NFPA®

National Fire Protection Association
International

Executive Offices
1 Batterymarch Park
P.O. Box 9101
Quincy, Massachusetts 02269-9101 USA
Telephone (617) 770-3000 Fax (617) 770-0700

SUMMARY
FIRE INVESTIGATION REPORT

HOSPITAL FIRE
BROOKLYN, NEW YORK
SEPTEMBER 1, 1993

PREPARED BY
MICHAEL S. ISNER
FIRE PROTECTION ENGINEER
NATIONAL FIRE PROTECTION ASSOCIATION

At 5:42 a.m. on Wednesday, September 1, 1993, the New York Fire Department received notification of a fire at the Maimonides Medical Center in Brooklyn. The fire involved an area on the seventh floor of an eight-story, fire-resistive building and resulted in the evacuation of several floors. Three patients died, one patient was seriously injured, and many others sustained minor injuries. In addition, 11 fire fighters were injured.

Investigators were unable to establish an exact cause for this fire; however, they did establish that the ignition likely involved medical equipment in a patient room. Moments after ignition, the fire involved oxygen, which caused conditions in the patient room to deteriorate rapidly and greatly increased the severity of the fire. In response to the severe fire, hospital staff attempted to suppress the fire, closed many patient room doors, and began to evacuate patients.

The combined actions of fire department personnel and hospital staff in conjunction with the hospital's fire protection systems prevented further loss of life and injuries.

Introduction

The National Fire Protection Association (NFPA), with the cooperation of the New York City Fire Department and the Maimonides Medical Center, investigated this fire as part of its on-going program to investigate technically significant incidents. It is not the NFPA's intention that the investigation and resulting report pass judgment on, or fix liability for, the loss of life or property resulting from this fire. Rather, the NFPA documented and analyzed this incident intending to determine the significant factors that resulted in the loss of life and property and to report the lessons learned in order that the fire service and others concerned about fire safety in health care facilities may reduce the potential for similar life and property losses.

Background

The Maimonides Medical Center in Brooklyn, New York, is a 705-bed facility providing most types of medical care, and occupying several buildings. The hospital's main building is an eight-story, fire-resistive structure, and through the years, several additions were built expanding the building. Like the main building, each addition is of fire-resistive construction, though each is slightly different in design.

The fire occurred in a 20-year-old addition to the main building. This addition has a steel structural frame with members that are either encased in construction or covered with spray-on fire resistive materials. The frame's metal columns support metal I-beams which, in turn, support corrugated metal decking covered by concrete slabs for the floor assemblies. The I-beams are approximately 24 feet apart, forming bays with sufficient space for two patient rooms. Exterior walls are nonbearing and constructed with masonry materials.

Interior walls forming corridors are constructed with gypsum wallboard-on-metal studs and extend from slab to slab. Like the corridor walls, walls separating patient rooms are constructed of gypsum wallboard-on-metal studs. Patient room separation walls are parallel to structural I-beams,

and in each patient room, one separation wall is in-line with the I-beams (see figure). The other patient room wall is installed between the I-beams. Walls in-line with I-beams extend from the floor slab up to the I-beam's bottom flange. Whereas, walls installed between the I-beams extend up to the underside of the corrugated metal decking, which is perpendicular to the wall.

The room of fire origin was a patient room with two beds. The bed closest to the window had an inflatable mattress, and the other bed had a standard mattress. Each bed space had a bed table, a chair with a wood frame and padded seat and back, a night stand, a privacy curtain, a wardrobe, an infusion pump, a feeding pump, and typical, wall-mounted medical equipment. In addition, each space had a ventilator equipped with a humidifier. A reinforced plastic hose connected each ventilator to a flow control meter that had a metal "tee" fitting with three connection points. One connection point was used to attach the flow control meter to the station outlet for the hospital's piped oxygen distribution system. Another connection point allowed oxygen from the hospital's piped distribution system, which was maintained at 50 psi, to flow directly to the ventilator without passing through the flow meter. The third connection point was a discharge orifice for oxygen flows that were to be regulated by the flow control meter.

