically significant fires. The NFPA's Fire Investigations Division documents and analyzes incident details so that it may report lessons learned for life safety and property loss prevention purposes.

The NFPA was assisted in data collection and analysis by SBCCI under an agreement between NFPA and the three model building code organizations to investigate significant structural fires and other emergencies throughout the United States. In addition to SBCCI, the other cooperating model building code groups are the International Conference of Building Officials (ICBO) and Building Officials and Code Administrators (BOCA). The three model building code groups assist NFPA by providing technical staff support for on-site field work and building code analysis.

The NFPA became aware of the fire on the day of occurrence, December 24, 1989. Michael S. Isner, Fire Protection Engineer, and Gregory J. Cahanin, Senior Life Safety Specialist, visited Johnson City to document the facts related to the fire incident. The NFPA investigators were joined and assisted by John Battles, SBCCI. A two-day, on-site study and subsequent analysis of the event were the basis for this report. Entry to the fire scene and data collection activities were made possible through the cooperation of the Johnson City Fire Department.

This report is another of NFPA's studies of fires having particular educational or technical interest. The information presented is based on the best data available during the on-site data collection phase and during the report development process. It is not NFPA's intention that this report pass judgment on, or fix liability for, the loss of life and property at the John Sevier Center fire. This report presents the findings of the NFPA data collection and analysis effort.

The firesafety conditions at the John Sevier Center and the findings regarding factors that contributed to the loss of life or property are based on NFPA analysis of collected data and observations during the investigation. Current codes and standards were used as criteria for this analysis so that conditions at the John Sevier Center on the day of the fire could be compared with current fire protection practices. It is recognized that these codes and standards may not have been in effect during construction or operation of the facility. NFPA has not analyzed the John Sevier Center as to compliance with the codes and standards that were in existence when the center was built or during its operation.

The cooperation and assistance of Fire Chief Douglas Buckles and Fire Marshal George Leonard of the Johnson City Fire Department and of Mr. William Wamsley and others from the Tennessee State Fire Marshal's Office are acknowledged and appreciated. The contributions to this report, provided by Mr. John R. Battles, P.E. of SBCCI, are also recognized.

II. BACKGROUND

Applicable Building and Fire Codes

In 1977 the building was converted to use as elderly housing. At this time, the State of Tennessee had adopted and was enforcing the 1973 Life Safety Code and the 1976 Standard Building Code. In late 1988, Johnson City adopted both the 1988 NFPA Life Safety Code and the 1988 Standard Building Code. These codes were being enforced at the time of this fire.

The Building

The building was initially designed and used as a hotel. The majority of the building was constructed in 1924 and included an "L" shaped 11-story high-rise, a two-story area, and a three-story wing (See Figure 1). About two years later, a 175 ft X 40 ft, one-story addition was constructed on the building's east face.

Both the original building and the addition were of fire resistive construction. The structural frames were poured-in-place concrete, and the nonbearing interior partitions that ran slab-to-slab were constructed with terra cotta tile and were covered with plaster. The floor assemblies were poured-in-place concrete slabs that included the metal pans that were used to form the slab during construction. The ceilings were plaster on metal lath that had been attached to the lower edges of the metal pan/concrete assembly, and the exterior bearing walls were masonry.

In the 1950s, the building was renovated because its original use as a hotel declined through the years. During this renovation, portions of the first three floors were renovated, but the original fire-resistive construction was not duplicated. For example, unprotected steel beams and poured-in-place concrete slabs were used to construct a new second floor at the original mezzanine level for the hotel lobby. In addition, a new, lower ceiling was also installed during the 1950's renovation. This ceiling was about one foot below the original plaster ceiling and had a 2 ft. X 6 ft. wood frame (See Figure 2). Wood strips were attached to the frame, and combustible ceiling tiles were then stapled to the strips.

Several gypsum wallboard-on-wood-stud interior partitions were constructed to create office spaces on the first floor. These partitions apparently extended only up to the combustible ceiling assembly, which left large, undivided concealed spaces over much of the first floor.

A second major renovation occurred in 1977 when the building was prepared for its current use as elderly housing. During these renovations, the room arrangement on the first floor was once again changed and space was allocated for a few small businesses, administrative offices, a large community area, and several apartments. Some of the original plaster-covered terra cotta walls and some of the walls constructed during the 1950's renovation remained in place when the newest gypsum wallboard-on-wood-stud interior partitions were installed. As a result, the walls enclosing rooms and corridors on the first floor consisted of a variety of construction materials. There was no information indicating that any of the walls enclosing rooms were intended to have a fire resistance rating.

The newest interior partitions extended up to a new ceiling assembly that was also constructed during this renovation. This ceiling was a nonfire-rated, suspended type with noncombustible tiles supported by a grid of metal channels. The ceiling was attached to and approximately 18 in. below the combustible ceiling previously installed; as a result, there were three ceilings above most occupant spaces.

