FIRE INVESTIGATION REPORT

Hospital Fire
Petersburg, VA

Five Fatalities
December 31, 1994

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At approximately 9:00 p.m. on Saturday, December 31, 1994, a fire occurred in a 468-bed hospital in Petersburg, Virginia. The fire, which was caused by smoking materials, resulted in the deaths of five patients.

The hospital, a full-care facility, was housed in a high-rise building of fire-resistive construction. The building had been equipped with many of the fire protection features currently required by fire safety codes, and hospital staff had been trained to respond to fire emergencies.

The fire began in a patient’s room, apparently as the result of the improper use of smoking materials, which ignited bedding, including an “air floatation” mattress with foam plastic padding. The fire intensified briefly when fed by oxygen released from the hospital’s piped oxygen distribution system.

Smoke spread into the corridor and other patient rooms because the door to the room of fire origin was not closed. Smoke also spread into a non combustible concealed space above the ceilings of the patient rooms on the same side of the corridor as the fire room. The smoke was able to enter these concealed spaces because the walls between these rooms were not continuous from the floor to the underside of the floor above. The smoke seeped from the concealed space into the patient rooms below, increasing the amount of smoke that accumulated in them.

The patient in the room of fire origin was killed, and the contents of the room were destroyed. Three other patients died in the area in which the fire occurred, as did one patient in an adjacent area. Even though this last patient was in a remote area, the death was attributed to the fire.

The NFPA investigation and analysis of findings revealed that the following factors contributed to the loss:

- Delayed fire discovery.
- Delayed fire alarm transmission to the fire department because the connection was taken out of service.
- The severity of the fire when it was discovered.
- The rapid fire growth and the rapid development of untenable conditions.
- The open door between the room of fire origin and the corridor.
- Walls between individual rooms that were not continuous from slab to slab.
- Lack of sprinkler system in the room of origin or in the corridor.
I. INTRODUCTION

The National Fire Protection Association (NFPA), with the assistance of Building Officials and Code Administrators International (BOCA), investigated the fire at the Petersburg Hospital to document and analyze significant factors that resulted in the loss of life and property. This investigation was funded by the NFPA as part of its on-going program to study technically significant fires. The NFPA’s Fire Investigations Department documents and analyzes the details of each incident so that it may report lessons learned for life safety and property loss prevention purposes.

BOCA helped the NFPA collect and analyze data 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 BOCA, the other cooperating model building code groups are the International Conference of Building Officials (ICBO) and the Southern Building Code Congress International (SBCCI). The three model building code groups provide technical staff support for on-site field work and building code analysis.

The NFPA became aware of the fire on the day it occurred and sent Edward Comeau, Chief Fire Investigator, and Michael S. Isner, Senior Fire Investigator, to Petersburg, VA where they were joined by Roland Hall, P.E., Manager of BOCA’s Eastern Regional Office and Mark Chubb, Fire Code Coordinator for the Southeastern Association of Fire Chiefs. Their 2-day, on-site study and their subsequent analysis of the fire form the basis of this report. Entry to the fire scene and data collection activities were made possible through the cooperation of the Petersburg Fire Department, whose cooperation and assistance we appreciate. We also appreciate the contributions of Mr. Hall and Mr. Chubb during the data collection phase and report preparation.

All information and details about fire safety conditions at the hospital are based on the best available data and observations made during the data collection phase and on any additional information provided during the report-development process. It is not the NFPA’s intention that this report pass judgment on, or fix liability for, the loss of life and property resulting from this fire. Rather, the NFPA intends that its report present the findings of our investigation and highlight the factors that contributed to the loss of life and property.

Current codes and standards were used as criteria for this analysis, so that conditions at the hospital on the day of the fire could be compared with current fire protection practices. We recognize that these codes and standards may not have been in effect when the facility was being built or operated. The NFPA did not try to determine whether the hospital complied with the codes and standards in existence during its construction or renovation.
II. BACKGROUND

Occupancy Classification

The Petersburg hospital is licensed by the Commonwealth of Virginia and provides the community with a full spectrum of medical services and procedures, including general medical, surgical, and emergency room services. The center was licensed as a hospital and was approved for 468 beds, though only 286 beds were being made available and 210 were actually being used on the night of the fire.

Applicable Codes and Enforcement

At the time of the fire, the City of Petersburg enforced the Commonwealth of Virginia Uniform Statewide Building Code, which was based on BOCA’s National Building Code. When the south wing, in which the fire occurred, was built, Petersburg was in the process of switching from a city building code to a state building code, and there is no documentation to indicate which code applied to the construction of this wing.

Inspectors from the Petersburg Fire Department inspected the hospital annually and were frequently in the facility observing and examining the many construction projects in progress. According to the Petersburg Fire Department, they were familiar with the facility and felt that the hospital administration was trying to provide a high level of fire protection.

The Building

The hospital had been built in several phases, so the design and construction details were changed in different parts of the building. The oldest section, constructed in 1952, was the tallest portion of the building at nine stories. The building’s south wing, in which the fire occurred, was completed in 1977 and was six stories high. Three areas of the south wing contained patient rooms (see Figure 1). One was west of the nurses’ station, another was south of the nurses’ station, and the third was east of the nurses’ station.

The south wing had a steel frame consisting of protected columns, unprotected I-beams and unprotected, lightweight steel bar joists. The I-beams supported the bar joists which, in turn, supported floor slabs. The floor slabs were made of reinforced concrete poured over corrugated metal pans. A suspended ceiling of acoustical tile was installed 3 feet 9 inches below the steel floor pans.

According to building plans, the ceiling and floor assemblies, which were designed to function together as a single fire assembly, met the criteria of UL’s Fire Resistance Directory for a G-235 floor-ceiling assem-
Figure 1: Plan View of Entire Hospital
bly. The 1972 edition of the directory noted that a G-235 floor-ceiling assembly had a 2-hour fire-resistance rating for both restrained and unrestrained installations. Observed construction details, including ceiling tiles with a fire-resistance rating and metal clips that secured the ceiling tiles in the metal frames, suggest that the ceiling/floor assembly was installed in accordance with the UL standard.

The columns were covered with three layers of 5/8-inch gypsum wallboard in both the occupant spaces and the void between the suspended ceiling and the concrete-and-steel floor assembly.

