FIRE INVESTIGATION REPORT

FISHING VESSEL FIRE
Seward, Alaska
May 27, 1995

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ABSTRACT

On Saturday, May 27, 1995, a fire occurred aboard the Alaska Spirit, a fish processing vessel, that moored alongside a Seward Marine Industrial Park dock in Seward, Alaska. The National Transportation Safety Board investigators determined that the fire had been ignited by an electric cooking pot that was left on in one of the ship officer’s quarters. The fire in the accommodations area spread to the deck above and gutted the area called the wheel house. The fire also spread to the deck below and caused minor damage on that deck. The ship’s captain died in this fire. He was on the deck of fire origin and was unable to escape. Combustible interior finish and rigid foam insulation contributed to the severity of the fire. The damage has been estimated at $3 million.

At the time of this fire, NFPA did not have any documents addressing safety to life from fires aboard vessels. NFPA 101®, Life Safety Code®, however, does address safety to life from fires in buildings and structures. The Life Safety Code contains several requirements that could have altered the outcome of this fire had they been applied to the shipboard environment. NFPA and the United States Coast Guard are currently involved in a joint project to produce a document intended to ensure safety to life from fires aboard vessels. The new document, NFPA 301, will be modeled after NFPA 101, Life Safety Code.

Another NFPA document, NFPA 1405, Guide for Land-Based Fire Fighters Who Respond to Marine Vessel Fires, contains information relevant to this incident. NFPA 1405 provides many guidelines for fire departments who are responsible for shipboard fire fighting. Issues such as incident command, the roles of both ship crew members and land-based fire fighters, and fire tactics and strategies are addressed in this document. Members of the Seward Volunteer Fire Department were faced with all of these issues during this incident.
The National Transportation Safety Board (NTSB) contacted the National Fire Protection Association (NFPA) regarding the fire aboard Alaska Spirit and requested the NFPA’s assistance during their investigation of that fire. NFPA has an ongoing investigation program and agreed to participate as a technical advisor to the NTSB investigation. Michael S. Isner, Senior Fire Investigator in the NFPA Fire Investigations Department, traveled to Seward, Alaska to assist in the NTSB’s onsite study of this incident. That three-day, on-site study documentation and subsequent analysis of the event were the basis for this report.

All information and details regarding this fire and conditions aboard the vessel were based on the best available data, on observations made during the on-site data collection phase, and on any additional information provided during the report development process. It was not the NFPA’s intention that its investigation and resulting report pass judgment on, or fix liability for, the loss of life or property resulting from this fire. Rather, the purpose of the NFPA’s activities was to provide the NTSB with technical assistance, to document the significant factors that resulted in the loss of life and property, and to report the lessons learned in order that the fire service and other concerned parties may reduce the potential for similar life and property losses.

Current NFPA codes and standards were used as criteria for this analysis so that conditions aboard the Alaska Spirit on the day of the fire could be compared with state-of-the-art fire protection practices. It is recognized, however, that these codes and standards were not in effect during construction or operation of that vessel.

The NFPA wishes to express its gratitude to the National Transportation Safety Board for the opportunity to participate in their investigation of the fire aboard the Alaska Spirit. The NFPA also wishes to acknowledge the cooperation and assistance of the Alaska State Fire Marshal’s Office, the Seward Volunteer Fire Department, and the United States Coast Guard.
BACKGROUND

The Ship

The Alaska Spirit was a factory trawler vessel of United States registry (see Photo 1). Originally, the ship was an off-shore oil-platform supply vessel. It was sent to Japan in 1990 where it was refitted for use as a fishing and processing vessel. As a result, much of the equipment aboard the vessel, such as components of the fire detection system, was of Japanese design and manufacture.

The 1418-gross ton* steel vessel was 202 feet (61.57 m) long and 37.9 feet (11.5 m) wide. It had five decks (see Figure 1, next page). Two of these decks, the O1 and O2 decks, were used for accommodations. The only exterior openings for the O1 and O2 decks were doors in the port and starboard side of the aft bulkhead on both deck levels. Neither deck had port holes or other window-like openings.

The O1 deck was at the same level as the ship’s main deck and contained cabins for most of the crew, the ship’s galley, a supply room, and several other rooms (see Figure 2, next page). This area was approximately 80 feet (24.4 m) long (including a storage area located in the bow) and covered the full width of the ship. The deck had two weather-tight doors in the aft wall of the deck. The port-side door opened into a corridor, and the starboard-side door opened into the galley.

A stairway located approximately midway along the port-side corridor connected the O1 deck with the O2 deck. The stairway had wood stair treads, risers, and stringers. The walls and ceiling that enclosed the stairway were covered with 1/4-inch (6.4-mm) thick plywood paneling. The exposed side of this paneling had a water-resistant veneer that appeared to be vinyl. A non-fire rated, hollow-core wood

* A gross ton is equivalent to 100 cubic feet of internal space of a vessel. Therefore a gross ton is a volume measurement rather than a weight measurement.
Figure 1: Elevation of ship showing all decks.