During the 1977 renovation, hotel rooms in the high-rise section were converted to apartments. The conversion included the installation of upgraded plumbing systems, kitchens in the apartments, new ventilation systems for the kitchens and bathrooms, and new entrance doors for the apartments. These new doors had a wood veneer, composite core and a 20-minute fire rating. Though initially equipped with closers, many apartment doors were without the closers because these devices had been removed throughout the years.

Three elevators served all 11 floors of the building. Two were passenger elevators used by all occupants, and the third was a service elevator intended for use by building maintenance personnel. The passenger elevators were located in the main lobby, and the service elevator was in a corridor near the building manager's office.

Interior Finishes

A variety of interior finishes were used in the first floor rooms and corridors. Walls in the apartments and most corridor walls appear to have been either painted gypsum wallboard or plaster-covered terra cotta. Some walls in the center lobby, offices, and other rooms were covered with wood paneling. Since the fire heavily damaged the majority of the first floor, it was not possible to establish the exact finish in all first floor areas.

Both the apartments and corridors on all other floors had painted gypsum wallboard or plaster covered terra cotta walls.

Means of Egress

First floor occupants normally exited through a center lobby area that had two grade-level exits; one was on the north side of the building and the other was on the south side. (See Figure 1.) In addition to these exits, they could also enter Stairway A and exit the building through that means. The occupants of the second and third floors had access to Stairways A and B, and they also had access to a third stairway, Stairway C, at the southwest corner of the building. This stairway discharged directly to the building's exterior.

Stairways A and B were constructed during the 1977 renovations and were located at the opposite ends of a central corridor on Floors 4 through 10. These stairways discharged directly to the outside of the building and were equipped with mechanically ventilated vestibules. Each vestibule had a forced supply air system using ducts and a fan that would supply air into each vestibule at a rate of 250 cubic ft. per minute (CFM). The vestibules also had an exhaust system including ducts and another fan that would remove air at a rate of 350 CFM in each vestibule. An enclosed exit passageway was incorporated into the centrally located Stairway B, thus providing a direct exterior discharge.

Fire Protection Systems

Hose cabinets with 1 1/2-in. unlined linen hose and a variable stream nozzle were located in center corridors on each floor next to Stairways A and B. A 4-in. riser was located in each stairway and supplied water to a hose cabinet in the corridor. The two risers were supplied by the single 6-inch municipal water main providing domestic water to the building. A test of the water supply indicated that 980 gallons per minute were available with a static pressure of 83 psig, a residual pressure of 78 psig and a flow pressure of 34 psig.

Two systems of smoke detectors were provided in the building. The first system included smoke detectors that were distributed throughout the corridors, and manual pull stations that were located near the exit stairways on each floor. A signal from any of these devices would send a signal to a "911" operator, initiate alarm bells throughout the building, illuminate a “fire indication” on an annunciator panel in the manager’s office, and initiate a taped evacuation message. The building manager could manually override the automatic message system by using a voice communication control panel also located in his office. This panel allowed the manager to provide messages to all floors or to any selected floor or floors.

A second system included smoke detectors in each apartment, which would provide an alarm to apartment occupants. Though not connected to the building's fire alarm system, the apartment smoke detectors were connected to the building's "emergency call" system. The "call" system included devices in the bathroom and bedroom of each apartment that allowed occupants to notify the building manager of any personal emergency. Like the fire detection system, the "emergency call" system annunciator panel was located in the building manager's office.

The facility was also equipped with a natural gas powered emergency generator. In the absence of normal commercial power, the generator provided electrical power to internally illuminated exit lights, to all light fixtures in the corridors and exit stairways, to the alarm and smoke detection systems, to the emergency public address system, and to the fans used for supplying air to and smoke removal from the vestibules in Stairways A and B.

Mechanical Systems

There was no central HVAC system for the residential floors; instead each apartment had a window-mounted heating and cooling unit. The sources of fresh air for air exchanges were the window-mounted HVAC units and natural seepage into the building. The kitchens and bathrooms on each floor were ventilated through a central system. The ducts for these systems ran horizontally in the space above the corridor's suspended ceiling, and the system discharged directly to the outside on each floor. The building's original bathroom ventilation system was equipped with fans for forced ventilation and opened into vertical terra cotta chases extending through the tower to an interstitial space between the 10th and 11th floors. This original system was not in service at the time of the fire.

Occupant Status

The center normally had 150 residents. On the afternoon of the fire many people were not in their apartments due to the Christmas holiday, and other residents had guests in their apartments. It appears however, that there were approximately 125 people in the building.

The John Sevier Center housed primarily persons whose ages ranged from 50 to 80, and all of these people were considered ambulatory at the time they applied for housing in this facility. However, many had mobility restrictions, and some had limited sight capabilities. Reportedly, residents in the facility were not receiving medical care from the facility operators. But in at least one case, a younger relative (age 29) was residing in the apartment and providing care to an older (age 80+) resident of the facility.