Observed building details suggested that the building was designed as a Type I (332) construction, according to the 1992 edition of NFPA 220, *Standard on Types of Building Construction*, and Type 1B construction, according to the 1993 edition of BOCA, *National Building Code*. The exterior bearing walls of such a structure have a 3-hour fire rating, as do the structural frame or columns and girders supporting loads for more than one story. The floor assembly has a 2-hour fire rating. This type of construction is consistent with regulations for existing health care occupancies found in the 1994 edition of NFPA 101, *Life Safety Code*.

Exterior non load-bearing walls were made with 2-by-4-inch metal studs. Applied to the interior surface of the studs was a layer of 5/8-inch gypsum wallboard and to the exterior, brick veneer. Similarly, the interior walls were of gypsum wallboard installed on

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**Figure 2: Plan View of South Wing**

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both sides of 2-by-4-inch metal studs. The thickness of the gypsum wallboard on these walls was not measured.

The wallboard on the walls between patient rooms extended only a couple of inches above the suspended ceiling assembly, while the wallboard on both sides of the corridor walls extended the full height of the wall from slab to slab. There were two layers of wallboard on the corridor side of the corridor walls and one layer in the void above the suspended ceiling. Below the suspended ceiling, the corridor walls were finished with a skim coat of plaster and a single layer of vinyl wall covering. On the room side of the wall there was a single layer of gypsum wallboard from the floor slab to the underside of the slab above.

Above the suspended ceiling, the walls separating the corridor from the patient rooms had numerous penetrations for conduits, supply-air ductwork, and related utilities, and it appeared that most of these penetrations were properly sealed against smoke movement. The supply ducts passing through these walls had no fire dampers.

Since the corridor walls extended from slab to slab, the void above the suspended ceiling was divided into three separate areas. For example in the south area of the south wing, one void was above the patient rooms on the east side of the corridor, another was above the corridor, and the third was above the patient rooms on the west side of the corridor.

The building was divided by several smoke partitions that also extended from slab to slab (see Figure 2). One was located between the south corridor and the nurses' station in the south wing, and another separated the south wing from the rest of the building. Similar to the interior walls, the smoke partitions were of gypsum wallboard installed on both sides of 2-by-4-inch metal studs.

Like the walls separating the corridor from the patient rooms, the smoke partition between the south area and the nurses' station had numerous penetrations for conduit, supply-air ductwork, and utilities, all of which also appear to have been properly sealed against smoke movement. A fire damper in the HVAC duct was installed in line with the smoke partition, and the smoke partition had an opening for the corridor and a pair of self-closing, 20 minute rated smoke barrier doors.

The Patient Room

The patient room (Room 418) in which the fire began was typical for this nursing unit. It had space for two patients and a bathroom next to the patient room door. The room was 21 feet long, 12 feet wide, and 7 feet 11 inches from floor to suspended ceiling. Its exterior window, which was curtained, was 8 feet wide and 4 feet 10 inches high.

Figure 3: Plan View of Patient Room
The patient room door was of solid-core wood 1 3/4 inches thick, and the core material appears to be particle board or a particle-board-like material. The door was equipped with positive latching hardware, but it did not have an automatic door closer or a self-closing device.

Each room contained a wall-mounted wardrobe, a night stand, a tray table, a guest chair, a privacy curtain, a bed, and a plastic trash basket for each patient. In addition, the room of origin contained a wall-mounted television and one geriatric chair. Geriatric chairs were provided to patients on an “as needed” basis.

The wall-mounted wardrobes were made of particle board covered with a wood veneer and contained the personal possessions—commonly combustible—of each patient. The night stands and tray tables had metal frames and some combustible components. The guest chairs consisted of metal-and-wood frames covered with foam plastic padding, topped by a vinyl material. The geriatric chair also had vinyl-covered foam plastic padding, although its frame was primarily of metal with only a small amount of combustible material. The privacy curtains and the window curtains are described as being a fire-resistant synthetic material designed for use in hospitals.

Both beds in the room of origin were electric hospital beds with air floatation mattresses. In the bed frames, which were of painted metal with plastic-covered metal rails, were sensors that signaled air pumps in the mattress to inflate or deflate the mattresses’ bladders, as needed. The mattresses also had approximately 22 pounds of foamed polyurethane padding and a cover made of synthetic materials designed to resist ignition. Each bed had sheets and blankets that were a 50/50 blend of cotton and synthetic materials.

According to the Petersburg Fire Department, on the day of the fire, one of the patients in the room of fire origin was transferred to another room on the unit, and the area was cleaned. As a result, there were no combustible materials in the wardrobe or the trash basket. The patient who remained in the room was receiving oxygen therapy, so a regulator had been plugged into the wall outlet supplied by the hospital’s piped oxygen system, which operated at 55 psi. At this pressure the regulator provided an approximate maximum flow rate of 120 liters per minute.

**Heating, Ventilation, and Air Conditioning (HVAC)**

The HVAC system for the south wing was designed to supply fresh air. A large supply air duct was installed above the wing’s suspended ceiling and passed through the smoke partition separating the nurses’ station from the south area. Smaller ducts passing through the corridor walls discharged the supply air through a ceiling vent near the bathroom in each patient room. The HVAC system pre-heated supply air to 55°F, but the temperature in the room could be controlled by an individual heating unit mounted under the window of each room. Fans in the unit forced room air over the coils of the unit, where it was heated by hot water and recirculated in the room.

The HVAC system could not mechanically exhaust air from patient rooms in the south wing. Air was primarily exhausted through natural movement through the corridors and building leakage. The only mechanical exhaust system was the bathroom venting system, which operated constantly and was completely independent of the HVAC system.