Figure 2: Plan view of 01 deck
door was located at the top of the stairway. This door was reported to be kept in the open position.

The O2 deck was 45 feet (13.7 m) long, covered and the full width of the ship, and contained crew cabins (see Figure 3). The height of this deck measured approximately 6 1/2 (2 m) to 7 feet (2.1 m) to the finished ceiling. The ship captain’s cabin was located on the port side near the stairway leading from the O1 deck. The cook’s room and cabins for several other crew members were located in the forward section of this deck. Another cabin and miscellaneous other rooms were along the starboard side. The area between the deck’s two corridors contained a toilet, a shower room/toilet, a general purpose room, and a former radio room. At the time of the fire, the former radio room was being used by the assistant fish master, but the room could be used as an additional berthing area when needed. This room was reportedly locked and had not been used for several days before the fire. The deck also had two weather-tight exterior doors in the aft wall. Both of these doors provided access to corridors; one on the port side and one on the starboard side of this deck.

The wheel house was 22 feet (6.7 m) long and 20 feet (6.1 m) wide and was the highest enclosed deck on the vessel. The wheel house was the area from which the ship was piloted. This area contained controls for operating the ship, navigational equipment, computers, and other electronic equipment. Like the O1 and O2 decks, the wheel house also had two weather-tight exterior doors in the aft wall.

Two vertical openings connected the wheel house with the O2 deck. One opening was a stairway on the port side. This stairway was similar to the stairway located
between the O1 and O2 decks in that it, too, had wood stair treads, risers and stringers, a plywood paneling interior finish, and a hollow-core wood door located at the top of the stairway that was normally kept open. The wheel house was also connected with the O2 deck by an enclosure through which wires had, at one time, been run from the former radio room. At the time of the fire, there were no wires in the enclosure. The enclosure had three metal sides that ran from floor to ceiling in the wheel house. The fourth side was covered with an access panel that was reported to be constructed of plywood paneling.

Even though the ship’s hull was steel, all ceiling assemblies in the accommodation areas and in the wheel house were wood structures that were attached to the steel hull. The ceilings had wood frames constructed with members that were approximately 1-inch x 3-inch (25 mm x 76 mm) in dimension (see Photo 2). The wood frames were bolted to the vessel’s steel structural components and constructed in such a manner that combustible concealed spaces ranging from 6 inches to 10 inches (150 mm to 250 mm) in depth were created above the finished ceilings. The finished ceilings were covered with the same 1/4-inch (6.4-mm) thick plywood paneling as the interior stairway. In some areas, such as the wheel house, several inches of polyurethane foam insulation were sprayed onto the underside of the metal plates for the deck above. In other areas, 2-inch (50-mm) thick, rigid styrene insulation was placed atop the ceiling’s plywood panels. Both types of insulating materials were combustible, adding to the fuel load in the concealed spaces. One of the shower rooms and the bathroom on the O2 deck had noncombustible fiberglass batt insulation attached to the metal deck above the ceiling assembly. The construction of the finished ceilings in these rooms could not be determined due to the fire damage.
The construction of the walls of the O1 deck, O2 deck, and the wheel house was similar to the construction of the ceilings. Most interior walls were constructed with wood studs, and both sides were covered with the same plywood paneling as used in the ceiling assemblies. Some walls, such as those enclosing the general purpose room and the assistant fish master room, were vertical steel plates continuous from deck to deck (see Photo 3). Vertical steel ribs welded to the plates strengthened the walls, and wood studs were bolted to the steel ribs. Again, the 1/4-inch (6.4-mm) thick plywood paneling with a water resistant vinyl veneer was used as the wall finish and nailed to the studs. As a result, the walls enclosing the assistant fish master room, when viewed from the corridor side, looked the same as the other interior walls in the accommodations area. Most of the insulation for the interior walls was rigid styrene. However, fiberglass batt insulation was observed in a few sections of the walls.

Vertical walls were constructed adjacent to the sloping contour of the ship’s steel hull to provide rooms with a typical rectangular appearance, rather than leaving the sloping contour of the hull visible. Similar to the corridor walls, the cabin walls had 1-inch x 3-inch (25-mm x 76-mm) wood studs covered with plywood paneling. The installation of vertical walls next to the sloping steel hull created combustible concealed spaces that ranged from approximately 6 inches to 18 inches (150 mm x 460 mm) in depth (see Photo 4, next page). The combustible materials enclosed in these combustible concealed spaces included both the wood used to construct the interior walls and approximately 3 inches to 4 inches (76 mm to 102 mm) of spray-on polyurethane insulation covering the ship’s steel hull.
Photo 4: Forward wall, O2 deck. Combustible concealed space between the wood interior wall (left) and the metal hull wall (right).