The hospital's fire protection systems include sprinkler, standpipe, fire detection, and occupant notification systems. The building's partial sprinkler systems, using standard 165°F sprinklers, protect corridors and some utility spaces. Standpipes with 2 1/2-inch hose connections are located in the building's exit stairways and are intended for use by fire fighters. Smoke detectors are installed in corridors, patient rooms, and other occupied spaces. All smoke detectors are hardwired and connected to a common smoke detection system which transmits alarm signals to a central station. Manual pull stations are located adjacent to all exit doors. The operation of any sprinkler, smoke detector, or manual pull station initiates local evacuation alarms and sends an automatic alarm signal to a central station which, in turn, notifies the New York City Fire Department.

In addition to the fire protection systems, ABC, dry chemical fire extinguishers intended for staff use were provided throughout the facility.

The Maimonides Medical Center administration has prepared fire/emergency response and disaster plans. To ensure that these plans will be implemented, all staff personnel receive regular fire safety training that includes instruction on the facility's fire/emergency procedures, evacuation procedures, and disaster planning. In addition, staff receive training regarding the selection and use of fire extinguishers. At least 12 fire/evacuation drills are held each year, complementing the fire protection training. The drills are divided among all three shifts as prescribed by New York City Fire Department regulations.

The Fire

On Wednesday, September 1, 1993, two patients were sleeping in Room 717. The patient in the bed closest to the window was an 85-year-old female, and the patient in the other bed was a 78-year-old female. Both patients were using ventilators to assist their breathing. Two other patients on the wing were also using ventilators.

At approximately 5:00 a.m., a nurse entered Room 717, and over the next one-half hour, she performed routine patient care tasks such as servicing the intravenous and other equipment for the patients. During the time she was in the room, the nurse did not sense any abnormal conditions. At approximately 5:30 a.m. an aide entered the room and smelled something burning as she approached the window bed. The aide made a comment about the smell, and the nurse who was at the foot of the window bed turned around facing the bed. At this time, both the aide and nurse, reportedly, heard a "hissing" or "frying" sound. When the aide moved away from the ventilator, the nurse saw flames that appeared to be near or in a small vial (possibly the water trap for an exhalation hose). Both the nurse and the aide were leaving the room when something "popped" or "banged" and conditions in the room rapidly deteriorated. The nurse was either knocked down by the aide or fell to the floor and crawled from the room amid heavy black smoke.

Another nurse at the nurses' station near Room 723 heard what she described as a "horrible explosion" and ran toward Room 717, closing patient room doors as she moved down the corridor. As she approached the room, she saw the nurse crawling out of the room and heavy smoke coming out. In addition, there was a pronounced hissing sound coming from the room. She began yelling "RACE".[1] Another staff member brought an ABC dry chemical fire extinguisher, and the nurse who came from the nurses' station took the extinguisher into Room 717. She found fire involving both the window bed and the ventilator. She discharged the extinguisher, temporarily knocking down the fire. Believing she had extinguished the fire, she left the room to get away from the dense smoke. A few moments later she re-entered the room and found that flames had returned; she discharged the extinguisher again and smoke forced her from the room a second time. This nurse made a total of five attempts to extinguish the fire before smoke forced her away from the fire area.

Recognizing that the fire in Room 717 was severe, hospital personnel responding to the wing of fire origin began evacuating patients from the wing. Over time, an estimated 60 patients were evacuated. Except for the 35 patients evacuated from the wing of fire origin, the evacuation of patients was mostly precautionary.

A central station contractor received an alarm from the Maimonides Medical Center at 5:42 a.m. In turn, the contractor notified the New York Fire Department of the alarm from the hospital. Within the same minute, the fire department dispatched a standard first alarm assignment; this included three engines, two trucks, and a battalion chief. In addition, a squad and a rescue were dispatched because the facility involved was a hospital.

---

1 RACE is an acronym commonly used by health care facilities to help staff remember recommended emergency response activities. RACE has been derived from the words rescue (R), alarm (A), confine (C) and evacuate (E).