**Fire Suppression Equipment**

The only fire suppression equipment in the south wing were standpipe systems and portable fire extinguishers. The standpipes supplied hose cabinets equipped with a 1 1/2-inch connection, a hose line, and a nozzle; this was a Class II system installed in accordance with the 1993 edition of NFPA 14, *Installation of Standpipe and Hose Systems*. Each hose cabinet also contained an ABC dry chemical fire extinguisher and a pressurized water extinguisher. The cabinets were installed in the corridor walls near each stairwell. The hose cabinet in the south area was approximately 20 feet from the room of fire origin.
Fire Detection and Alarm Systems

The hospital was equipped with a multizone, 110-volts a.c. fire detection and alarm system. In the area of fire origin, the system’s initiating devices were manual pull stations and smoke detectors. The manual pull stations where located by every stairway, and the ceiling-mounted, spot-type, ionization smoke detectors were spaced approximately 30 feet apart along the length of the corridor. Smoke detectors were also installed on each side of smoke barrier doors and at the nurses’ station. There were no smoke detectors in the patient rooms.

The manual pull stations and smoke detectors activated a building-wide fire alarm system and normally transmitted alarm signals to on-site and off-site locations. The on-site location was the safety and security office, staffed most of the day by hospital security personnel. This person was in radio contact with other security personnel, who could respond when a signal was received. The off-site location was a central station monitoring facility. At some point before the fire, the hospital had the central station place the alarm system out of service due to on-going construction. As a result, the central station did not receive alarm signals from the hospital on the night of the fire.

In addition to the ceiling-mounted smoke detectors, there were smoke detectors in the supply-air ducts of the HVAC system downstream of the smoke barrier walls. When these were activated, the duct smoke detectors closed the smoke damper, shut down the HVAC system, and initiated the building-wide alarm system. To close the damper, the duct smoke detector must send a signal to a remote controller, which released the damper.

According to information provided by the hospital staff during the investigation, the dampers were also designed to close when any fire alarm initiating device in the zone operated or when they were exposed to the elevated temperatures of a fire. The higher temperatures apparently melted a fusible link in the cable connecting the damper, releasing it.

Means of Egress

There were two means of egress from the fire area (the south area), one down the enclosed exit stairs at the south end of that area, and the other through a set of swinging smoke doors at the north end of the wing, which led to more enclosed exit stairs. The smoke doors opened into the nurses’ station and the elevator lobby, from which one had access to several stairways and other smoke compartments.

Disaster Plan and Staff Training

The medical center had detailed fire and disaster plans. In the introduction of the fire plan, the hospital emphasized that fire prevention is the best defense against fire but that fires can and do occur. The plan then presented, in great detail, the functions of all departments, the duties and responsibilities of all personnel, and the specific policies and procedures for fire responses.

According to the disaster plan, when a fire is discovered, hospital personnel were to first remove the patient from danger and isolate the fire by closing doors and windows. They were then to notify the switchboard in a moderate tone, and the switchboard is to call the fire department. If a pull box is convenient, personnel were supposed to use it, but they were to notify switchboard in any event. After they’ve accomplished all this, they were to then fight the fire with the nearest appropriate extinguisher. The person in charge of the department or unit is to call the switchboard and report “ALL CLEAR” when that department or unit is secured.

The plan also stated that the switchboard operator is to call the fire department as soon as he or she is notified of a fire and make a building-wide coded announcement to alert all staff that a fire has been reported and the location of that fire. In response to this announcement, staff is to take appropriate actions, as designated by the fire emergency plan.
At the time of the fire, the hospital was in the process of revising its internal disaster plan. Hospital administrators were aware of the command systems used by fire service personnel and were in the process of implementing their incident management system modeled after those systems. Hospital representatives participated in incident command system (ICS) training at the Chesterfield, Virginia, Fire Department and used that information to develop their new incident management system. However, the new system had not been completely implemented at the time of the fire, so hospital managers and staff used the existing system.

The staff received regular fire safety training that reinforced their understanding of their responsibilities and the procedures described in the fire plan. This training was complimented by at least 12 fire drills each year, four drills on each shift. In fact, the nurses on duty in the south wing when the fire broke out had successfully completed a fire drill just 2 days before. Evaluation forms completed after the drills showed that the staff generally had a good grasp of fire and evacuation procedures, even though minor fire safety problems had been noted.

### Building Occupants

The south wing was reserved for general medical/surgical patients, who ranged in age from the mid-40s to late 70s. At the time of the fire, six nurses were on duty in the south wing, and they were all either in patient rooms or at the nurses’ station. Ten patients were in the west-area (Rooms 401 - 410), fourteen patients were in the south area (Rooms 411 - 421), and two patients were in the east-area (Rooms 423 & 424). There were also a few visitors in the patient rooms. Though no specific information was available about the patients’ various medical conditions, some were able to move without assistance while others required different levels of assistance.

### Petersburg Fire Department

At the time of the fire, the Petersburg Fire Department protected a 23-square-mile community with a population of approximately 40,000 and responded to an average of 3,200 emergency calls a year. The department had 86 paid fire fighters divided between three shifts. Twenty-four fire fighters, including a battalion chief, were assigned to each shift. The department’s four engines and one ladder truck were positioned throughout the city in four fire stations. The engines responded to the hospital fire with one officer and two fire fighters, and the ladder responded with one officer and three fire fighters.

### III. THE FIRE

#### Discovery and Staff Activities

A few minutes after 9:00 p.m., a nurse going from Room 419 to Room 420 heard the patient in Room 418 yelling and went to investigate. When she opened the partially-closed door and entered the room, she discovered a fire involving the top part of the bed closest to the door. The fire also appeared to be extending to the wall behind the bed. The patient in the room who was still in the burning bed was leaning to her left, with her right hand stretched over the bed rail.

The nurse immediately left the room and used the manual pull station by Room 415. While in the hall, this nurse yelled, “I need some help, she’s on fire... I need some help!” and then she ran to a linen cart outside the multi-purpose room and grabbed a blanket. Upon reentering Room 418, she tried to smother the flames and tried to remove the patient from the bed. However, the growing fire and the accumulating smoke forced her out of the room before she could do so. According to information provided by the Petersburg Fire Department, when she left the room to get help, she failed to close the door.
Another nurse, who was near the nurses’ station, heard the first nurse yell for assistance and looked down the corridor to the south. She saw black/gray smoke coming from the top of the door to Room 418. The nurse immediately went to use a manual pull station, but the building fire alarm was already operating, so she tried to call the switchboard operator instead. When she got no response on her first try, she called again and got through to confirm the fire. The nurse then headed to Room 418. On the way, she met a patient leaving Room 411 and directed her to leave the unit. The nurse found another nurse having trouble breathing so she assisted that nurse and they left the unit.