Photo 5: Picture of unburned crew cabin on the O1 deck.
All of the crew cabins had similar interior finishes and contents. Like the corridors, the walls and ceilings were finished with the vinyl-covered, 1/4-inch (6.4-mm) plywood paneling. Doors to these rooms were non-fire rated and with hollow cores like the doors for the interior stairways. The bunks were wood framed and combustible bedding materials were used (see Photo 5, previous page). Wood closets were provided for the crew members’ clothing and personal possessions. All rooms were provided with portable electric space heaters and many rooms contained personal electronic equipment such as radios, computer games, and refrigerators.

Fire Protection

All occupiable rooms were provided with system heat detectors (see Figures 4 & 5, next page). The bi-metallic type detectors were manufactured in Japan and had a rated operating temperature of 70°C (158°F). The detectors had an automatic reset capability, but could be reset manually. Smoke detectors were also installed in the cargo areas. All heat and smoke detectors were connected to a fire detection control panel. With the activation of any initiating device, electronic horns would operate throughout the ship.

Fire suppression equipment was positioned throughout the vessel (see Figures 4 and 5). This equipment included hydrants where the hose lines could be connected to the ship’s fire main system and two types of fire hose lines. One type of fire hose had threads matching those on the fire hydrant, but the other type of hose did not have matching threads. Adapters that were kept in the engineers’ cabins were to be used to connect the incompatible hose lines with the hydrants. In addition, the vessel had fire stations where fire hose was pre-connected to the fire hydrants.

A shipboard fire pump that took suction from sea water supported the fire mains. Two other pumps on the ship, the sea water service pump and the general service pump, could be connected to the fire mains by opening valves and could be used to support the fire mains. Controls for the fire pump were installed in both the wheelhouse and the engine room. A fixed carbon dioxide (CO₂) system with 14 one hundred-pound (45-kg) compressed CO₂ cylinders protected the engine room. Seventeen (17) ABC dry chemical and CO₂ fire extinguishers were positioned throughout the vessel, and fire axes were also available at various locations. In addition to the suppression equipment, two sets of fire fighter personal protective gear, and self-contained breathing apparatus (SCBA) were provided for the crew members’ use. This equipment was kept in a cabinet at the aft end of the O1 deck corridor.
Figures 4: Plans showing the fire protection equipment on the decks.

Figures 5: Plans showing the fire protection equipment on the 02 decks.
Crew Information

The ship could have a maximum crew of 48 members when at sea. The crew typically consisted of one National Marine Fisheries Service observer, 12 crew members of the deck department, two crew members of the engineering department, 31 crew members of the processing department, one cook, and a cook’s assistant. These numbers could vary because staffing levels were not regulated for a vessel of this type.

The U.S. Coast Guard requires that the master, mate, chief engineer, and assistant engineer be licensed on fishing vessels over 200 gross tons. However, no licensed personnel are required to be aboard the vessel while in port. The Alaska Spirit’s master and two engineers were properly licensed by the U.S. Coast Guard.

The Alaska Spirit was in port for repairs on the day the fire occurred, so only eight crew members were residing on the ship. These crew members had been working on the ship for a few years and had each received the standard safety briefing given to all shipboard personnel each time the ship left port. During the pre-departure briefing, all personnel would be advised of the occupational, health, and fire safety rules that were to be followed while onboard the ship. In addition, fire drills, abandon ship, “man overboard,” and flooding procedures were discussed, and personnel would be assigned duty stations for the emergency procedures. Video training materials were used during this briefing to introduce crew members to fire and abandon ship procedures.

At least one crew member, the assistant engineer who was aboard at the time of the fire, had received certified shipboard fire-fighting training through a program that was monitored and approved by the U.S. Coast Guard.

When the ship’s full crew was aboard, six crew members would be assigned to the ship’s emergency response team and would assist the ship’s chief engineer during fire emergencies. The emergency response team members received additional fire response training than that provided in the pre-departure briefing, and were responsible for the initiation of the shipboard fire suppression operations. All members of the emergency response team participated in fire drills approximately once every month. The chief engineer was the only member of the ship’s emergency response team who was aboard the ship at the time of the fire.

Once at sea, the fire alarm system would be tested every Sunday. All members of the ship’s crew would meet in the galley and emergency procedures would be reviewed. The crew members would not lay out or charge the fire hose lines from hydrants, don SCBA’s, or wear fire-fighting equipment during the fire drills. During the abandon ship drills, the crew would not don survival suits.
THE FIRE

Ship Crew’s Response

On the morning of May 27, 1995, the Alaska Spirit was moored to a dock located at the Seward Marine Industrial Center (SMIC). At approximately 2:00 a.m., five crew members (the ship’s captain and four others) were aboard the vessel. The captain was in his cabin on the O2 deck, and four crew members were sleeping in their respective cabins on the O1 deck. A security guard responsible for watching the Alaska Spirit and the Alaska Ranger, another fishing vessel owned by the same company which was moored next to the Alaska Spirit, was also aboard the Alaska Spirit performing one of his routine inspections on the factory deck. Two crew members were still in town and the last crew member, the ship’s cook, was returning to the vessel.