Upon arrival, fire fighters were met by security personnel who provided initial information regarding the fire's location and brought the attack crew to the stairway that would provide best access to the fire area. As the fire fighters moved through the building, they found the hospital staff evacuating patients both horizontally and vertically. Several minutes after the first fire fighters arrived on the scene, the window in Room 717 violently shattered, allowing fire to vent to the building's exterior.

The stairway that the initial attack crew used brought them to the southeast corner of the wing of fire origin. When the fire fighters reached the seventh floor, they connected their hose line to the standpipe system's 2 1/2-inch connection and entered a corridor on the wing of fire origin. They found that the corridor was filled with smoke, but temperatures were not high in the area near the stairway. Crawling through the black smoke, which was down to the floor, the fire fighters located the fire by moving toward the sound of operating sprinklers. Once at the room of fire origin, fire fighters found the door to Room 717 open and flames venting into the corridor. Inside the room, intense torch-like flames comprised the main body of fire. Using their 2 1/2-inch hose line, the fire fighters quickly extinguished all of the fire. Fire officials have estimated that fire fighters began to apply water on the fire about 9 to 12 minutes after the fire department received notification of the incident.

During the suppression operations, senior fire officers considered shutting down the flow of oxygen to the room of fire origin; however, hospital representatives indicated that other patients might still be on the same oxygen zone and cautioned against shutting down the oxygen. Following the extinguishment of the fire, fire fighters crimped the end of the supply lines in order to initially stop the flow of oxygen. Sometime later the zone valve was closed, ensuring the complete shutdown of oxygen flow to the zone involved.

The senior officer requested a second alarm at 5:54 a.m. When these fire fighters arrived, some were assigned to assist in the fire attack and others were assigned to assist in the evacuation of patients. Due to the copious smoke that was produced during the fire, the evacuation of patients

continued for a period of time after the fire was extinguished. In fact, a third alarm request was made simply to bring fire-fighting personnel to the scene in order to assist in the evacuation, which taxed the abilities of both hospital staff and fire-fighting personnel.

The fire department incident commander declared the fire to be "under control" at 8:07 a.m. even though the fire was extinguished much earlier than that time. The declaration of control was given when fire officers were certain that all building occupants were safely located in areas away from the fire area. Ultimately, 35 fire companies and 175 fire-fighting personnel were used during this incident.

Three patients died (see figure for victims' location). One patient, reportedly, sustained serious injuries, and many other patients received minor injuries. In addition, 11 fire fighters were treated on the scene for exhaustion.

Analysis

Investigators from the U. S. Food and Drug Administration in collaboration with representatives for the ventilation equipment manufacturer examined evidence in the room of fire origin and took many statements from witnesses. These investigators were unable to determine the precise cause of this fire. However, they did determine that the ignition likely occurred in the space between the ventilator and the window bed. Moreover, they determined that the fire ignition likely involved an operating ventilator and humidifier, an operating feeding pump or infusion pump, and/or an interaction between these devices.

Once the ignition occurred, the fire may have been intensified by the normal oxygen-enriched discharge from a ventilator. In addition, the fire damaged the hose through which oxygen was being supplied to the patient in the window bed releasing even more oxygen very early in the scenario. This oxygen release caused the fire to spread almost simultaneously to bedding materials and uninvolved components of the ventilator and humidifier. Shortly thereafter, the growing oxygen-enriched fire damaged

the hose connecting the ventilator to the hospital's piped oxygen distribution system, components of the ventilator, and/or components of the humidifier. This damage allowed oxygen at 50 psi to discharge into the room. Over time, the fire damaged the oxygen supply hose for the second operating ventilator/humidifier. In addition, the fire damaged both flow control meters, allowing the pressurized oxygen to enter the fire area through four orifices. This unregulated, 50 psi oxygen sustained the intense torch-like flames that were observed by fire fighters.

Extensive damage to the wall across the room from the oxygen station outlets (the room's east wall) confirmed the localized severity of the fire. Gypsum wallboard in an area approximately 2-to 3-feet wide and nearly the full height of the room was calcinated.[2] This damage was much more severe than the damage observed on the remainder of the wall surfaces in the room of fire origin.