Though the facility was intended for the housing of elderly, the contents of a few apartments suggested that some occupants were young adults, and in at least one apartment, the presence of children's clothing suggested that children likely visited the resident in that apartment. In addition, there were reports that some residents might have been deinstitutionalized mentally impaired individuals.

Weather

The Johnson City weather was cloudy, dry, and cold. The air temperature at 5:00 p.m. was 17^{0}F, and the wind was steady from the southwest at 7 mph.

III. FIRE INCIDENT

Discovery

The building manager was exiting the service elevator when he reportedly heard one alarm operating continuously and thought it was the local fire alarm. He went to the alarm control panels in his office and found that an "emergency call" signal was coming from Room 102. Before he could leave to investigate, the "911" operator called to verify a fire alarm activation in the building and to get information regarding the location of the fire. Upon completing his conversation with the operator, the building manager went to Room 102. When he arrived at the first floor room, the manager reportedly found the elderly female occupant standing in the corridor near her apartment door which swung open as he approached. Dark black smoke and heat were coming out.

Fire Department Notification and Response

The "911" operator notified the Johnson City Fire Department at 5:10 p.m. and the first assignment crews were dispatched. These fire fighters arrived on the scene about four minutes after dispatch. They found fire venting from a first floor window, and smoke was beginning to vent from areas on the upper floors.

The first engine crews attempted to quickly knock down the fire with an exterior attack using a 1 3/4-in. hose line directed into the window from which the fire was venting. When this proved ineffective, they stretched a 2 1/2-in. hose line to the building's south entrance and began an interior attack.

Fire fighters from other arriving companies entered the exit stairways on the first floor and began rescue operations. Initially, they could only remove those occupants who were in the exit stairways, but as more personnel became available, search and rescue activities extended into corridors and apartments in the tower. All survivors were rescued in approximately one hour; however, the search for victims continued for another nine hours.

Additional personnel were also committed to fire suppression. A second 2 1/2-in. hose line was brought into the north entrance to the first floor in order to attack the fire. Other hose lines were stretched up to the second floor to suppress the fire, which had extended to apartments on that floor. Using a total of ten hose lines, fire fighters were able to control the fire in approximately five hours, and the fire was declared out at 11:00 p.m. However, the search for hot spots and overhaul operations continued for another 48 hours.

Three Johnson City engines, three ladder trucks, nine other units, all Johnson City on-duty fire fighters, and five on-duty public safety officers (PSO) responded to the alarm. In addition, 99 off-duty Johnson City fire fighters and PSO's and 250 fire fighters from 27 surrounding communities responded to the call for assistance. The emergency personnel were also assisted by many bystanders and personnel from the Red Cross, Tennessee Highway Patrol, Virginia Highway Patrol Medical Flight, and other agencies.

Casualties

The 16 fatalities were found in various locations (See Table). One victim was found in Apartment 107 and another was in Apartment 108. Both of these first floor apartments had windows directly to the outside, and the occupants of neither apartment escaped out the windows. The other 14 victims were found on the floors above. In most apartments, only one occupant became a victim; however, two victims were found in both Apartment 813 and 1007. Many of the apartments containing victims were adjacent to the elevator lobby and a common pipe chase.

Approximately 80 people were rescued and of these people about 40 were injured. No information was available with respect to the nature or severity of the injuries.

IV. ANALYSIS

Cause and Origin

State and local fire investigators indicated that the occupant was a heavy smoker, and during their activities to determine the cause and origin, they eliminated all incendiary and accidental causes other than discarded smoking materials or careless smoking. The investigators also determined that the fire most likely began in the northeast corner of the living room in Apartment 102. (See Figure 3.) The furnishings in the area of origin included a wood table, a loveseat and an upholstered chair. The last two items had cloth-covered foam padding and wood frames.

Occupational Notification

The smoke detector in Apartment 102 activated providing an alarm signal in that apartment, and the apartment occupant safely escaped. The detector also initiated an "Emergency Call" alarm in the manager's office. However, the manager was not in his office when this alarm activated.

The manager first heard the fire alarm signal when he returned to the first floor using the service elevator. He immediately went to his office to check the fire control panel and this is when the "911" operator called to verify a fire alarm signal. Since the corridor smoke detectors send a signal to the "911" operator, the fire would have had to generate enough smoke to fill the upper portion of Apartment 102 and to reach the smoke detector in the corridor. Therefore, the fire had to have been burning for a period of time before the manager became aware of it.