As the cook walked down the gangplank to board the ship, he saw flames on the port side of the O2 deck and wheel house (see Photo 6). He ran onto the main deck, and approached the fire area where he was met by the night watchman who had just left the ship’s factory deck. After talking to each other, the security guard ran to the Alaska Ranger to call the fire department, and the cook went up to the O2 deck. Looking in the port-side door, the cook saw fire in the area of the bathrooms and smoke in the corridor. He also reported that smoke was spreading up the stairway to the wheel house. Feeling that there was too much fire to enter the corridor, the cook went to the starboard corridor on the O2 deck where he observed light smoke, but no fire.
The chief engineer and the assistant engineer were awakened by the ship’s fire alarm system. When they left their cabins, the O1 deck was clear of smoke. The two crew members went to the stairway that led to the O2 deck and the chief engineer went up a few steps. He observed an orange glow and smoke on the O2 deck. The two crew members decided to initiate a fire attack. The chief engineer went for a hose line and the assistant engineer intended to go to the engine room to start the fire pumps.

A deckhand sleeping in an O1 deck cabin was also awakened by the fire alarm. After leaving his cabin, he checked a cabin where another crew member was sleeping and found the cabin door locked. The deckhand caught the attention of the assistant engineer who was on his way to the engine room and told him of the crew member who might be in the cabin. The deckhand and assistant engineer forced open the locked cabin door and removed the crew member who was thought to be intoxicated. The deckhand, at one point, attempted to go up the stairway to the O2 deck where he observed red flames on both the ceiling and the floor of that deck.

After leaving the O1 deck, the assistant engineer proceeded to the engine room where he started the fire pump. He then went to the main deck where he saw the chief engineer and the cook working with a hose line outside the O2 deck. When the chief engineer and the cook had first attempted to connect a hose line to the fire main, they found that the hose line threads were incompatible with the fire main threads. The chief engineer had to go to his cabin to get an adapter before they could make the connection. At some point after the fire hose was connected, the chief engineer went down to the engine room where he shut down electrical equipment and made valve adjustments that allowed the two service pumps to support the fire mains. He then brought an SCBA to the galley with the intention of using it to reach the O2 deck. Before he was able to don the SCBA, he realized that the fire on the O2 deck had become too severe for him to enter that area so he did not put the SCBA on. The cook discharged the hose into the O2 deck. The deckhand who had helped to remove the crew member from the cabin joined up with the cook to assist him with the hose line.

After becoming aware of the fire, Alaska Ranger crew members responded to the Alaska Spirit, and the assistant engineer helped them to set up a second fire attack hose. This hose line was brought into the port corridor on the O1 level and crew members discharged the hose up the stairway to prevent the fire from spreading down to their level. With the two hose lines in place and operating, some of the Alaska Spirit crew members began to remove potentially hazardous materials from a paint locker close to the fire area and to conduct a second search of the O1 deck cabins to ensure that all personnel had safely left the area.

During the crew’s fire suppression operation, damage to the controls in the wheel house caused the fire pump to shut down. Since the chief engineer had already opened valves that allowed the service pumps to support the fire mains, water pressure in the mains decreased slightly but was never lost when the fire pump stopped operating.
Fire Department Response

At approximately 2:09 a.m., a cab driver monitoring the radio channels used by fishing vessels overheard personnel from two vessels discussing a fire they could see. According to them, the fire appeared to be aboard a docked vessel at SMIC. The cab driver called 911.

The Seward Volunteer Fire Department, which had 28 members and eight apparatus, was dispatched at 2:11 a.m. A deputy chief and some fire fighters responded to the fire station at SMIC where Engine 4 and Rescue 2 were positioned. Other fire fighters responded to the main fire station in downtown Seward, approximately 7 to 8 miles away from SMIC. Many fire fighters, using their personal cars, responded directly to the scene.

The chief of the Seward Fire Department was the first to arrive on scene. He boarded the Alaska Spirit for a visual check of conditions and found that members of the ship’s crew had brought a hose through the door on the port side corridor of the O1 deck. The crew members were spraying water up the stairs toward the O2 deck. The chief also saw that the men on O1 deck were not wearing SCBAs. The fire chief talked with the ship’s engineer who reported that the ship’s captain might still be in his cabin on the O2 deck and that two other crew members were not accounted for and might be missing. The engineer also gave the fire chief information about the ship’s construction and layout.

The deputy chief arrived at the SMIC fire station first. He drove Engine 4 to the Alaska Spirit a few hundred yards away and reached the ship at approximately 2:20 a.m. The fire chief arrived shortly thereafter. Engine 4 laid a 5-inch (127-mm) supply line from the nearest hydrant to the dock area, and the deputy chief began preparations for a fire attack using the “hotel pack” — two 1 3/4-inch (45-mm) attack lines attached to a 2 1/2-inch (65-mm) supply line by a gated wye. During these preparations, other fire fighters began to arrive in their private cars and in apparatus brought from the main fire station. One of the arriving fire fighters reported that she could see brownish gray smoke, but no flames, coming from the upper part of the ship. Some fire fighters helped to stretch the attack lines aboard the ship, other fire fighters donned their SCBAs.

