NURSING HOME FIRE

Norfolk, VA

October 5, 1989

NFPA INTERNATIONAL

FIRE INVESTIGATIONS

NATIONAL FIRE PROTECTION ASSOCIATION

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FINAL FIRE INVESTIGATION REPORT
NURSING HOME FIRE
NORFOLK, VIRGINIA
October 5, 1989
12 Fatalities

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(Revised October 1991)

ABSTRACT

On October 5, 1989, a nursing home fire in Norfolk, Virginia, resulted **in** the death of 12 patients and required hospital treatment or relocation of 96 others. The building, built in 1969, is a four-story, nonsprinklered, **fire** resistive structure housing 161 elderly patients at the time of the fire. The first floor contained general administrative offices and support facilities and patient rooms were located on floors two through four. The fire was discovered sometime after 10:00 p.m. by the nursing staff who immediately began to evacuate patients, activate the fire alarm system, close patient room doors, and notify the fire department. However, during this process, the fire grew within the patient room of origin and extended into the exit access corridor, forcing the staff to take refuge from the fire.

Norfolk Fire Department received notice of the fire at 10:18 p.m. and fire fighters arrived on the scene within four minutes of the notification. Upon arrival, they observed fire extending from a second floor window and lapping to the floor above. An interior fire attack was begun utilizing the building standpipe system while other fire fighters **laddered** the building, extended a **handline** and "knocked down" the majority of the fire. Severe heat and smoke conditions existed on the fire floor and fire fighters began to realize many of the patients remained in their rooms. Because of these severe conditions, fire fighters began to evacuate patients from the fire floor.

Other arriving fire fighters, summoned by additional alarms, found moderate smoke conditions existing on the third and fourth floors. Eventually, the entire nursing home was evacuated. Nine patients on the second floor died during the fire, eight were within the smoke zone of origin.

Local investigators have listed the probable cause of the fire as careless disposal of smoking materials. An open flame ignition source ignited bedding materials on a patient's bed which soon involved a polyurethane decubitus pad, and the bed's mattress. The fire grew very rapidly while the staff was attempting to complete their emergency procedures. Within an

estimated three to four minutes of discovery, flashover conditions were reached in the room of origin and the fire extended into the corridor.

The following are significant factors in this fatal fire incident:

1) The rapid growth and development of the fire within the patient room;
2) The absence of automatic sprinklers that could have prevented full room involvement or flashover;
3) The lack of compartmentation due to the open door to the room of fire origin;
4) The lack of automatic detection and failure of the fire alarm system to function properly.

I. INTRODUCTION

The National Fire Protection Association (NFPA) with the assistance of the Building Officials and Code Administrators International, Inc. (BOCA) investigated the Hillhaven Rehabilitation and Convalescent Home fire in Norfolk, Virginia 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 incidents. The NFPA's Fire Investigation 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 BOCA under an agreement among NFPA and the three model building code organizations to investigate significant structural fires throughout the United States. In addition to BOCA, the other cooperating building groups are the International Conference of Building Officials (ICBO) and the Southern Building Code Congress International (SBCCI). The three model building code groups are supporting NFPA by providing technical staff support for on-site field work and building code analysis.

The NFPA became aware of the fire on October 6, 1989. Thomas J. Klem, Director of NFPA's Fire Investigation Division, Richard Ortisi-Best, Fire Protection Specialist, and Ron Cote, P.E., Senior Life Safety Engineer, traveled to Norfolk to document the factors related to this fire. The NFPA investigators were joined and assisted by Martin Conant, Senior Service Coordinator, Mid-East Regional Office, BOCA. An initial three days of 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 Norfolk Fire Department. This report presents the findings of the NFPA data collection and analysis effort.

This report is another of NFPA's studies of fires that have particularly important 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 resulting from the Hillhaven Nursing home fire. Current codes and standards were used as criteria for this analysis so that conditions at the Hillhaven Nursing Home 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 at the time this fire occurred.

The cooperation and assistance of Fire Chief Thomas Gardner, Fire Marshal Carl H. Welch, Investigator Forest L. Parham, and Fire Inspector Edward S. Palaszewski, Norfolk Fire Department; Chief Fire Marshal, Howard Summers, Regional Engineer, Investigators Frank Duffee and Code Supervisor Quinn Harris, Office of the State Fire Marshal, and the staff and management of the Hillhaven Corporation is acknowledged and appreciated.

Also noted are the inputs in writing and in technical review of the report by Richard Ortisi-Best, Martin Conant, and Ron Cote'. Ron Cote' made specific input to the Life Safety Code analysis of the report. Similarly, Martin Conant compiled the BOCA code analysis.

BACKGROUND

The Hillhaven Rehabilitation and Convalescent Center, constructed in 1969, was licensed and certified to provide both intermediate and skilled care for up to 172 patients. There were 161 patients in the facility at the time of the fire; most were elderly and nonambulatory. The nursing home was located in a residential area of the city of Norfolk at 1005 Hampton Boulevard. At the time of construction, the 1957 building code for the City of Norfolk was used as a basis for its construction requirements. To maintain its certification for federal government funding under medicare/medicaid programs, yearly inspections were conducted of the facility by representatives of the state fire marshal's office. The compliance basis of the inspection was the 1967 edition of the Life Safetv Code for existing nursing homes. Its last annual inspection was conducted in November, 1988 and only minor deficiencies were noted. Follow-up inspections revealed that the noted deficiencies had been corrected.