Fire Spread

The fire spread into the space above the suspended ceiling for Apartment 102 and ignited the combustible ceiling tiles that were installed during the 1950's renovation and spread into the space above the combustible ceiling assembly. The fire, which was now being fueled by both the combustible tiles and the combustible framework, travelled horizontally over the majority of the first floor because many of the interior partitions did not extend up to the original floor/ceiling assembly constructed in 1924.

State and local investigators have also concluded that the fire most likely spread from the living room toward the open apartment door and corridor. This finding is supported by the minor fire damage that occurred in the bedroom of Apartment 102. Even though the door between the bedroom and living room was likely open during the fire, and the wall separating these two rooms did not extend up to the combustible ceiling assembly, the most severe fire damage occurred in the living room and kitchen. Since the apartment entrance door was not equipped with a closer and the occupant left that door open when she left the room, the fire in the apartment's kitchen readily spread into the corridor.

Once in the corridor, the primary fire spread appears to have been toward the north past Apartment 103, which had its door closed and past Apartment 104 which had a closed door. The fire continued down the corridor and spread into the public areas that had combustible interior finishes. (See Figure 3.) These combustibles contributed to the fire intensity in the lobby area.

The figure also shows that some fire, i.e., secondary fire spread from Apartment 102, travelled south in the corridor toward the lobby. Other secondary fire spread paths were noted between the suspended ceiling and combustible ceiling assembly. Small holes, duct penetrations, and other voids in the interior partitions allowed the corridor fire to spread into spaces above the ceiling in Apartments 103 and 104, the maintenance shop, and other areas.

The elevators in the lobby were apparently a factor that affected the direction of the fire spread. According to a Center for Fire Research report, the upward gas flow in the elevator shaft due to the natural buoyancy effects would have likely drawn the air and fuel gases toward these areas.[1] Even though the fire had been drawn towards the elevator shafts, the majority of the fire remained on the first floor and spread in a westerly direction to other first floor areas.

The fire fighters' initial suppression efforts were directed against the fire in the occupied space of Apartment 102. When their attempt to quickly knock down the fire by attacking it through the window failed, fire fighters entered the lobby and once again attacked the fire in the occupied space. During these initial attacks, fire fighters were probably not aware of the

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1 Steckler, K., Quintiere, J. and Klote, J., Johnson City Fire --- Key Factors, Center for Fire Research, NIST.

hidden fire spreading in the concealed space above their heads. The lowest ceiling assembly also protected the fire from the fire fighters' suppression efforts for a period of time. As a result, flames were able to spread extensively over the first floor area.

Once the hidden fire broke through the ceiling and fire fighters became aware of its existence, they could not immediately react with sufficient resources to quickly control the fire. The capabilities of suppression crews were already being taxed by the large fire in the occupied space, and additional suppression personnel were not immediately available because many fire fighters had to be committed to search, rescue, and survivor care activities. As a result, the fire spread horizontally and involved almost all areas on the first floor.

The first floor fire also travelled vertically into two second floor areas. The area of heaviest fire damage occurred toward the center of the building and involved two second floor apartments. The fire was able to spread vertically because a 6 in. wide by 40-ft. long "L"-shaped hole was cut through the concrete floor slab so PVC plumbing pipes could be installed during one of the renovation projects. The second area of vertical fire spread damaged one apartment and was the result of fire spreading through penetrations cut into the floor slab for bathroom plumbing fixtures.

Smoke Spread

Unlike the fire spread, which involved most of the first floor and only a small portion of the second floor, smoke travelled rapidly throughout the building. The three elevator shafts were the primary mechanisms for smoke spread, though the greatest amount of smoke moved through only one of the passenger elevator shafts.

The two passenger elevators were next to each other, and a continuous masonry wall separated their respective shafts. When the fire alarm system activated, the passenger elevators were recalled to the first floor. However, during this incident only one passenger car arrived on the first floor, and its doors opened into an area that became involved in the intense fire. Combustion products entered that shaft through the open doors and spread vertically to all floors. The second passenger elevator stopped between the first and the second floors, so the elevator doors on the first floor never opened. The only smoke that travelled up through this shaft was that which could seep in through cracks and voids. As a result, less smoke spread up this shaft.

The building manager had returned the service elevator to the first floor and left the doors to this elevator open also. However, the lobby for this elevator was in a corridor that fire fighters protected during their attacks; and as a result, it too was less exposed to smoke.

Many penetrations were made in walls and slabs at all floor levels during the years the building had been operating. During the normal operations of the building, the openings were not readily visible because they were concealed behind walls and above ceilings. Nonetheless, these openings and voids were present, providing the secondary means for smoke to migrate to upper floors of the high-rise building.

Similar to other high-rise fires, such as the MGM Grand in Las Vegas, NV[2], the Prudential Center in Boston, MA[3], Dupont Plaza, San Juan, Puerto Rico[4], the Midtown Towers in Watertown, NY[5], and other high-rise fires, the smoke's natural buoyancy and "stack effect" forces propelled the smoke up through the vertical shafts and voids.