The fire chief ordered the first attack line to be brought into the port door of the O2 deck so an attempt could be made to rescue the captain. As the severity of the fire became clear, the fire chief requested mutual-aid assistance from Bear Creek, a neighboring community. Some fire fighters from Bear Creek stood by at the Seward Fire Department main station in the event that a second fire should occur in the town, and other Bear Creek fire fighters assisted at the fire scene.

Fire fighters preparing for entry into that door found the corridor filled with a thick, dark-black, gritty smoke down to the floor level. They crawled into the port corri-
Do not hallucinate.
that the ship’s stability was never endangered. Most of the runoff water was flowing overboard, and the ship’s pumps were easily removing water reaching lower areas.

The fire chief had the fire fighters use 1 3/4-inch (45-mm) hose lines rather than 2 1/2-inch (65-mm) hose lines in order to maximize their mobility during the fire attack. Shipboard equipment and cables blocked access to the aft doors to the O1 deck, O2 deck, and wheel house. In addition, the many rooms in the accommodation area created a maze-like configuration. This configuration, in conjunction with the narrow corridors, made movement with a charged hose line of any size difficult. The Seward fire fighters did not use the shipboard hose lines because they did not know how reliable shipboard fire equipment would be and they were more familiar with their own equipment.

Over the many hours of fire suppression activities, the fire fighters attempted a variety of tactics to gain control of the fire. During most of the suppression activities, fire fighters maintained and operated a hose line at the base of the stairway between the O1 and the O2 decks. This prevented the fire from spreading down to the O1 deck. Hose operations on the O2 deck changed several times, however. The main fire attack on the O2 deck involved only a single hose line operating at any one moment. Initially, the operating hose line was used in the port corridor (see Figure 6). As conditions changed, the port-side hose was shut down, the fire crew was removed, and the hose line was operated in the starboard corridor. In this way, the fire crews did not push the fire over one another. Fire fighters did, at one time, attempt to simultaneously operate a hose line in each of the O2 corridors. This attack was not successful, however, and was quickly abandoned. Fires deeply seated in the captain’s quarters and in the forward part of the O2 deck were not accessible to the fire fighters during most of the incident. Fire spreading from these areas decreased the effectiveness of fire suppression operations in those areas that fire fighters could reach.
Early in the incident, fire fighters in the starboard corridor observed that the starboard wall of the assistant fish master room was glowing red and that there was intense fire in that room. Fire fighters found they could gain access to the room from the port corridor. Thinking that there may be flammable liquids in the room, the fire fighters used Aqueous Film Forming Foam (AFFF) to suppress the fire.

Recognizing that the lack of natural ventilation was making suppression operations more difficult, fire fighters placed a fan in one of the O2 deck corridors with the idea of forcing smoke and heat out the open door of the other corridor. This attempt proved to be only marginally successful. Some hours later, fire fighters used power saws and sledge hammers to make several holes in the metal deck and in the forward bulkhead for the O2 deck. Heat and smoke from the fire area were immediately released through these openings. Fire fighters also inserted nozzles into some of these holes so they could discharge water into areas that interior attack crews could not reach due to the extreme conditions. Even with these openings, more than one hour passed before the fire fighters controlled the fire in hard-to-reach areas. Once the fire was controlled, fire fighters entered the spaces that were untenable at earlier times and extinguished the remaining hot spots in those areas.

While the fire on the O2 deck was out of control, the fire chief did not worry about the fire burning in the wheel house. The chief felt that the open stairway from the O2 deck was allowing fire to continually spread up to the wheel house and that this could not be stopped until the fire on the O2 deck was extinguished. In addition, the metal deck where the fire fighters would have to operate was hot because it was above the O2 area. Lastly, the chief attempted to keep his limited personnel available for the simultaneous operations on the O1 and O2 decks.

As fire suppression operations continued past 9:00 a.m., fire department personnel became increasingly tired and the equipment resources were taxed well beyond normal situations. With the intent of minimizing the risk to his fatigued fire fighters, the fire chief established an arbitrary target time of 9:45 a.m. for fire control. If control had not been reached by that time, he planned to remove fire fighters from the fire area until the fire could be suppressed with minimal risk to the fire fighters. Approximately 30 minutes before his target time, fire fighters controlled the fire. Fire fighters continued their suppression activities focusing on hot spots for another 30 to 40 minutes. During this time, the ship captain's body was found in his quarters and removed.