A nurse, who was in Room 409, heard the yelling and ran into the corridor. When she realized that there was a fire in Room 418, she picked up a fire extinguisher and rushed to the room. By this time, however, conditions in Room 418 were so severe that they prevented her from entering. Instead, she began closing patient-room doors. She also helped two patients to evacuate.

By this time, nurses throughout the south wing had heard the alarm and the commotion and had begun closing the doors to their patient’s rooms. They closed most of the doors in the south area, but no one managed to shut the door to the room of fire origin.

Staff members also evacuated several patients before they were forced from the area by deteriorating conditions. However, they were not able to get everyone out. For example, a nurse who had removed one patient from Room 417 also attempted to remove a patient from Room 421 but was forced from the room by heavy smoke before she could do so. She is reported to have closed the door before leaving.

At some point, the fire in Room 418 grew large enough to damage the oxygen regulator in the wall receptacle, and pure oxygen was released, increasing the intensity of the fire. The oxygen continued to flow until a maintenance person used a zone valve to shut off the oxygen flow to several rooms, including Room 418. This occurred prior to the arrival of the fire fighters.

The fire also broke the window in Room 418, allowing it to vent outside. This provided fresh air for the fire.

The door to one of the patient’s rooms as viewed from the corridor. Note the heavy soot stains on the walls, indicating that the smoke level was within several feet of the floor.

Fire Department Notification

The Petersburg Police Department Emergency Communication Center is the public safety answering point (PSAP) for Petersburg, so it initially received all the 911 calls from the hospital and it dispatched the Petersburg Fire Department in response to the calls.

A patient in Room 413 was the first person to call. She dialed 911 at 9:11:30 p.m. and reported “an emergency” at the hospital, stating that a woman was throwing things around and that there was smoke on the fourth floor.

Six seconds later, the PSAP received another 911 call from a Chesterfield, Virginia, Fire Department ambulance crew that was leaving the hospital when the building’s fire alarm operated. As the crew walked
out of the building, they noticed a man and a woman in the parking lot pointing excitedly toward the hospital. When they went over to see what was wrong, they noticed heavy fire and smoke coming from a fourth-floor room and spreading up the exterior of the building. A crew member, who was also a Petersburg fire fighter, ran back to the emergency room and called 911.

The hospital switchboard operator also called 911 to report the fire. The fire department received that call at 9:11:45 p.m. and dispatched the first-alarm assignment, consisting of two engines, a truck, an ambulance, and a battalion chief, at 9:12:20 p.m.

The ambulance crew member who had made the 911 call from the emergency room also used a radio to contact the responding battalion chief. The ambulance crew member reported that there was heavy fire showing on the outside of the building and that an unknown number of people were trapped. Based on this information, the battalion chief requested a second alarm response, and Petersburg’s last two engines were dispatched. A neighboring community also dispatched a truck company, in accordance with the communities’ mutual-aid agreement. The second alarm units were dispatched at 9:14:30 p.m.

Fire Suppression Operations

Engine 2 (E-2) was the first unit on the scene, arriving at 9:15 p.m., and responded to the main entrance on the west side, according to the department’s standard operating procedures. Crew members reported that nothing was showing there and walked up Stairway 3 to the fourth floor with their high-rise pack, which consisted of 100 feet of 2 1/2-inch hose, a gated wye, 100 feet of 1 3/4-inch hose, and a nozzle.

Fire fighters on Engine 4 (E-4), which approached the hospital from the east side, saw flames aggressively venting out a fourth-floor window and up the exterior of the building, apparently to the floor above. This crew connected a hose to a hydrant and to the fire department connection supporting the standpipe system, then walked up Stairway 3 to the fire floor.

An exterior photo of the south wing showing the spread of fire and smoke up the exterior of the building.

Truck 1 (T-1) responded to the east side of the building, where two fire fighters entered the hospital to help the engine crew. The other two fire fighters from T-1 were ordered to rescue a patient who was in imminent danger of falling out of a fourth floor window. This patient was in Room 416. The layout of the building prohibited them from using the aerial ladder, so they brought a large extension ladder to the roof of a one-story section of building below the window and rescued the patient from there.

The battalion chief arrived at the east side of the building at 9:18 p.m. and assumed command. As he approached the hospital, he could see the fire venting from the fourth floor window and described it as “a clean fire, pushing real hard.” Six or 7 minutes after his arrival, however, the blaze noticeably diminished in intensity.

The battalion chief established his command post in the parking lot to the southeast of the building. During the course of the fire suppression and rescue operations, he tried to get specific information about hospital equipment, such as the location of elevator controls, but he did not receive it until late in the incident. Nor did he receive regular updates about the activities of the hospital staff.
The E-2 officer and one fire fighter arrived on the fourth floor at approximately 9:18 p.m. and found some staff and patients in Stairway #3. When they entered the fourth floor, they noticed light smoke in the corridor and headed toward the fire area, where they ran into a set of closed smoke barrier doors. Passing through the doors, the fire fighters encountered a deep, heavy smoke layer banking down from the ceiling. Although the smoke obscured their vision, they managed to locate the standpipe closest to the nurses’ station, connect their 1 3/4-inch hose line and extend it toward the closed smoke doors of the south area.

Joined by the two fire fighters from T-1, the E-2 crew passed through the south area smoke doors and found heavy smoke and heat filling the corridor from floor to ceiling. They moved down the hall and began searching rooms. These fire fighters found one patient and removed the patient from the area. As the fire fighters approached the room of fire origin, they saw smoke and flames extending out of the room into the hallway. Two crew members advanced their hose line to Room 418 and began attacking the fire.

The fire fighter operating the hose nozzle reported that the door to the room of fire origin was closed and that he had to reach up and “move it” in order to enter the room. Physical evidence examined after the fire revealed the door was actually only partially closed and that the fire fighter would have had to push it out of the way to enter the room. Once inside, he found the room and its contents fully involved.

Fire fighters first applied water toward the window and knocked down that body of fire before turning to their right and knocking down the fire in that area. They had the blaze under control at 9:31 p.m., approximately 19 minutes after they were dispatched.