The Building

The nursing home is a four-story structure having outside dimensions of approximately 161 by 137 feet. Fire department access is from all sides of the building. Each floor of the building contains approximately 14,400 square feet. The first story (ground floor) was utilized for general functions such as administrative services, kitchen and eating facilities, general storage and other functional areas incidental to the operation of the facility. The upper three floors of the L-shaped building contained patient rooms positioned on both sides of a center exit access corridor. The longest portion of the building contained a 160-foot corridor, running east/west, that included smoke barrier doors at approximately its mid-point. There are exit stairways located at each end of this corridor and one stairway located at the end of the approximate 100-foot north/south corridor. The nurses' station was positioned at the intersection of the corridors as were the building's two elevators.

The construction of the fire resistive facility includes exterior load-bearing masonry walls having a three-hour fire resistance rating and floor/ceiling

assemblies, consisting of light-weight concrete on a metal deck supported by steel bar joists with suspended noncombustible ceiling tiles. The floor-ceiling was designed in accordance with UL 72-2 (G211) which list the assembly as having a two-hour fire resistance rating. Exit access corridor partitions, consisting of gypsum material on metal studs, were constructed to meet a one-hour fire resistance rating design. The corridor walls were tight to the floor deck above and had an insignificant number of unprotected penetrations. Interior partitions between patient rooms were also of gypsum material on metal studs and terminated at the finished ceiling level. Exit stairs were enclosed with masonry materials having a two-hour fire-resistive rating. Openings to the stair enclosures at each floor level were protected with 1 1/2-hour fire protection rated self-closing fire doors. Interior wall finish of patient rooms and exit access corridors consisted mostly of vinyl wall covering material. The construction classification most closely resembles Type II (222), according to NFPA 220, types of building construction, 1985[1], and Type 1-B BOCA National Building Code - 1987.

Patient room doors appear to meet a 20-minute fire protection rating. The 44-inch doors were 1 3/4-inch thick, solid wood material and were not equipped with self-closing devices. The latching mechanism for the doors was a "roller-type" latch. In the closed position the roller latch creates a resistance force that keeps the door closed but allows easy opening from an external force such as a "push". Examination of most of the doors in the nursing home after the fire revealed that the resistance force of the latch did not seem to be consistent. Further, it was determined that in order to completely close the door, it was necessary to momentarily hold the door in the closed position for the latching mechanism to be effective.

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1 The NFPA system for building type classification lists the minimal fire-resistance rating for the exterior bearing walls (first digit), for the structural frame (second digit), or for the floor assemblies (third digit), and those ratings are included in the numbers appearing in the brackets. A Type V (000) structure has no fire rating for at least one of those categories.

Each floor of the building was divided into two separate smoke zones utilizing an interior partition and smoke barrier doors (see diagram). The smoke barrier doors, positioned in the exit access corridor, were held in the open position by magnetic hold-open devices; a component of the fire alarm system (see later description). Although a fire resistive barrier was provided above the smoke barrier doors to fill the void to the floor deck above, the partition did not extend above the suspended ceiling in adjacent patient rooms.

The building was equipped with a fire alarm system which was connected to a central station service. On each floor, components of the system included manual pull stations and alarm bells located at each exit stairway and a ceiling-mounted smoke detector located on each side of the smoke barrier doors. Activation of the system would result in the closing of all smoke barrier doors, sounding of an internal, audible alarm, and would provide automatic notification to the fire department through the central station service. The building was not provided with automatic sprinkler protection.

In addition to these features, the building was provided with a standpipe system having a 4-inch riser in each stairway. The standpipe system was supplied from the municipal water supply system and could be supplemented through the fire department connection located on the east side of the building. At each stairway landing, a 2 1/2-inch fire department hose connection was provided. Also part of the standpipe system were hose stations, having 1 1/2-inch hose with straight tip nozzle. The hose station enclosures were located in the exit access corridors near stairway entrances. The enclosure also included a multi-purpose portable fire extinguisher. Emergency illumination was provided for corridor areas and for marking stairway entrances. Emergency illumination and the fire alarm system were connected to an on-site emergency generator.

Each patient room, consisting of a patient area and bathroom, was approximately 350 square feet. Patient rooms typically contained two beds, nightstands, chairs and a wardrobe area. In addition to these materials, a

number of the beds within the facility were provided with polyurethane decubitus pads which were placed on patient mattresses when ordered by the attending physician. The distance from the floor to the finished ceiling of patient rooms was 8 1/2-ft. Further, each room had an approximate 8 by 6 ft. window in its exterior wall.

Patient rooms were provided with individual HVAC units that were vented to the exterior for make-up and exhaust air exchange. Conditioned air for the exit access corridor was provided from roof mounted HVAC units. At locations where the vertical supply ducts penetrated the two-hour floor/ceiling assemblies, heat activated fire dampers were provided.

Emergency Planning

The Norfolk Fire Department is actively involved in emergency fire training with the staff and in developing a disaster/evacuation plan for the facility. The Hillhaven staff fire training included emergency fire response procedures as well as training in the use of portable fire extinguishers. The staff training emphasized RACE, Rescue, Alarm, Contain, and Extinguish, an easy reminder to help guide them in their emergency procedures. The facility also held monthly fire drills, which were conducted at various hours throughout the day, simulating actual fire occurrences.