There were several means by which the smoke spread within this building. Of these, the most significant was open doors. The nurse who entered the room and attempted to extinguish the fire, reportedly, closed the door to the room of fire origin when untenable conditions forced her from that room. However, arriving fire fighters, reportedly, found the door in the open position when they initially approached Room 717. With the door open, hot smoke and flames from the room spread into the corridor. At least one other patient room door may have been left open allowing smoke to fill the room before fire fighters reached the fire area. That door was to Room 719, and the only patient in the room at the time of the fire, a 76-year-old male, was found dead in his bathroom. The cause of death, reportedly, was smoke inhalation.

In addition, smoke spread into the adjacent smoke zone through corridor fire barrier doors. These doors automatically closed when the fire alarm was activated or were closed by staff personnel. However, the doors were opened numerous times by staff and fire fighters who were evacuating

---

2 The surface of the wall board was burned clean of carbon and the gypsum had been dehydrated converting it to a crumbly solid.

patients and by fire fighters involved in fire suppression operations. Even though no one held the doors open, smoke was able to spread through the door openings every time the doors were used.

Another means for smoke spread was over walls separating patient rooms. This phenomenon was the primary cause for smoke spread into Room 716. The wall between this room and Room 717 was located between the I-beams; therefore, the wall ran from the floor slab up to the corrugated metal decking above. Even though this wall was part of the smoke barrier system separating the wing of fire origin from the rest of the building, voids between the top of the wall and the corrugated metal deck were not sealed against smoke movement. As a result, pressurized smoke from Room 717 was forced over the wall into Room 716.

In other situations, however, walls acted as effective barriers against smoke spread. For example, the wall separating Room 717 and Room 718 was in-line with an I-beam, and, as a result, the wall was tightly sealed against the I-beam's bottom flange. In addition, spray-on fire-proofing materials for I-beams filled the voids between the top of the I-beam and the corrugated metal deck. During the emergency response a staff member, reportedly, entered Room 718 and closed the door to that room. Since smoke from Room 717 was not able to pass over the top of wall and the door was closed, the risk to the staff member and the patient was greatly reduced and both were able to remain in the room until the fire was extinguished. After the corridor was relatively clear of smoke, fire fighters evacuated the two survivors in Room 718 and brought them to a safe area.

Similar to the walls and doors, other features of this building's fire protection system had an impact on the result of this incident. Early in the fire, an automatic alarm was sent to central station which, in turn, notified the fire department initiating their response. Based on the available information, investigators believe that a smoke detector in the room of fire origin was the first initiating device to send a signal to the central station monitoring the hospital. Since the room of fire origin was not sprinklered, a total of five corridor sprinklers activated minimizing flame spread from the room. The operating sprinklers could not, however, stop smoke from

spreading throughout corridors on the wing of fire origin. Other equipment used during this incident included a fire extinguisher, which one staff member used during her initial response, and standpipes, which fire fighters used as their water supply for their fire attack.

The actions of staff members are a critical component of a hospital's response to a fire emergency; as such, hospitals, including the Maimonides Medical Center, conduct regular training to ensure staff can effectively respond to fire emergencies. Immediately upon discovery of this fire, staff began alerting other staff personnel, and at least one staff member reportedly yelled "RACE," the acronym for fire emergency response in a hospital. Another staff member attempted to use a fire extinguisher, and staff members closed patient room doors. Though for reasons that have not been determined, at least two patient room doors may not have been closed during part or all of this fire incident. The hospital's operator made a building-wide announcement regarding the fire, and this announcement made staff throughout the facility aware of the emergency. The hospital's emergency plan was activated allowing staff to initiate and organize the evacuation of many patients. The staff's ability to respond immediately, despite the presence of a fire that was much more severe than typical patient room fires, and the staff's ability to conduct the large-scale evacuation appear to reflect the regular fire safety and emergency response training provided to all staff members.