A battalion chief assigned to the interior found a number of fire fighters and hospital staff in the corridor on the north side of the smoke barrier doors north of the nurses’ station and established a system for transferring the patients to the staff. He had fire fighters bring the victims from the fire area to the nurses’ station, where they were met by two hospital staff members, who moved them to a stretcher and took them to a triage station in a safe area further down the hall. The triage station was staffed by an emergency room physician, who evaluated the patients’ conditions and determined the care required. Patients were then sent to the emergency room for further treatment or to other rooms in the hospital.

Fire officials estimated that the evacuation of the south area was completed in approximately 25 minutes. The patient in Room 411 evacuated himself without assistance, and fire fighters evacuated one patient in Rooms 412, 413 and 414. Fire fighters also removed two patients from Room 415. The patient in Room 416 was rescued by ground ladder, and six other patients were evacuated from Rooms 417, 419, 420, and 421. The patient in Room 418, the room of origin, died. Fire fighters found her in her bed after the fire was extinguished.

The victim removed from Room 418 was the only patient who was burned. In fact, she was severely burned and died as a result. According to the medical examiners office, the other four fatalities died as a result of smoke inhalation.

Another twelve patients were evacuated from the adjacent areas in the south wing. As a precautionary measure, approximately twenty-two patients were also evacuated from adjacent floors.

**Rescue Operations**

While the crews from E-1 and T-1 were extinguishing the fire in Room 418, other fire department personnel arrived on the floor to begin rescue operations.

**Damage**

The fire gutted the room of origin, completely consuming most of the combustible materials. Only the metal frames of the furniture were left. Even though the gypsum wallboard had calcined in many areas, the wall remained intact and did not fall away from the metal studs on which it was mounted. However, the entire suspended ceiling collapsed, and at least
three metal bar joists were deformed by exposure to the fire. Some of the metal pans under the concrete were also deformed. As the fire spread into the corridor, it consumed the top half of Room 418's solid-core wood door. It also caused flame and heat damage on the corridor walls in the area of fire origin.

Extremely heavy smoke stains accumulated on the ceiling and top half of walls along the length of the corridor, in Rooms 411 and 421, and, to a lesser extent, in Rooms 416, 417, 419 and, 420. Rooms 412, 413, 414, and 415, and the multipurpose room had the least amount of smoke staining. In addition, heavy smoke stains covered the north side of the smoke doors to the south area, and light smoke stains collected on the wall and other surfaces in areas as far away as the nurses' station. There were no perceivable smoke stains in the east and west areas of the south wing or in areas beyond the smoke doors north of the nurses' station.

**Casualties**

Five patients died as a result of this fire. One patient was in the room of origin and died of injuries received from the fire. Two of the other patients were in each of the rooms immediately adjacent to the room of origin and died as a result of smoke inhalation. The fifth patient, who was in an adjacent wing, also died of exposure to smoke products. This patient was moved through the contaminated area during the rescue operations.

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![Diagram](image-url)

**Figure 4: Victim Location & Fire/Smoke Damage**
IV. TIME LINE

(Approximate) Time   Activity

9 p.m. + +  Nurse 1 heard yelling in Room 418, investigated and found fire. She took several actions including activating of building fire alarm system, yelling for assistance, attempting to extinguish fire with blanket and attempting to rescue patient.

Fire and smoke forced her to leave the Room 418 before she could rescue the patient. She did not close the room door.

Nurse 2 heard Nurse 1 yelling and saw smoke coming from Room 418. Nurse 2 called the switchboard operator to confirm the fire.

Nurse 3 in 409 also heard Nurse 1 yell for help. She got a fire extinguisher and went to Room 418 and the door was open. Conditions in the room prevented her from entering the room.

Nurse 2 moved went Room 418 but is met in the hall by the patient from Room 411. After directing this patient to a safe area, she returned to the fire area, where she encountered another nurse who was having trouble breathing. Nurse 2 escorted this nurse out of the fire area.

9:11:30 p.m.  The patient in Room 413 called 911.

9:11:36 p.m.  The ambulance crew member called 911.

9:11:45 p.m.  The hospital switchboard operator called 911.

9:12:20 p.m.  The first alarm assignment (2 engines, 1 truck, 1 ambulance and a battalion chief) was dispatched.

9:13:44 p.m.  The ambulance attendant radioed the responding battalion chief and told him that heavy fire was showing and people were trapped.

9:14:30 p.m.  The second alarm is dispatched.

9:15 p.m.  E-2 arrived on building's west side and reported that nothing was showing.

9:16 p.m.  Unit 530 (battalion chief) arrived on Side 3.

9:18 p.m.  E-2 crew arrived at fourth floor and found staff and patients in a stairway

9:31 p.m.  Fire was under control.

9:40 p.m. +  Evacuation of the south area was completed.
V. ANALYSIS

Origin and Cause

Due to the extensive damage in the room of fire origin, local fire investigators were unable to establish the cause of this fire with complete certainty. However, they did determine that the most probable cause was the improper use of smoking materials. Given this ignition scenario, bedding materials were probably the first items ignited.

Photo of the room of origin. The bed in which the patient was located was in the right edge of the picture.

Fire Growth and Spread

The staff’s observations and the limited number of actions that the staff members were able to take provided a relative sense of the fire growth rate. A nurse found the fire when it was already well-established in a bed. She left the room, used a manual pull station, grabbed a blanket from a nearby cart, and immediately returned to the fire room. She tried to extinguish the fire and remove the patient from the burning bed, but the fire was growing so fast she had to leave the room before she could do either or before she could close the door, according to the Petersburg Fire Department. Other nurses and staff personnel who responded were able to close doors, but they did not have enough time to remove most of the patients from the south area. To have became severe enough to force staff from the area before they finished their emergency response, the fire in Room 418 had to be growing very fast.

It is not known exactly when the switchboard operator began the emergency procedures, which included making a building-wide, coded announcement about the fire and calling the fire department. However, we do know that the switchboard operator called the fire department after the fire had broken the window in Room 418 and was venting to the outside. The fact that the fire in the bed was able to break a window across the room also supports the theory that the fire grew extremely fast.