Fire fighters from both the Seward Volunteer Fire Department and Bear Creek Volunteer Fire Department were involved in this operation, which lasted almost eight hours. Of the 30 fire fighters who were at the scene, approximately 20 were involved in the suppression operations while the other 10 served as advisory and support personnel performing tasks such as filling the estimated 100 air bottles used by the suppression personnel.
Casualties and Damage

The ship’s captain, the only victim of this fire, was found near the door to the hospital (see Figure 7). Two samples of the victim’s blood were tested for carbon monoxide and other chemicals. The result of one test recorded a carboxyhemoglobin (COHb) saturation level of 90.6 percent and the result of the second test was a COHb saturation level of 84 percent. Since rapid death occurs at COHb saturation levels of 80 percent and higher, both test results confirm that the cause of death was smoke inhalation.

The heaviest fire damage occurred on the O2 deck. The damage on this deck occurred in the forward part of the deck and extended around to the port side where the captain’s quarters were located. Almost all of the combustible materials in the ceiling assemblies of these areas were consumed by the fire. In addition, many of the walls and other combustible materials were consumed down to a level 4 feet to 5 feet (1.2 m to 1.5 m) above the deck (see Photo 8, next page).

The assistant fish master room also sustained severe fire damage (see Photo 9, next page). In this room, all of the interior finish materials were consumed and most of the room’s combustible contents were heavily damaged. The bunk room along the starboard corridor was heavily burned and the bathrooms sustained only heat and smoke damage. The wood paneling lining the stairway from the O2 deck to the wheel house was deeply charred, but was not totally consumed by the fire.
Photo 8: Forward berthing area, O2 deck. View from port to starboard. Note: wood in ceiling and forward wall (left side of photo) have been consumed, only metal hull components remain. Total consumption of wood wall materials.

Photo 9: Fire damage inside the assistant fish master room. This is a view of the aft and port walls.
The wheel house was heavily damaged by the fire though the damage was not as extensive as on the O2 deck (see Photo 10). For example, many areas of ceiling were not totally consumed by the fire, and the upper portions of most walls were not incinerated as was the case on the deck below.

Fire damage also occurred on the O1 deck. Even though fire fighters were able to stop flames from spreading down to the O1 deck, hot smoke entered the corridor at the base of the stairway. The heat caused the surface of the plywood paneling to de-laminate and char. The charring of surface materials occurred in close proximity to the stairway. However, de-lamination of surface materials continued down the length of the corridor in both directions. The surface materials in these areas were also discolored by their heat exposure.
ANALYSIS

Ignition and Fire Growth

The National Transportation Safety Board (NTSB) concluded that the most likely ignition source was an electrical cooking pot in the assistant fish master's room. This room was unattended for about six days before the fire and was most probably locked during that period.

The fire was well beyond its incipient stage when first observed by crew members. For example, the ship's cook reported that as he approached the ship the fire seemed to involve the port side of both the O2 deck and the wheel house. The cook also said that when he looked into the O2 deck he saw fire in the bathrooms. These bathrooms were next to the weather-tight door at the aft of the O2 deck. The crew members who observed the fire shortly after being awakened by the fire alarm said they saw light and even flames when they looked up the stairway into the O2 deck. Since investigators determined that the fire started in a vacant room, the fire would have had to become large enough to spread from the area of origin to the corridor in order for the witnesses to have seen the fire as they described.

All walls and ceilings were finished with combustible wood paneling with vinyl veneer. The wood paneling, in conjunction with the combustible contents of the room would have contributed to the rapid fire growth. The size of the room also contributed to the rapid fire growth. All the rooms in the accommodation space were small, so a room's combustible contents would have been close to the combustible interior finish. Ceilings were only 7 feet (2.1 m) high, so the distance between the hot-gas layer developing at ceiling level and the combustible materials at floor level was less than it would have been in a typical onshore residential room. Under these conditions, radiant heating of the exposed floor-level combustible materials would have been enhanced, reducing the time to flashover.

The combustible framing materials, combustible interior finish, and combustible contents of the cabins were not the only significant fuels in the vessel. Rigid polyurethane foam insulation was sprayed onto metal surfaces, and rigid styrene insulation was placed inside the walls and in the ceiling assemblies. These materials added to total fuel load, and increased the magnitude and duration of the fire. The burning insulation also produced a thick, dark-black, gritty smoke that was down to the floor. This smoke obscured the fire fighters' vision complicating their interior fire fighting operations.
Fire Spread

There were two ways the fire could have spread up to the wheel house early in the scenario. One means was the enclosure that had, at one time, been used to run wires between the assistant fish master room and the wheel house (see Photo 11). This enclosure was not sealed at the ceiling level of the assistant fish master room. Therefore, any fire in that room would have quickly entered the enclosure. It would then have been just a matter of time before the fire burned through the combustible material covering one side of the enclosure and entered the wheel house. The second means for fire and smoke spread into the wheel house was the open stairway along the O2 deck’s port-side corridor (see Photo 12). Since this stairway was open, nothing would have prevented the fire in the O2 deck portside corridor from spreading up to the wheel house. Additionally, the ship’s combustible interior finish would have also enhanced rapid fire spread up that stairway.