Stack effect is characterized by a strong draft from the ground floor to the roof of tall buildings. The magnitude of this effect is a function of the building's height, the air tightness of exterior walls, air leakage between floors of the building, and the temperature difference inside and outside the building.[6] All of these factors were apparently contributing to the "stack effect" in this incident.

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2 "Fire at the MGM Grand Hotel", Fire Journal, November 1982, Vol. 76, No. 6, pp 68-70.

3 Klem, T. J., Kyte, G., "Preliminary Investigation Report -- Fire at the Prudential Building, Boston, MA", Fire Command, March 1986, Vol. 53, No. 3, pp 14-17.

4 Klem, T. J., Investigation Report on the Dupont Plaza Hotel Fire, December 31, 1986, San Juan, Puerto Rico, National Fire Protection Association, Quincy, MA.

5 NFPA Alert Bulletin: Three Major Fires in Elderly Housing, National Fire Protection Association, Number 90-1, February 1990.

6 Nelson, H.E., "Smoke Movement in Buildings", Section 7, Chapter 10, Fire Protection Handbook, 16th ed., 1986, p. 7-129.

Exit Stairway Performance

The location of exit stairways and travel distances in the building were consistent with the requirements of the 1988 Edition Life Safety Code. The two exit stairways for the high-rise part of the building were at the opposite ends of the central corridor maximizing the remoteness of the stairways. Similarly, the low-rise part of the building had several remotely located exits.

Soot stains on walls in both Stairway A and B revealed that some smoke from the first floor occupant area entered these stairways through small voids and seams in the stairs and wall assemblies. The heaviest soot stains, however, were observed at the second floor ceiling level in Stairway B. The increased smoke seepage at this level was a result of fires that gutted two apartments that were next to that stairway. The fires in these apartments were caused by first floor flames spreading through the "L" shape hole cut in the floor slab and igniting the contents in the apartments. The smoke was able to seep through voids in the walls that enclosed the stairway itself. Therefore, it appears that the mechanically ventilated vestibules provided little protection for Stairway B.

Smoke that seeped into the stairways appears to have affected both occupants and fire fighters. Stairway B reportedly became untenable early in the fire so unprotected occupants were not able to use this stairway during their evacuation. One occupant from an 8th floor room was found dead on a landing in one of the stairways equipped with the mechanical ventilation system. Fire fighters indicated that they immediately needed to use their SCBA protection upon entering Stairway B, and as conditions worsened they needed SCBA protection in all stairways. The need to wear their SCBA while climbing from the ground level up through the building caused fire fighters to deplete a portion of their air supply before reaching areas for search and rescue.

Some smoke also entered the stairways through the mechanically ventilated vestibules once the emergency power in the building was discontinued. The generator that supplied emergency power to fans and other emergency equipment stopped operating when fire fighters shut off the natural gas to the building approximately 45 minutes after their arrival. The discontinuation of power to the fans allowed smoke to also enter vestibules and stairways and to leave stains in those areas. As a result, it was not possible to accurately determine the effectiveness of the mechanical ventilation systems.

V. DISCUSSION

In just 13 days in December, 1989, major fires killed 23 residents in three different elderly housing complexes. Four occupants died in a six-story building in Roanoke, Virginia, on December 14; three residents died in a sixteen-story building in Watertown, New York, on December 15; and 16 occupants died in the eleven-story John Sevier Center in Johnson City, Tennessee, on December 24.

These three fires took on special significance because elderly Americans (age 65 or over) are one of the two high-risk age groups in the population, with a fire death rate per million population that is *twice* the national average and *three times* the rate for young adults. There is a growing move toward facilities catering to large numbers of elderly citizens, and these may pose a special risk.

Each of the three noncombustible buildings contained some fire protection equipment; however, these provisions were not sufficient to prevent the multiple death fires. In the John Sevier Center, a major factor contributing to the loss was the combustible ceiling assembly that remained in place above the suspended ceiling. This assembly contributed to the total fuel load and provided a concealed space through which the fire could spread over the first floor. Had the combustible ceiling assembly been removed or had sprinklers been installed to protect the combustible concealed space, the volume of fire and smoke and the speed with which they travelled would likely have been significantly reduced.

A second contributing factor was the failure of compartments to contain the fire. This failure was due to walls that did not extend slab-to-slab, holes and voids that were made during renovations, and doors that did not have closers. Various vertical openings also allowed the fire and smoke to spread throughout the building and even into exit stairs and passageways.

Automatic sprinkler protection was not provided during the 1977 renovations at the John Sevier Center. A standard sprinkler in the room of origin would have suppressed or controlled the fire in its initial growth, greatly reducing the potential of the fire entering the combustible concealed space or the corridor outside the apartment of origin. This in turn, would have reduced the risk to occupants throughout the building.