Local fire investigators determined that the wall-mounted oxygen regulator was damaged at some point in the fire. When the damaged regulator was tested, it still released oxygen at normal system pressure. This release contributed to the fire’s extremely fast growth, which ultimately led to the development of untenable conditions.

Rapid fire growth and the development of untenable conditions were significant factors contributing to the loss of life and property because those conditions forced staff from the room and then from the area before they could successfully complete their emergency response.

Smoke Spread

The smoke generated in Room 418 spread to other rooms in the south area primarily through the open door of the room of fire origin and secondarily through the common concealed space over the rooms on the east side of the corridor.

Since the corridor door to Room 418 was left open, smoke quickly filled the common corridor serving all patient rooms in the south area. The corridor doors to Rooms 411 and 421 also remained open for most of the incident, so smoke conditions similar to those in the corridor occurred in these rooms, as well. The corridor doors to all the other rooms in the south area were closed. Still, smoke seeped through the cracks...
between the closed doors and their frames in Rooms 412, 413, 414, 415, 416, 417, 419, and 420, and in the multipurpose room. The amount of smoke seeping around the doors was significantly less than that entering the rooms through open doors.

ceilings of these rooms reveal that the smoke collecting in the concealed space seeped into the rooms below. The combined seepage of smoke through the ceiling and around the doors allowed lethal levels of smoke to accumulate in Rooms 417 and 419—rooms with closed doors.

This is a photo of the corridor side of a patient's room door that is typical of the smoke staining seen in the corridor of the fire wing.

The walls between individual patient rooms was not continuous from slab to slab, but instead stopped at the suspended ceiling. The suspended ceiling was part of a fire rated assembly, yet failed at some point in the fire, allowing fire and smoke to spread into the void space and to the adjacent rooms.

This is the interior of Room 415, which was located on the opposite side of the corridor at the south end of the fire wing. Note the soot staining around the door, which was in a closed position during the fire.

Smoke spread into adjacent rooms on the east side of the corridor through the void space. Soot staining can be seen at the corners of the suspended ceiling tiles in this photograph.

At some point before the fire was suppressed, the suspended ceiling in Room 418 collapsed. Because the walls between patient rooms did not extend from the floor to the underside of the floor slab above, smoke filled the concealed space common to the rooms on the east side of the corridor. Stains on the suspended
tributed to the spread of smoke from beyond the room of origin. Either a closed door, or room separation walls that extended up to the floor slab above, would have served to contain the smoke within the room of origin and reduced the spread of smoke to the corridor and other rooms.

When the suspended ceiling failed, smoke and fire spread into the void space on the east side of the corridor.

Smoke also spread to other areas of the south wing, and small amounts of smoke spread beyond the south wing. The primary cause of smoke spread to other areas of the south wing was the opening of the smoke barrier doors adjacent to the nurses’ station. In the early stages of the fire, nurses opened the smoke barrier doors between the nurses’ station and the south area several times during their emergency response. The repeated opening of the doors, as well as natural seepage around them when they were closed, allowed enough smoke to spread into the nurses’ station to obscure the fire fighters’ vision when they entered the area for the first time.

Even more smoke spread into areas adjacent to the fire area during suppression operations. In order to attack the fire, fire fighters had to run a hose line through the smoke barrier door opening, which held one door slightly ajar. Like the nurses, the fire fighters also had to open the doors a number of times to remove patients and perform other activities during suppression and rescue operations. These doors provided the only path through which staff could move patients to safe areas on the same floor, and they were the only means of access fire fighters operating from the nurses’ station had to the fire area. Patients from the three wings that made up the nursing unit were all moved through the smoke environment during the rescue operations.

Fire Protection Equipment

The building was equipped with fire protection equipment, including fire extinguishers, standpipes, occupant hose stations, fire detection systems, manual pull stations, and fire dampers in the HVAC ducts.

At least one staff member reportedly tried to use a fire extinguisher on the fire in Room 418, but was unable to because conditions in the room were untenable before he even reached it. Fire fighters used the standpipes as the water supply for their attack line, but none of the hospital staff or the fire fighters tried to use the occupant hose.

Since the fire detection system had detectors only in the corridor and not in patients rooms, the system did not detect the fire before it was discovered by the nurse. Once the nurse became aware of the fire she activated the building’s alarm system by using a manual pull station. The building-wide alarm alerted staff in other areas that an emergency was in progress, and many staff members began their emergency response.

Provisions to notify the fire department automatically had been temporarily suspended before the fire. As a result, the fire department was notified later than it would have been had the alarm system’s provision for automatic notification been operational.

The building’s wall and ceiling/floor assemblies were built to resist the effects of exposure to fire. Even though the fire in Room 418 was extremely intense and the wall surfaces in the room were heavily damaged, the walls did not fail and kept the fire from spreading horizontally through them. The ceiling/floor assembly also prevented the fire from
spreading to the floor above the fire room, even though the assembly was damaged. However, the suspended ceiling assembly did fail at some point in the fire, allowing fire and smoke to enter the void space and spread laterally. Corridor walls and smoke barrier walls were continuous from the floor slab to the underside of the floor slab above, and all the penetrations in these walls were properly sealed. As a result, the corridor walls reduced the amount of smoke that spread from the patient rooms to the corridor, and the smoke barriers walls reduced the amount of smoke that spread from one smoke zone to another in the building.

According to information provided to NFPA investigators by the hospital staff at the time of the investigation, the HVAC system was designed in such a way that if any device on the fire alarm system (pull station or smoke detector) in a wing went into alarm, the damper in the supply duct would automatically close. It was determined during the on-scene investigation that the damper in the supply duct to the fire wing did not close. However, since the HVAC system was a 100% fresh air supply system, the smoke was not recirculated through the system into other areas of the hospital.

**Staff Performance**

Many staff members responded immediately to the discovery of the fire. The nurse who first noticed the fire pulled the manual alarm to notify others, then tried to rescue the patient in the room of origin. She also used a blanket in an effort to extinguish the fire, and a maintenance person took a fire extinguisher to the room with the intention of using it. A number of nurses evacuated patients and closed patient room doors. All of these actions were consistent with the actions that the NFPA 101, *Life Safety Code* and NFPA 1, *Fire Prevention Code* require as part of a hospital’s written fire safety plan. The staff’s combined actions, though not all equally effective, helped reduce the number of patients injured and killed.