BEFORE THE INCIDENT

The Convalescent and Rehabilitation Center was occupied by **161** patients at about 10:00 p.m. on Thursday, October 5, 1989. Most of the patients, on all floors, were in bed except for a few who were in day rooms. There were 21 staff members present in the building at the time of the fire; seven were located on the second floor, the floor of the fire origin. Also on that floor were a total of 54 patients; 23 were in the smoke zone containing the room of fire origin.

The house supervisor, a registered nurse (R.N.), had been writing in her log and went back to the Nurses' Station on the second floor a few minutes after 10:00 p.m. Another R.N. and other licensed practical nurses (L.P.N.) and certified nursing assistants (C.N.A.) were on all patient floors either making rounds, in patient rooms and day rooms with patients, or at Nurses' Stations. The assistant administrator for the nursing home was photocopying a time schedule on the first floor.

THE INCIDENT

Sometime after 10:00 p.m. a nursing assistant was making her rounds on the second floor and smelled smoke as she was coming out of a utility room. She first checked Room 224 and then went to Room 226 where she discovered a fire located on the patient's bed that was positioned closest to the window. The fire was at the foot of the bed and extending approximately 1-3 feet above it. To alert others, she hollered in the direction of the Nurse's Station, "Fire in 226".

The nursing assistant then moved into the room to begin evacuation of one of the patients who was seated in a chair adjacent to the burning bed. She aided the occupant in walking from the room to the exit access corridor where other staff assisted him to a patient room on the north/south corridor. The nursing assistant then returned to the room of origin and began removed the bed containing the second patient. She was assisted by other staff members and the patient was also relocated into a patient room on the north/south corridor. During the evacuation of the room of origin and throughout the incident, the door to the room of origin remained in the open position.

The nursing assistant then began to close other patient room doors along the east/west corridor. During the process of closing doors, she reported that she had to get below the smoke which was accumulating in the corridor.

After hearing the initial report of the fire, an L.P.N. at the second floor Nurses' Station dialed 911 and reported the fire and the location of the nursing home to the emergency center. At the same time, the R.N. also at the second floor Nurses' Station heard a staff member in the east/west corridor yell something. She could not hear what was said, but from the look on her face she knew there was an emergency. The R.N. then observed very thick black smoke coming from Room 226 and began assisting the ambulatory patient from the room of origin (standing in the corridor) to a patient room on the north/south corridor.

Also, during these initial moments, one of the nursing staff paged a building maintenance worker to report to the second floor STAT (a signal indicating a need for immediate response). The page was then repeated. Also during these initial moments staff members closed patient room doors (on both wings). Further, two staff members reportedly attempted to extinguish the fire using a portable fire extinguisher but were unsuccessful.

Several staff members indicated that during their emergency procedures they activated a manual pull station, but the fire alarm system provided no audible response.

The nursing staff moved the two patients in Room 226, who were in immediate danger, to rooms located off the north/south corridor. During this process, the magnitude of the fire eventually drove them from the corridor. Some were forced from the floor while others took refuge in patient rooms. The nursing assistant who had first discovered the fire, for example, ended up in the north/south corridor in Room 210 with two female patients. She opened the window to the room to alert fire fighters and put towels at the base of the door to prevent smoke seepage. She and the patients were eventually removed from the room by fire fighters.

Emergency procedures on the third and fourth floors were similar to those taken on the fire floor once the staff on those floors learned of the fire. The R.N. from the second floor, after her initial actions, recalled that a patient on the third floor was on oxygen. As a result, she went to the third floor to alert the staff of the fire. The staff on upper floors also learned of the fire as word spread among the staff, or as they began to smell smoke. Most of the staff on the upper floors were first alerted to something unusual when they heard the page for the maintenance worker, "STAT". One nursing assistant on the third floor above the room of origin saw flames outside a patient room window.

During their emergency procedures on the upper floors, which mostly consisted of closing patient room doors, the staff reported smoke coming

from around the elevators and through HVAC ducts at the end of the east/west corridor.

Before fire department arrival there were reports of several civilians entering the east stairway in an attempt to assist in the fire. Best indications are that they did not make entry onto the fire floor but may have allowed some smoke migration into the stairway by opening the stairway door. There were no confirmed reports that civilians assisted in the evacuation of patients.

The Norfolk fire department received the alarm for a fire at the nursing home at 10:18 p.m. and dispatched Engines 6 and 7 to the scene. Upon their approach and arrival at 10:22 p.m., the crew from Engine 6 saw the fire venting from a second floor window and advised Engine 7 to "lay a line coming in". The flames were estimated to be 8 to 10 feet in height and were lapping to the floor above. Fire fighters feared that the fire might extend to the floor above.

Fire fighters, from Engine 6, wearing full protective gear, entered the east stairway with a standpipe hose pack and proceeded on to the second floor. They attached their hose to the standpipe and advanced down the east/west corridor. They did not see any flames; however, they did report poor visibility and deteriorating conditions as they approached the smoke barrier doors and the room of fire origin. The crew from Engine 6 reported that the smoke barrier doors were closed as they approached them.* Meanwhile, a ground ladder was raised to the second floor room of origin and a 1 3/4-inch hoseline was used to "knock down" the majority of the fire.

The fire fighters who were advancing the line down the corridor were, momentarily, halted by heat and products of combustion forced into the corridor by the exterior fire attack. Fire fighters estimated that the fire was completely extinguished within 20 minutes of their arrival.