Like the incident at the John Sevier Center, the lack of automatic sprinkler protection and the loss of compartmentation contributed to the severity of the fires in Norfolk, Virginia, and Watertown, New York. In addition, combustible interior finishes were factors in both the John Sevier Center fire and the Norfolk incident, and rapid fire growth affected all three incidents. These factors have also been common factors in other multiple-death fires in residences, independent of age considerations. Establishing what effect, if any, the age of occupants had on the outcome of these fires is not within the scope of this report.

There are building and firesafety codes and standards available to eliminate factors such as those determined from this analysis, in housing for the elderly or for that matter, in multi-family residential housing. The building and fire protection community should continue to assess the level of fire protection needed for all residential facilities. This type of assessment is especially important in facilities that primarily house elderly residents since NFPA statistics have shown that this population is a high risk group with respect to fire death rates.

VICTIM DATA

Number[a]	Age[b]	Apt. No.[c]	Victim Location	COHb[d]	Cyanide[d]
1	---	107	107	38.2%	---
2	*	108	108	---	---
3	*	403	403	33%	1.2 mcg/ml
4	82	503	503	---	---
5	*	510	510	---	---
6	*	604	604	---	---
7	30+	604	Elevator Lobby 6th Floor	41%	4.9 mcg/ml
8	*	608	608	40%	0.5 mcg/ml
9	*	704	704	9%	0.9 mcg/ml
10	---	710	710	31%	0.4 mcg/ml
11	*	801	In one of the stairways	59.5%	---
12	---	803	803	41%	0.6 mcg/ml
13	*	813	813	---	---
14	*	813	813	41%	0.8 mcg/ml
15	29	1007	1007	41%	2.3 mcg/ml
16	80+	1007	1007	---	---

(a) This number is randomly assigned.

(b) *Denotes persons who were described as elderly; no age data available.

(c) The victim resided in the apartment shown in this column.

(d) Carbon monoxide saturation of greater than 25% is considered toxic, with the lethal range approximately 50%. There are certain conditions in which a carbon monoxide saturation of less than 50% will be lethal, especially in elderly individuals. A blood cyanide level of greater than 0.2 mcg/ml is considered toxic, with levels of greater than 1.0 mcg/ml lethal. All of the bodies on whom blood was drawn had toxic or lethal levels of cyanide with the lowest level of 0.4 and the highest of 4.9 mcg/ml. Toxic cyanide levels with toxic carbon monoxide levels may be readily lethal.