Unfortunately, the staff did not perform one critical act: No one closed the door to the room of fire origin, which would have reduced the potential for death and injury, not only for the patients in Rooms 417 and 419, but for patients in all areas outside of the room of fire origin.

The staff continued to perform many actions even after the fire forced them from the area and the fire fighters arrived. Staff personnel continued to help patients in areas where conditions were deteriorating, and they assumed primary responsibility for the evacuation of patients in most areas outside the fire area. The hospital’s disaster plan was activated, putting into place various systems to care for the patients who were displaced and injured. As fire fighters removed patients from the involved areas, hospital personnel received them and brought them to triage areas for evaluation. Since hospital personnel were able to immediately care for the patients being removed from hazardous areas, fire fighters could focus on their suppression and rescue operations.

**Fireground Operations**

Once it was notified of the fire, the Petersburg Fire Department responded quickly and established effective suppression and rescue operations shortly after they arrived on the scene. The fire fighters’ aggressive fire attack helped to reduce the number of fatalities that could have potentially occurred.

After the fire, officials stated that everything had gone smoothly. However, they did feel that making certain changes in the hospital’s fire protection hardware and blending the hospital’s incident management system with the fire department’s would have improved their operations.

The fire protection hardware in question is reflective markers on the floor or low on the wall near the standpipe. Smoke prevented the first fire fighters to enter the nurses’ station from seeing the walls and ceiling—and the standpipe. A reflective marker on the floor or low on the wall would have helped them find the standpipe, since the floor was clear of smoke and they could see more clearly at that level.

The incident commander also thought that the presence of a hospital liaison at the fire department com-
mand post would have helped improve fireground operations. The incident commander had numerous questions about equipment and other details of the hospital, but he could not get answers quickly because he could not easily contact hospital personnel. Nor could he stay current with the hospital staff activities as he did not have direct communication with the hospital’s emergency response coordinator.

**Code Analysis**

The 1994 edition of the NFPA 101, *Life Safety Code* and the 1992 edition of the NFPA 1, *Fire Prevention Code* were used to compare various details of this incident with current national consensus codes, although we recognize that these codes were not part of the legal requirements governing life safety at the medical center. The following discussion concerns requirements that have particular relevance to this fire. It is not intended to be a complete description of all parts of the codes that could be applied.

For the purposes of this code analysis, the medical center will be considered an existing health care occupancy, according to the *Life Safety Code* criteria. Chapter 13 of the *Life Safety Code* contains the requirements for existing health care facilities, and the following excerpt from which is particularly relevant to this fire:

13-1.1.1.11 The requirements of this chapter are based on the assumption that staff is available in all patient-occupied areas to perform certain functions, as required in other paragraphs of this chapter and Chapter 31.

This paragraph states the fundamental concept incorporated into health care facility requirements. The *Life Safety Code* has always assumed that staff will be in continuous attendance in all health care facilities and has assigned to the staff certain critical functions, such as rescuing patients from the room of fire origin, closing the door to the room, and activating the fire alarm system. Consistent with the *Life Safety Code*’s assumption, there were hospital staff in the area in which the fire occurred, and the hospital’s fire safety plan trained them to handle critical functions. During the fire, the staff tried to perform these functions, but the rapidly growing fire and other conditions prevented them from doing so.

13-1.1.3 **Total Concept.** All health care facilities shall be designed, constructed, maintained and operated to minimize the possibility of a fire emergency requiring the evacuation of occupants. Because the safety of health care occupants cannot be ensured adequately by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities, adequate staffing and development of operating and maintenance procedures composed of the following:

(a) Design, construction, and compartmentation; and

(b) Provision 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.

According to the 1994 *Life Safety Code Handbook*, the *Life Safety Code* requirements, which were based on a “defend in place” philosophy, were intended to minimize the probability that a fire would require moving occupants vertically. The code also recognized that patients in critical care areas might be connected to life-support equipment, making movement difficult, if not impossible. Barriers were required to provide for the horizontal movement of patients to safe areas on a single floor and to limit the number of occupants exposed to any single fire. Vertical evacuation of patients was to be a “last line of defense.”

As patients were evacuated from the fire area in this particular fire, they were move horizontally to safe areas beyond the barriers that stopped smoke spread to the north side of the hospital. After being evaluated by medical staff, some patients were moved to other floors.
13-3.4.1 General. Health care occupancies shall be provided with a fire alarm system in accordance with Section 7-6.

13-3.4.2 Initiation. Initiation of the required fire alarm systems shall be by manual means in accordance with 7-6.2 and by means of any required detection devices or detection systems.

13-3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 7-6.3 Presignal systems shall be prohibited.

13-3.4.3.2 Emergency Forces Notification. Fire department notification shall be accomplished in accordance with 7-6.4.

These *Life Safety Code* requirements ensure that hospital staff and fire department personnel can be quickly made aware of a fire so they can begin their emergency response as quickly as possible. During this incident, the building-wide alarm system alerted most of the hospital staff to the fire, but there was a delay in notifying the fire department because the alarm system's automatic fire department notification feature had been temporarily deactivated.

13-3.4.5 Detection.

13-3.4.5.1 Corridors. An approved, automatic smoke detection system shall be installed in all corridors of limited care facilities. Such system shall be installed in accordance with Section 7-6.

This requirement, applicable to limited-care facilities rather than hospitals, is the only requirement for an automatic smoke detection system in existing health care facilities. According to this paragraph, the installation of a corridor smoke detection system in an existing hospital exceeds the minimum requirements of the current *Life Safety Code*. Since the fire started in a patient room whose door was partially closed, even the presence of corridor smoke detectors did not alter the events.

13-3.6.2.1* Corridor walls shall be continuous from the floor to the underside of the floor or roof deck above, through any concealed spaces, such as those above the suspended ceilings, and through interstitial structural and mechanical spaces, and shall have a fire resistance rating of at least 20 minutes.

The corridor walls in this hospital complied with this requirement. The walls formed a substantial barrier, preventing all smoke movement. The only smoke that seeped into the patient rooms on the west side of the corridor entered through open doors or the cracks between closed doors and their frames.

13-3.6.3 Corridor Doors.