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* Physical evidence indicates that they were open during most of the fire. The magnetic devices for the doors appear to have separated (resulting in their closing) at some time during the fire, explaining the apparent inconsistency.

Once the fire was extinguished, fire fighters were confronted with severe smoke conditions throughout the second floor including smoke in patient rooms. With only the illumination from their flashlights, they discovered that many of the patients were in their rooms, and fire fighters immediately began to evacuate them through corridors to stairways to the exterior of the building. Many patients in immediate danger were restrained or attached to life sustaining systems. As a result, evacuation was time-consuming and it usually required several fire fighters to complete a rescue. The bedridden patients, from the second floor, were carried by fire fighters through heavy smoke and heat conditions to the exterior. Realizing this labor intensive task, additional assistance was requested. After calling a second and third alarm, arriving fire fighters assisted the staff (now also assisting in the evacuation) and fire fighters in further evacuation and relocation of patients.

Additional arriving fire fighters equipped with full protective gear first assisted the ongoing evacuation of patients from the second floor fire area, where conditions were more severe. Moderate smoke conditions were reported on other floors and evacuation of those patients was also begun. Because the fire incident commander realized the labor intensive process of evacuation, fire fighters then began to hold patients in less severe smoke conditions in their rooms with the doors closed and windows open until conditions improved.

In addition to these actions, some patients were removed from their rooms by fire fighters utilizing ground ladders. As conditions stabilized, all patients were eventually evacuated from the nursing home. All patients were first brought to a triage area for assessment by EMT personnel emergency treatment, and transportation to other medical facilities. Rescue efforts on the second floor took an estimated 35 minutes.

During the latter part of the evacuation, the fire department's high volume air movement fan was placed at the main entrance door and activated. The equipment operates by slightly pressurizing the interior and thus forcing smoke through ventilation openings to the exterior. The effectiveness of its operation is being evaluated by the Norfolk Fire Department.

CASUALTIES AND DAMAGE

Nine patients on the second floor died during the fire; eight of them were within the smoke zone of fire origin. Most of these fatalities occurred in rooms where the room door was found partially open. The first patient removed from the room of fire origin died in the north/west exit access corridor, despite having been relocated earlier to within a patient room. Following the fire, three additional patients died. Two of those fatalities were from the second floor. One was from the third floor; this patient's condition before the fire was reported to have been critical. Reportedly, all fatalities were due to smoke inhalation or to complications as a result of the fire.

The intense fire completely consumed the contents of the room of fire origin and resulted in structural damage to several of the bar joists above the area of origin. Further, the fire extended from the room of origin into the exit access corridor consuming the wall covering; approximately 30 feet in both directions from the room of origin. There was no fire extension beyond these areas and only minor heat damage to some patient rooms. However, smoke from the fire spread throughout the second floor including through patient room door openings where the door was found not to be in the fully closed position. In addition, smoke spread to the floors above by way of elevator shafts and through HVAC ducts that penetrated the floor/ceiling assembly. Severe smoke conditions existed throughout the second floor and moderate smoke was reported on the upper two floors of the facility.

ANALYSIS

Norfolk fire officials have listed the probable cause of the fire as careless disposal of smoking materials. Investigators believe that the occupant of the room of origin, seated in a chair next to the window, attempted to discard a lighted match. The match apparently came in contact with the bedding material on his bed, and soon involved the polyurethane decubitus pad. It is believed that it was at this point that the fire was discovered by the nursing staff. At discovery, the fire was described as producing 1 to 3-ft. flame height from on top of the bed and producing thick black smoke; typical of burning polyurethane. The first detection of the fire was by human means. At detection, fire products had not migrated from the room of origin to make its location obvious. At first awareness therefore, its likely that an in-room smoke detector could have alerted the staff sooner as to its presence and location even though a corridor detector was within 10 feet.

Since the flames were extending from the bed, only a short distance existed, (2 to 3 feet), between the top of the flame to the ceiling. When in the growth of a fire it reaches this point, the rate of the fire growth changes significantly. It is at this point that energy (heat) begins to significantly radiate back to the fire and begins to pre-heat other combustibles. Based on staff descriptions, this was the stage of fire growth observed during the evacuation of the room of origin.

From its magnitude just after detection, the fire likely involved at least the decubitus pad and began to involve the mattress and other combustibles adjacent to the bed. With the involvement of these materials, the room became increasingly more untenable and eventually reached flashover conditions. Once flashover conditions are reached it threatens those in its immediate area and presents severe fire suppression challenges. Investigators estimate that flashover occurred within three to four minutes of discovery of the fire in the room of origin and before fire department arrival. Research data on fire growth rates involving fuels, such as those contained in the room of origin and in similar geometric arrangements, align with the investigator's estimated time interval to flashover. There

apparently is no research data that quantifies the burning rate of the decubitus pad and the mattress in a combination involving various ignition scenarios (e.g. smoldering, open flame, etc.). Some researchers speculate that the decubitus pad may have led to the horizontal spread of the fire across the top of the pad exposing a larger portion of the mattress than with other scenarios (one of the nursing staff described the fire on the bed as having a S-foot base area). Further, because when burning this material can flow, flames may also have been impinging on the mattress from several sides because of this phenomena. Eyewitnesses corroborate this by their reporting flames "on the floor" adjacent to the bed. Another possible scenario is that bedding materials may have fallen onto the floor but whatever scenario occurred, individually or in combination, the result would have been in more rapid growth. This likely resulted in involvement of the mattress and in flashover being reached in a more narrow time interval than would be expected because of the increased area and direction of exposure. A recent report of such scenarios indicate that the most significant material affecting fire growth is open flame impingement on the mattress.*