The fire was able to spread horizontally to most areas on the O2 deck by various means (see Photo 13, next page). The most obvious were the corridors and doorways between rooms. Once the fire entered the corridors, the combustible interior finish allowed the fire to spread quickly along the length of the corridor. In the closed position, the hollow-core wood doors for the crew cabins would have been a relatively insignificant barrier against the severe fire in the corridor. In the open posi-
tion, the doors would not have interrupted fire spread from one area to another. As a result, the fire that was seen in the corridor would have spread into some of the crew cabins early in the incident. Another means for fire spread on the O2 deck was the concealed space above the ceilings. This space was divided by a few metal walls, such as those enclosing the assistant fish master room. As a result, any fire entering the space above the ceilings could have readily spread to other areas. Other combustible concealed spaces between crew cabin walls and the ship’s hull may have also allowed fire to spread between areas. Since the fire continually spread into areas containing combustible materials, fire growth was regulated by ventilation.

Fire Detection

The heat detection system aboard this vessel operated at some point after ignition and alerted the occupants of the O1 deck.

The NFPA recognizes that smoke detection equipment provides the best protection in land-based residential environments. The following excerpt from Section A-2-2.1.1 of NFPA 72, National Fire Alarm Code, 1993 edition, explains this understanding:

Experience has shown that all hostile fires in family living units generate smoke to a greater or lesser degree. The same statement can be made with respect to heat buildup from fires. But the results of full-scale experiments conducted over the past several years in the U.S., using typical fires in living units, indicate that detectable quantities of smoke precede detectable
levels of heat in nearly all cases. In addition, slowly developing, smoldering fires may produce smoke and toxic gases without a significant increase in the room’s temperature. Again, the results of experiments indicate that detectable quantities of smoke precede the development of hazardous atmospheres in nearly all cases.

For the above reasons, the required protection in this code utilizes smoke detectors as the primary life safety equipment that provides a reasonable level of protection against fire.

Many who are familiar with marine fire protection systems have questioned how factors such as ventilation patterns, vibration, salt air, and high moisture environments can affect the performance of smoke detectors installed on vessels. Several research projects intended to answer these, and many other questions, have been initiated. For example, the U.S. Coast Guard provided a research grant to Underwriter’s Laboratories (UL) in Chicago, Illinois. Under this grant, UL is initiating a project to determine if smoke detectors can provide comparable protection aboard ships. Even though the project’s focus is on smoke detection aboard recreational vessels, the results of this research may be transferable to other classes of vessels. In another attempt to improve maritime fire safety, the U.S. Coast Guard has also asked the National Fire Alarm Code committee to include marine applications in future editions of NFPA 72.

**Fire Suppression**

Upon discovery of the fire, crew members performed many tasks that included fire suppression. They were unable to control the fire, however, before land-based fire fighters arrived. Several factors appear to have contributed to their inability to attain fire control.

As indicated earlier, witness accounts strongly suggested that the fire was well beyond its incipient stage when crew members first observed the fire in the port corridor. In order for the crew to have controlled the fire at this point, they would have had to advance their hose line through the corridor to the area of fire origin, which was an enclosed room. If the fire was spreading in the concealed spaces above the ceiling assembly and behind the walls, they would have had to open the ceiling and the walls in order to attack the fire. In either case, crew members did not have the training, experience, personal protective gear, or tools to effectively initiate a direct and aggressive attack on this severe fire.

The crew members also experienced two equipment problems that detracted from their fire suppression operation. First, the chief engineer and cook could not readily connect the shipboard fire hose to the shipboard fire main because the threads were not compatible. They were able to get an adapter to correct this problem, but the length of time between the discovery of the fire and the application of the first hose stream was increased. Second, the fire pump shut down when the pump con-
trols located in the wheel house were damaged by the fire. Fortunately, other pumps servicing the vessel were able to be used to support the fire mains and the problem occurred after land-based fire fighters had placed some of their hose lines in service.

The coordination between crew members and the land-based fire fighters was effective. Recognizing that the fire was well beyond their abilities, crew members readily withdrew from the fire area as the land-based fire fighters took over the suppression operation. The crew members remained on board and provided land-based fire fighters with whatever assistance they could without endangering themselves. The chief engineer remained in contact with the fire chief and provided him with information as needed.

Structural suppression tactics were applied to this shipboard fire by the land-based fire fighters whenever possible. For example, the fire fighters attempted to ensure that hose lines were not operated in both corridors on the same deck at the same time. This conscious effort prevented one fire crew from forcing the fire onto another fire crew. At one time in the fire, the fire fighters attempted to improve ventilation by using fans. The fire officers also attempted to rotate suppression crews regularly to reduce their fatigue. The fire chief kept aware of changing fire conditions and modified his fire tactics and strategies accordingly.