13-3.6.3.1 Doors protecting corridor openings in other than required enclosures of vertical openings, exits, or hazardous areas shall be substantial doors, such as those constructed of 1-3/4 in. (4.4-cm) thick solid bonded core wood or of construction that will resist fire for at least 20 minutes.

13-3.6.3.2* Doors shall be provided with means suitable for keeping the door closed that is acceptable to the authority having jurisdiction. The device used shall be capable of keeping the door fully closed if a force of 5 lbf (22N) is applied at the latch edge of the door. Roller latches are prohibited on corridor doors in buildings not fully protected by an approved, automatic sprinkler system in accordance with 13-3.5.1.

13-3.6.3.3 Door-closing devices shall not be required on doors in corridor wall openings other than those serving required enclosures of vertical openings, exits, or hazardous areas.

The patient room doors at this facility complied with these *Life Safety Code* requirements. When closed,
they reduced smoke spread into the patient rooms to
the smoke that could seep through small cracks.

Recognizing that health care facilities have trained
staff on duty at all times, the Life Safety Code does
not require closing devices on patient room doors.
Rather, it anticipates that the staff will be able to de-
tect a fire quickly and close other doors, including
the door to the room of fire origin. In this incident,
however, the staff did not close the door to the room
of fire origin. This was also the case in three other
multiple death fires in health care facilities that the
NFPA has investigated since 1985.

The importance of the staff’s role in health care fire
safety can be gleaned from the fact that Chapter 31
of the Life Safety Code contains several re-
quirements directed at hospital administrators and staff.
Moreover, these requirements are repeated in the
NFPA Fire Prevention Code. The requirements of
Chapter 31 are:

31-4.1.1  The administration of every hospi-
tal, nursing home, and limited care facility
shall have, in effect and available to all super-
visory personnel, written copies of a plan for
the protection of all persons in the event of
fire and for their evacuation to areas of refuge
and for evacuation from the building when
necessary. All employees shall be periodical-
ly instructed and kept informed with respect
to their duties under the plan. A copy of the
plan shall be readily available at all times in
the telephone operator’s position or at the se-
curity center.

The provisions of 31-4.1.2 to 31-4.2.3 in-
cusive shall apply.

(12-2.1.1, NFPA 1, Fire Prevention Code,
1992 edition)

31-4.1.2*  Fire exit drills in health care occup-
cancies shall include the transmission of a
fire alarm signal and simulation of emer-
geney fire conditions. Drills shall be con-
ducted quarterly on each shift to familiarize
facility personnel (nurses, interns, mainte-
nance engineers, and administrative staff)
with signals and emergency action required
under varied conditions. When drills are con-
ducted between 9:00 p.m. (2100 hours) and
6:00 a.m. (0600 hours), a coded announce-
ment shall be permitted to be used instead of
audible alarms.

(12-2.1.2, NFPA 1, Fire Prevention Code,
1992 edition)

31-4.2.1*  For health care occupancies, the
proper protection of patients shall require the
prompt and effective response of health care
personnel. The basic response required of
staff shall include the removal of all occup-
cants directly involved with the fire emer-
gency, transmission of an appropriate fire
alarm signal to warn other building occu-
cpants, confinement of the effects of the fire
by closing doors to isolate the fire area, and
the execution of those evacuation duties as
detailed in the facility’s fire safety plan. (See
Appendix A for a more detailed suggested
emergency plan.)

(12-2.2.1, NFPA 1, Fire Prevention Code,
1992 edition)

31-4.2.2  A written facility fire safety plan
shall provide for:

(a) Use of alarms.
(b) Transmission of alarm to fire department.
(c) Response to alarms.
(d) Isolation of fire.
(e) Evacuation of area.
(f) Preparation of building for evacuation.
(g) Extinguishment of fire.

(12-2.12.2, NFPA 1, Fire Prevention Code,
1992 edition)
The hospital’s plans, procedures, and training programs were consistent with these Life Safety Code and Fire Prevention Code requirements. The performance of most staff members revealed that they generally understood the hospital’s fire emergency procedures as taught and reinforced by in-house training. Still, the staff failed to close the door to the room of fire origin, the single most important act that would have minimized the threat to patients in other south wing rooms.

The training requirements in Chapter 31 prepare the staff for a fire. Staff members must understand that they are integral part of the fire protection features in a health care facility and that they are responsible for detecting fires, ensuring that others are made aware of fires, rescuing patients, and suppressing small fires. Pre-fire training must expose staff members to all the fire protection equipment that has been provided for their use, such as manual pull stations and fire extinguishers. If a facility has occupant hose stations, the staff should be taught to use them. Without specific training, staff members will probably not use unfamiliar equipment during an actual fire.

Pre-fire training can also help prepare hospital staff for the reality, both physical and psychological, of a severe fire in an occupied patient room. Not only did the nurses in this facility face the rapidly deteriorating conditions, smoke, heat, fear, and confusion of a real fire, but they were suddenly confronted with their own inability to rescue one of their patients from certain death.

**IV. DISCUSSION**

Sprinkler protection in health care facilities has been a topic of debate for many years. The Life Safety Code currently specifies the permissible types of construction for new health care facilities and requires that these facilities be equipped with approved automatic sprinklers. The Life Safety Code also requires approved automatic sprinklers in existing health care facilities, but this requirement is affected by a building’s construction and the number of stories it has. Thus, the fire protection in an existing health care facility will vary according to the facility’s characteristics.

Historically, approved automatic sprinklers have proven to be reliable, easy to maintain, and extremely effective against fire. Recognizing the value of approved automatic sprinkler systems, the Life Safety Code reduces many other fire protection requirements in buildings equipped with sprinklers. In health care facilities that are unsprinklered, however, it is imperative that all of the other fire protection features required by the Life Safety Code be present to the fullest extent possible. A failure in any part of the complex blend of staff responsibilities, fire protection equipment, and building features required by the Life Safety Code can lead to loss of life in a fire.

**Postscript:**

Following the December 31, 1994 fire in the Petersburg hospital, the general assembly for the Commonwealth of Virginia met and passed legislation requiring all health care facilities in the Commonwealth, both existing and new, to install sprinklers in patient care rooms. The installation of this fire protection is to be completed by January 1, 1997.