One flashover occurred, the fire extended through the open patient room door and into the exit access corridor and extended through the exterior window (although window breakage could have occurred slightly before flashover). Combustion products moved in the corridor in both directions from the room of origin, where fire barriers were not provided or were voided. These products moved beyond the initial fire compartment areas, in this case into patient rooms on the wing of origin and to the adjacent north/south corridor. Many patient rooms on the wing of fire origin showed physical evidence of their doors being open during the fire. Smoke barrier doors were also determined to have been open. During post-fire interviews the staff indicated that they had closed patient room doors. One possible explanation of this apparent inconsistency is that in their haste to complete their emergency procedures they may not have momentarily held

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* See NIST report "Engineering Analysis of Fire Development in the Hillhaven Nursing Home, October 5, 1989."

the door in its closed position, resulting in the door "bouncing" to a partially open position. Another possible explanation is that patient room doors were forced open by the pressures generated by the fire or in the suppression of the fire.

The fire ultimately consumed the entire contents of the room of origin and extended through its open door into the corridor for approximately 30-feet in both directions from the room of origin. However, smoke spread was throughout the second floor and to a lesser extent on floors above. The second floor corridor smoke barrier doors were open during much of the fire incident, coming closed during fire extension through the corridor. Until then, however, smoke spread beyond the smoke zone of fire origin and to upper floors by way of the elevator shaft and HVAC ducts located in the corridor.

Fire department response and extinguishment was prompt but fire fighters believed that severe smoke conditions still threatened the lives of patients, especially on the floor of fire origin. Based on the conditions found, fire fighters decided to evacuate the entire building in order to lower the threat to life. This proved to be a labor-intensive and time-consuming task that was eventually supplemented by holding patients in their rooms and by activating the smoke removal apparatus.

Once the nursing staff became aware of the fire they immediately searched for the source of smoke on the second floor. It appears that their actions resulted in prompt evacuation of the room of origin and in notification of the fire department. However, after the evacuation of the room of fire origin, the door was left in the open position. Although the staff did activate the fire alarm system, it did not function. The lack of an audible fire alarm may have momentarily confused the staff during these first moments. Staff attempts at extinguishing the fire were futile since the fire had grown beyond that capable of being controlled by a portable fire extinguisher. The effectiveness of the staff at closing patient rooms doors was negated in part

by the lack of positive latching and by the rapid growth and spread of the fire.

The room of fire origin did not contain fire detection or suppression equipment that might have alerted the staff sooner to the developing fire. As a result, the staff was alerted by their senses, had to search for its origin, and found a severe fire. The fire was discovered in the flaming stage having 1-to-3-foot flame heights. Fire of this magnitude posed an immediate threat to the occupants of the room and only a short interval of time exists for intervention. The staff effectively utilized this time interval by rescuing both occupants of the room but failed to close the door to the room of origin and the fire extended into the corridor.

It is likely that had an in-room smoke detector or a fast response sprinkler been provided in the room of fire origin, the detection of the fire would have occurred sooner. If provided, this would have allowed more time for the staff to complete their emergency procedures or for the initiation of fire safety measures. Detection may have occurred while the fire was in a controllable state for extinguishment by either a portable fire extinguisher or by the sprinkler itself. Although the effect of the fire alarm system not operating likely did not delay fire department notification (since discovery was before significant smoke build-up in the corridor), failure of the system to operate was significant since it did not notify others immediately of the fire and failed to close smoke barrier doors and notify the fire department. Based on their investigation, Norfolk fire officials determined that there may have been a time delay that delayed fire department notification.

Like many other nursing homes the Hillhaven Rehabilitation and Convalescent Center is designed (among other protection philosophies) to withstand a hostile fire by having most of its occupants stay within fire-rated compartments. This component of the design philosophy is commonly referred to as "defend in place". Key concepts of the effectiveness of such a design is awareness by both the nursing staff and fire fighters of their actions during fire emergencies. To this extent fire plans are developed (or are as in this case required) through the coordinated efforts of the staff and fire department. The plan usually places significant

emphasis in emergency staff training on confining the fire and protecting affected patients by closing doors. Fire department command officers can effectively utilize such a design during an actual fire emergency to place priorities of persons or of floors to evacuate. Because the fire products were not contained to the intended fire compartment area, this design concept was violated early in this developing fire. Unfortunately, this is a common occurrence in multiple-death health care fires. However, fire incident command officers can still effectively utilize the design and optimize the limited resources (usually manpower) by only evacuating occupants in extreme danger such as those on the first floor. Others that are within compartmented areas should be relatively safe until conditions stabilize. Aware of this, this should be integrated into emergency plans and practiced by state and fire command officers.

Investigators from the Norfolk Fire Department have concluded that the fire alarm system for the building was inoperative (due to a "blown electrical fuse"). As earlier mentioned, this likely did not significantly delay fire department notification; however, it failed to notify staff on other floors of the facility so that they could begin their emergency procedures. Further, smoke barrier doors on the floor of origin did not close, allowing smoke to spread throughout the floor of origin and subsequently to the floors above due to peculiarities of the HVAC system. This means of smoke spread to the upper floors diminished once the heat activated fire dampers activated. However, by this time significant amounts of smoke were present on the upper floors requiring the evacuation of these floors as well.