Though an infrequent occurrence, fires involving oxygen-enriched environments will significantly increase fire severity and can require special responses on the part of staff members before the arrival of fire fighters. Recognizing the extreme conditions that result when oxygen is involved in fire, NFPA 99, *Standard for Health Care Facilities*, 1993 edition provides in Appendix C[3] a suggested procedure for responding to fires, including fires involving oxygen-enriched environments. Section 8.3.3 of Appendix C contains the following information regarding the closing of an oxygen supply:

---

[3] Appendix materials are not part of the requirements of NFPA standards. This material, however, is provided as guidance and reflects important issues that have been considered by the committee responsible for the standard.

- In the event of a fire involving respiratory therapy equipment connected to an oxygen station outlet, the zone valve supplying that station is to be closed.

- All personnel are cautioned to be aware of the hazard of such a step to other patients receiving oxygen supplied through the same zone valve. Steps should be taken to minimize such hazards, realizing that closing the valve is of foremost importance.

The closing of the oxygen zone valve could have significantly reduced the severity of the fire at Maimonides Medical Center, and if steps were taken to protect any other patients on the same oxygen zone, the closing of the oxygen zone valve could have minimized the risk to all patients in the facility.

New York City Fire Department officials recognized the value of the fire protection equipment provided at the facility and remarked about the sincere effort and coordination exhibited by members of the Maimonides Medical Center staff during the extensive and complex evacuation activities. However, New York Fire Department Officials also acknowledged that the following changes could have contributed to a more successful outcome in this fire scenario:

- Shutting down oxygen zone valves. Shut down of oxygen zone valves could have been accomplished by trained staff members who took steps to protect other patients in rooms serviced by the zone valve. The early removal of oxygen would have minimized the fire severity, reducing the risk to occupants of the hospital.

- The installation of automatic door closers on patient room doors. An automatic door closer could have closed the door of the room of fire origin, keeping most of the combustion products in that room.[4]

- The presence of a fire safety coordinator who could provide responding fire officers with detailed information about the building's fire protection and other critical systems. A person who can fulfill this function should be available at the facility 24 hours a day.

---

[4] The NFPA recognizes the life saving potential afforded by closed patient room doors and requires that staff be trained to close patient room doors as part of their standard emergency response. Neither the NFPA nor any other model building code group currently require automatic door closers for patient room doors.

Even though security personnel provided fire fighters with useful information about the fire and its location, other information, such as sprinkler system details and elevator control, was not readily available. A fire safety coordinator who is knowledgeable about the building's fire protection and other critical systems could have minimized delays experienced by fire fighters who used various systems within the complex.