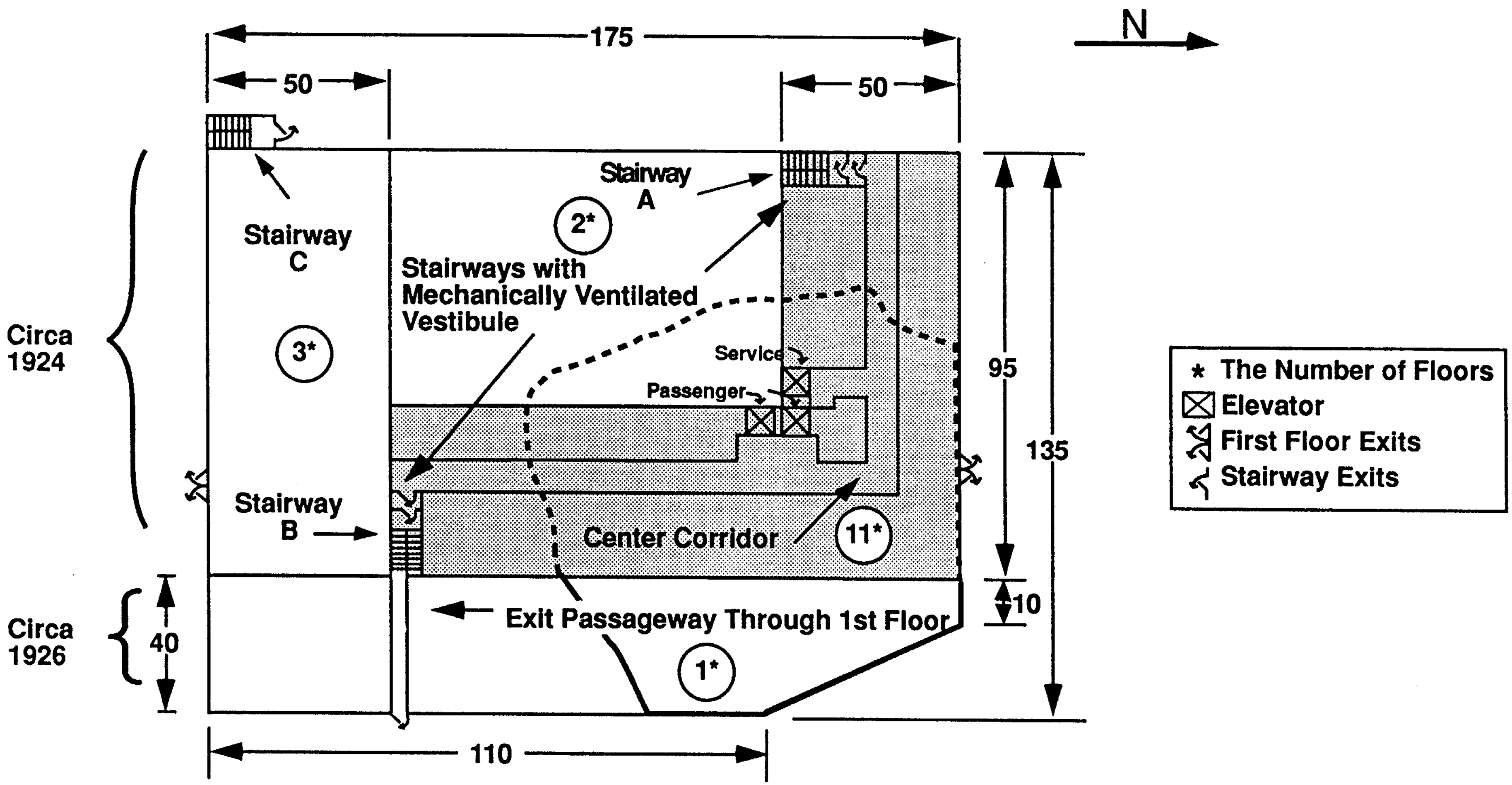

Figure 1: Building Plan and Exit Arrangement

Notes: Dimensions Rounded to Closest 5 Feet

First Floor Area Shown in Figure 3