The fire scenario exemplified by the Norfolk nursing home incident is very similar to the scenarios in other health care facility fatal fires investigated by NFPA. In the hospice fire of Southfield, Michigan (December 1985), and the Kansas City, Missouri hospital fire (December 1986), the contents and furnishings provided enough fuel to result in full room involvement or flashover in four to five minutes. Such rapid fire development also occurred in the Norfolk fire. If flashover occurs in these first critical minutes, the health care facility staff most likely will not have sufficient time to complete emergency procedures to ensure life safety.

Properly designed and operational automatic sprinklers can prevent flashover and greatly-reduce the potential for fire deaths beyond the room of origin. NFPA has no record of a multiple-death fire (killing three or more people) in a completely sprinklered public assembly, educational, institutional, or residential building where the sprinkler system was operating properly. Following this latest tragic multiple-death fire, the Hillhaven nursing home has been sprinklered.

LIFE SAFETY CODE ANALYSIS

The analysis in this section is based on the application of the 1988 edition of NFPA 101, Life Safety Code (Code). Except as noted, this analysis does not include an analysis of the Hillhaven Rehabilitation and Convalescent Home fire in terms of other codes that may have been applicable.

The 1988 edition of the Life Safety Code was used for this analysis so that the conditions at Hillhaven on the date of the fire could be compared to the latest edition of the Code. It is recognized that the 1988 edition of the Life Safety Code was not in effect in Norfolk, Virginia, during construction or operation of the Hillhaven home.

The Life Safety Code deals with life safety from fire and similar emergencies. It addresses those construction, protection, and occupancy features necessary to minimize danger to life from fire, smoke, and fumes. The Code identifies the minimum criteria for the design of egress facilities so at to permit prompt escape of occupants from buildings (especially for health care occupancies which are characterized by occupants who are mostly incapable of self-preservation) into safe areas within the building. The Code recognizes that life safety is more than a matter of egress and, accordingly, deals with other considerations that are essential to life safety. The Code does not attempt to address those general fire prevention or building construction features that are normally a function of fire prevention and building codes.

The Life Safety Code applies to both new construction and existing buildings. In various chapters there are specific provisions for existing buildings that may differ from those for new construction. For this analysis the following portions of the Code were used:

- Chapter 13, Existing Health Care Occupancies
- Chapter 31, Operating Features (particularly Section 31-4), Health Care Occupancies)
- Associated base or fundamental Chapters 1 through 7

Health care occupancies, like the Hillhaven Home, provide sleeping accommodations for the occupants and are occupied by persons who are mostly incapable of self-preservation because of physical or mental disability, age, or because of security measures not under the occupants' control. The Life Safety Code requires that all health care facilities be designed, constructed, maintained, and operated so as to minimize the possibility of a fire emergency requiring the evacuation of occupants. Because the safety of health care occupants cannot be assured adequately by dependence on evacuation of the building, their protection from fire is provided using a protect-in-place or defend-in-place strategy. The Code calls the strategy the total concept. The system is directed toward:

1) Prevention of ignition,
2) Detection of fire and notification,
3) Control of fire development,
4) Confinement of effects of fire,
5) Extinguishment of fire, and
6) Provision of refuge and evacuation facilities

1) Prevention of Ignition

Precautions to prevent ignition are intended to be taken on a continuing basis, as opposed to something which is done once when the building is constructed. Thus, Code provisions aimed at preventing ignition are contained in Chapter 31, Operating Features. From among those provisions, the following seem particularly applicable to the fire at the Hillhaven Home:

31-4.4(b) Smoking by patients classified as not responsible shall be prohibited.

Exception to (b): When the patient is under direct supervision.

31-1.4.2 Furnishings or decorations of an explosive or highly flammable character shall not be used.

3 l-4.5.5 Newly introduced upholstered furniture within health care occupancies shall be shown to resist

ignition by cigarettes as determined by tests conducted in accordance with **NFPA 260B**, Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes, and shall have a char length not exceeding 1.5 in.
Exception: Health Care Occupancies protected throughout with an approved automatic sprinkler system in accordance with Section 7-7.

Smoking was regulated at the Hillhaven Home and limited to the lounge *or* **dayroom** located on each patient room floor. Apparently the nursing staff had removed smoking materials from one of the occupants of Room 226. Cause of the fire was determined to have involved smoking materials. The foamed plastic decubitus pads, like the one which quickly spread the incipient-stage fire across the mattress and bed, were described by the **staff** as being of the flammable character. The decubitus pads were allowed on patient beds only when specifically prescribed by the patient's attending physician. Particular expertise in use of the Code could be expected to be required before staff would have equated the decubitus pad with the requirements applicable to upholstered furniture as described above in **31-4.5.5.** Also see results of fire tests conducted by NIST.

2) Detection of Fire and Notification

Smoke detectors, although required by the Life Safety Code in corridors of new nursing homes, would not be required in an existing nursing home. Rather, staff members are expected to provide the detection function and with required proper training sound an alarm and respond to patient needs. These concepts are described in 31-4.2 as follows:

31-4.2.1 For health care occupancies, the proper protection of patients requires the prompt and effective actions of health care personnel. The basic actions required of staff shall include the removal of all patients directly involved with the fire emergency, transmission of an appropriate fire alarm

signal **to** warn other building occupants, 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 Firesafety Plan. See Appendix A of the Code for a more detailed suggested emergency plan.