Discussion

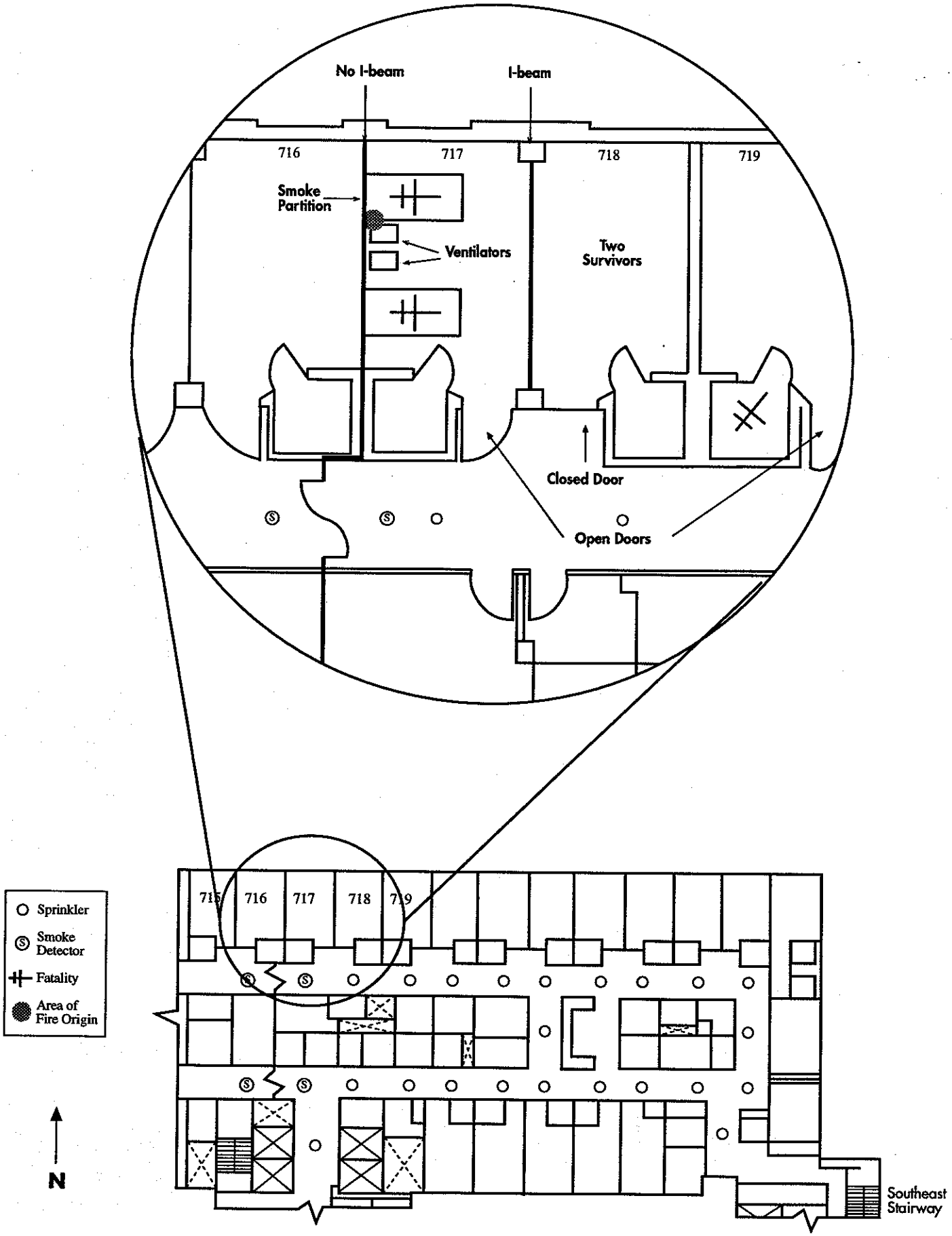
Health care facilities provide sleeping accommodations for people who are incapable of self-preservation because of age, physical disability, or mental disability. Still, a reasonable level of safety for occupants may be provided by limiting fire development, restricting it to the room of fire origin. To accomplish this, the NFPA Committee on Safety to Life states that

> "...protection from fire shall be provided by appropriate arrangement of facilities, adequate staffing, and careful development of operating and maintenance procedures composed of the following:
>
> (a) Proper design, construction, and compartmentation; and
>
> (b) Provisions for detection, alarm, and extinguishment; and
>
> (c) Fire prevention and the planning, training, and drilling in programs for the isolation of fire, transfer of occupants to areas of refuge, or evacuation of the building."

The above approach is called the "total concept" toward life safety in a health care facility. It emphasizes that designs for fire safety in health care facilities must not depend wholly upon any single safeguard. The value of this approach became clear during the fire at Maimonides Medical Center.

The Maimonides Medical Center fire safety program included many of the policies, procedures, and hardware called for by the "total concept" outline preparing staff personnel for typical fire emergency responses. Due to the early involvement of oxygen, staff were confronted with an extremely severe fire producing a large volume of smoke and heat in an exceptionally short period of time. This reduced the amount of time in which staff, a hospital's primary fire defense, had to act in the fire area. During that time, the oxygen was not shut down, allowing the fire to burn ferociously.

Fortunately, the Maimonides Medical Center was equipped with automatic sprinklers in the corridor, which prevented the fire from spreading beyond the room of fire origin, and many walls minimized smoke spread while staff moved patients away from danger. Once on the scene, fire department personnel quickly extinguished the fire, rescued patients and staff who were trapped on the wing of fire origin, and assisted with evacuation in other areas of the hospital. Thus, it was the combined actions of hospital staff and fire department personnel with the hospital's fire protection systems and construction details that prevented further loss of life and injuries.



Fire Area – Maimonides Medical Center
Figure 1