High Rise, Floors 4-11

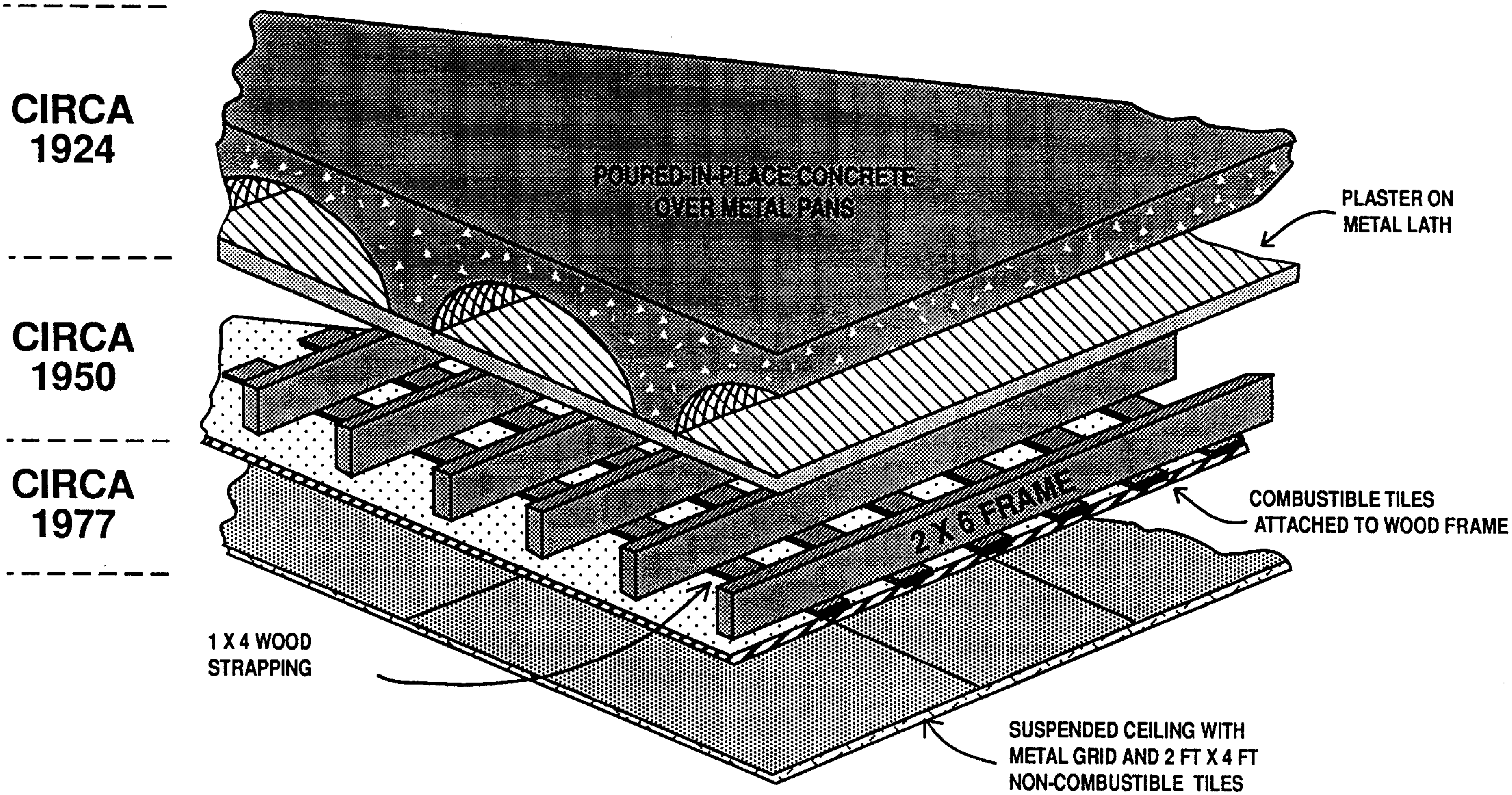

Figure 2: Floor/Ceiling Assemblies

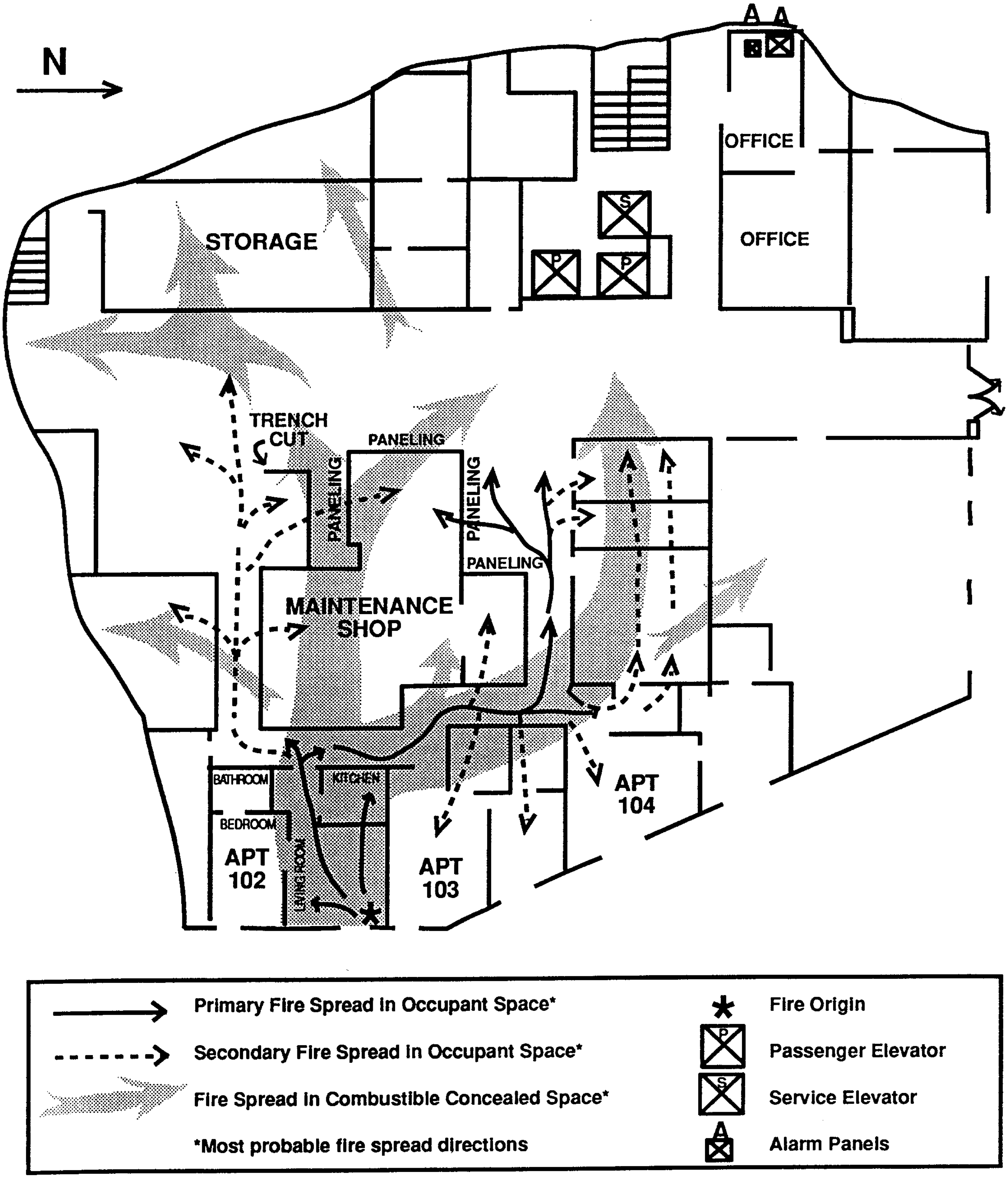

Figure 3: Area of Fire Origin