31-4.2.3 All facility personnel shall be instructed in the use of, and response to, fire alarms; and, in addition, they shall be instructed in the use of the code phrase to ensure transmission of an alarm under the following conditions:

(a) When the discoverer of a fire must immediately go to the aid of an endangered person.

(b) During a malfunction of the building fire alarm system. Personnel hearing the code announced shall first activate the building fire alarm using the nearest manual pull station and shall then immediately execute their duties as outlined in the firesafety plan.

A fire alarm system with appropriate initiation and notification features is required by the Code as follows:

13-3.4.1 **General.** Health care occupancies shah be provided with a fire alarm system in accordance with Section 7-6.

13-3.4.2 Initiation. Initiation of the required fire alarm system shall be by manual means in accordance with 7-6.2 and by means of any detection devices or detection systems required. ***Exception No. 1: Fire alarm pull stations in patient sleeping areas may be omitted at exits if located at all nurses' control stations or other continuously attended staff location, provided such pull stations are visible and continuously accessible and that travel distances in 7-6.2.4 are not exceeded.***

13-3.4.3 Notification.

13-3.4.3.1 **Occupant** Notification. Occupant notification shall be accomplished automatically, without delay, upon operation of any fire alarm activating device by means of an internal audible alarm in accordance with 7-6.3. **Presignal systems** are prohibited.

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

In addition to requiring that the alarm system be present, the Code requires that it be maintained as follows:

31-1.3.2 Every required automatic sprinkler system, fire detection and alarm system, smoke control system, exit lighting, fire door, and other item of equipment required by this Code shall be continuously in proper operating condition.

31-1.8 **Maintenance.** Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance with the provisions of this ***Code,*** such device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be permanently maintained unless the ***Code*** exempts such maintenance.

The Hillhaven Home was provided with an automatic fire alarm system with appropriate pull stations for initiating the building alarm. Upon initiation, the building fire alarm system was arranged to notify staff throughout the building via an audible alarm signal. Fire department notification was to occur automatically via a central station connection. Because the building fire alarm system was inoperative, there was a delay in notifying staff on floors other than the floor of fire origin. Similarly, automatic fire department

notification did not occur and the fire department was notified by telephone. On the floor of fire origin, staff communicated among themselves in the appropriate manner intended by the Code.

3) Control of Fire Development

In order to control the initial spread of fire, the Life Safety Code regulates interior wall and ceiling finish materials and furnishings, such as window draperies and patient privacy curtains, as follows:

13-3.3 Interior finish on walls and ceilings throughout shall be Class A or Class B, in accordance with Section 6-5.
Exception: In buildings protected throughout by an approved supervised automatic sprinkler system, Class C interior finish may be continued in use on all walls and ceilings within rooms separated from the exit access corridors in accordance with 13-3.6.

31-4.5.1 Draperies, curtains, including cubicle curtains, and other similar furnishings and decorations in health care occupancies shall be in accordance with the provisions of 31-1.4.

31-1.4.1 Draperies, curtains and other similar furnishings and decorations shall be flame resistant where required by the applicable provisions of this chapter. These materials required herein to be tested in accordance with NFPA 701, ***Standard Methods of Fire Tests for Flame-Resistant Textiles and Films,*** shall comply with both the small-and-large-scale tests.

The interior wall and ceiling finish materials, draperies, and privacy curtains at the Hillhaven Home are believed to have been Code-complying and did not significantly affect the initial spread of the fire. Although a sprinkler system would have avoided room flashover and thus controlled fire development, no sprinkler system was required for this facility by the Code. Although a maximum rate of heat release requirement on the foamed plastic decubitus pad, however, could also have helped to avoid room flashover and thus control fire development, no such requirement appears in the Code.

Further, based on recent test reports such intervention may better be directed to limiting the heat release rate resulting from open flame scenarios on mattresses.

4) Confinement of Effects of Fire

To help confine the effects of the fire to the room of fire origin, the Code requires corridor walls, corridor doors with a means for suitably keeping the door closed, and proper staff reaction as follows:

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.

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) solid bonded core wood or of construction that will resist fire for at least 20 minutes.

13-3.6.3 Doors shall be provided with means suitable for keeping the door closed and acceptable to the authority having jurisdiction.

13-3.6.3.4 Door-closing devices are not required on doors in corridor wall openings other than those serving required enclosures of vertical openings, exits, or hazardous areas.

3 l-4.2.1 For health care occupancies.... .The basic actions required of staff shall include....confinement of the effects of the fire by closing doors to isolate the fire area.....

The corridor walls were judged to be Code-complying. The doors, although of solid core, were provided with roller latches. Those latches required special attention such that the door needed to be held in its closed position for a second or two before being released

or the door would bounce open. These latches did not provide **sufficient** force to keep the door closed under the pressures generated by the fire or in the suppression effort

Although the staff attempted to close all patient room doors, the door to the room of fire origin remained open. The Code attempts to prevent the effects of the fire from moving vertically through the building as follows:

13-3.1.1 Any stairway, ramp, elevator hoistway, light or ventilation shaft, chute, and other vertical opening between stories shall be enclosed in accordance with Section 6-2.4 with construction having a 1-hour fire resistance rating.

13-5.2.1 Heating, ventilating, and air conditioning shall comply with the provisions of Section 7-2 and shall be installed in accordance with the manufacturer's specifications.

7-2.1 Air conditioning, heating, ventilating ductwork, and related equipment shall be installed in accordance with NFPA 90A, ***Standard for the Installation of Air Conditioning and Ventilating Systems,*** or NFPA 90B, ***Standard for the Installation of Warm Air Heating and Air Conditioning Systems,*** as applicable.
Exception: Existing installations may be continued in service, subject to approval by the authority having jurisdiction.

Vertical openings, including stair enclosures, elevator shafts, plumbing and utility chases, and heating, ventilating and air conditioning openings were substantially in compliance with Code requirements. The mandatorily referenced NFPA 90A, ***Standard for the Installation of Air Conditioning and Ventilating Systems,*** would have required that conditioned air for the exit access corridor, which was provided by roof-mounted HVAC units, be conveyed to the patient floors by a properly fire resistance rated shaft enclosure as opposed to a vertical supply duct with fire dampers at floor penetrations. The exception to 7-2.1, as noted above, permitted the

authority having jurisdiction to allow the continued use of the existing HVAC vertical supply duct installation. Elevator doors had the appropriate fire protection ratings but did not provide an effective barrier to the passage of smoke from one floor to another.

5) Extinguishment of Fire

For various occupancies, the Code relies on combinations of the following for effective extinguishment of fire:

- Automatic sprinkler systems,
- Portable fire extinguishers,
- Standpipes, and
- Fire department extinguishing actions.

For a nursing home of the type of construction described earlier in this report, the Code did not require automatic sprinkler protection. See 13-1.6.2 and 13-3.5. Although portable fire extinguishers are required by Code paragraph 13-3.5.5, and were provided, the fire developed too rapidly to allow for it to be controlled by nursing staff in its incipient stage.

The fire department response and associated extinguishment actions eventually extinguished the fire. However, a severe life-threatening fire existed and it appeared to be extending vertically to the floor above upon their arrival. To reduce this threat an exterior fire attack was undertaken.

6) Provision of Refuge and Evacuation Facilities

Requirements of the Life Safety Code for health care occupancies are aimed at providing safe refuge areas on patient floors where occupants should be expected to be able to wait out the effects of the fire burning on the other side of a fire resistance rated smoke barrier. Minimum building construction requirements are then expected to help to assure structural integrity of the building for the time necessary to extinguish the fire or evacuate the refuge areas.

The three-story Hillhaven Home was of NFPA 220 Construction Type II (222) as allowed by the Code.

Smoke barriers, to divide a patient floor into a minimum of two smoke compartments, are required by the Code as follows:

133.7 Subdivision of Building **Spaces**
13-3.7.1 Smoke barriers shall be provided, regardless of building construction type, to divide every story used for sleeping rooms for more than 30 patients into at **least** two smoke compartments. The maximum area of any such smoke compartment shall not exceed 22,500 sq ft (2,100 sq m), of which both length and width shall be no more than 150 ft (45 m).

13-3.7.3 Any required smoke barrier shall be constructed in accordance with Section 6-3 and shall have a fire resistance rating of at least 1/2 hour.

13-3.7.5 Openings in smoke barriers shall be protected by wired glass panels in steel frames, by doors of **20-minute** fire protection rating, or by **1 3/4-in (4.4-cm)** solid bonded wood core doors as a minimum.

13-3.7.6 Doors in smoke barriers shall comply-with Section 6-3 and shall be self-closing. Such doors in smoke barriers shall not be required to swing with exit travel. Positive latching hardware is not required.
Exception: Doors may be held open only if they meet the requirements of 13-2.2.2.6.

13-2.2.2.6 Any door in an exit passageway, stairway enclosure, horizontal exit, smoke barrier or hazardous area enclosure may be held open only by an automatic release device that complies with 5-2.1.8. The automatic sprinkler system, if provided, the required fire alarm system, and the systems required by 5-2.1.8(c) shall be arranged so as to initiate the closing action of all such doors by zone or throughout the entire facility.

The required subdivision of building space via smoke barrier construction was accomplished substantially in accordance with Code requirements. The cross-corridor smoke barrier doors were held open by automatic hold-open devices as allowed by the exception to **13-3.7.6** and the requirements of **13-2.2.2.6.**

Because the fire alarm system failed to operate, it did not release the door hold-open devices, and the smoke detector associated with that function did not release the doors so they would become self-closing. The refuge area, i.e., the north/south corridor, thus was not separated from the fire/smoke compartment and conditions quickly became untenable.

Summary of Life Safety Code Analysis

Overall, the Hillhaven facility, its staff training and staff preparedness were substantially in Code compliance. However, the door to the room of origin should have been shut; patient room door latching mechanisms should have kept the doors closed; the building alarm system should have functioned; the smoke barrier doors should have closed earlier.

The following are significant factors in this fatal fire incident:

1) The rapid growth and development of the fire within the patient room;
2) The absence of automatic sprinklers that could have prevented full room involvement or flashover;
3) The lack of compartment&ion due to the open door to the room of fire origin;
4) The lack of automatic detection and failure of the fire alarm system to function properly.

References:

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NFPA Fire Investigation Report, "Hospital Fire, Kansas City, MO, December **30, 1986."**

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Norfolk Nursing Home
Second Floor Plan