Like the crew members, the fire fighters experienced many problems throughout their fire suppression operation. The most prevailing problem was the fire fighters’ inability to reach the seat of the fire. The O2 deck was constructed with very few openings, so the accumulating hot smoke could not be effectively removed from the area. Late in the fire suppression operation, fire fighters cut several small holes into the metal deck above the O2 deck and in the forward bulkhead for that deck. These holes increased venting in active fire areas. In addition to allowing the smoke to vent from these areas, the penetrations served as access points into which fire fighters could insert hose stream nozzles to reach fire areas that were otherwise inaccessible.

Other problems that the land-based fire fighters encountered included:

- restricted access to the fire area due to shipboard equipment installed in close proximity to the aft doors of the decks.

- combustible concealed spaces shielding the fire from hose streams and complicating fire suppression operations.

- inability to maintain operational hose streams during crew rotations. Due to small size of the space where crews were working, the number of personnel had to be limited and hose lines were removed from the area in order to change attack crews. Many times the fire would burn back into areas that had been suppressed and forward progress against the fire was lost.
Shipboard fire-fighting tactics and strategies are, in many ways, similar to those used during structural fire suppression operations. However, a ship's construction and other conditions aboard a vessel can cause fire fighters to modify their standard structural tactics and strategies. For example, land-based fire fighters can expect limited access points to a ship's interior, limited openings for ventilation, narrow corridors, and steel walls and floors. As a result of these environmental differences, land-based fire fighters may consider using equipment and tactics that they might not normally use just as they would do during a structural fire involving unique environmental conditions.

An example of a modified structural fire suppression operation and the use of non-standard equipment was documented during the NFPA investigation of the April 29, 1986 fire at the Central Library in Los Angeles, California. The fire occurred in the library’s book storage area referred to as the “bookstacks.” The bookstacks were several stories tall and completely enclosed in the core of the building. The area had a limited number of door openings, its concrete walls were 3 feet (0.9 m) thick and the ceiling covering the area was a 6-inch (150-mm) concrete slab. Like the fire aboard the Alaska Spirit, extremely hot gases accumulated in the area and prevented fire fighters from reaching the seat of the fire. After fighting this fire for approximately four hours and making very little progress, fire fighters chose a rather unique method to ventilate the fire — they used pneumatic hammers to cut open the concrete floor slab directly above the fire in order to release the captured gases. The improvised ventilation method dramatically changed conditions in the bookstack area and attack crews were able to make significant progress against the fire. (See the NFPA Fire Investigation Report, Central Library Fire, Los Angeles, California, April 29, 1986, for more information regarding this incident.)

During the Alaska Spirit fire, fire fighters realized that improved ventilation could help them gain access to the fire area and they considered different methods of ventilation. For example, they discussed using an oxygen/acetylene torch. However, this option was discounted because fire fighters felt that they could not get the equipment to the required areas and the use of such equipment would have exposed fire fighters working inside the vessel to spraying molten metal. Instead, the fire fighters decided to cut several holes into the metal hull plates using standard fire department equipment, i.e., power saws and sledge hammers. The procedure proved to be laborious and time consuming, but it provided the desired results. The trapped gases were released allowing suppression crews to advance into the fire area.
Code Analysis

The NFPA does not currently have a consensus document addressing life safety aboard marine vessels. It is, however, currently developing such a document in conjunction with the U.S. Coast Guard. In the absence of a life safety document for marine vessels, NFPA believes that current codes that are intended for structures, such as NFPA 101, Life Safety Code, contain some requirements that may be effective aboard vessels. The following discussion will highlight transferable requirements that have particular relevance to this fire.

The accommodations area aboard the Alaska Spirit could be considered an existing dormitory according to the occupancy classifications in the 1994 edition of the Life Safety Code, so the requirements of Chapter 17, Existing Dormitories, would apply.

Interior Finish

Combustible interior finish was a major factor contributing to the severity of this fire, and it probably contributed to the death of the ship’s captain. Interior finish and its potential affect on occupant survival has long been recognized by the Life Safety Code:

17.3.3.1 Interior Wall and Ceiling Finish. Interior finish on walls and ceilings shall be as follows:
(a) Exit Enclosures — Class A or Class B.
(b) Corridors and lobbies that are part of an exit access — Class A or Class B.
(c) All other spaces — Class A, Class B, or Class C.

Paragraph 6-5.3.2 of the Life Safety Code defines interior wall and ceiling finishes as follows:

- **Class A Interior Wall and Ceiling Finish.** Flame spread 0 - 25, smoke development 0 - 450.
- **Class B Interior Wall and Ceiling Finish.** Flame spread 26 - 75, smoke development 0 - 450.
- **Class C Interior Wall and Ceiling Finish.** Flame spread 76 - 200, smoke development 0 - 450.

No information was available regarding the flame spread rating for the paneling used in the accommodation areas of the ship. However, it was very unlikely that the paneling, as it was installed, would have been able to achieve even a Class C rating. The ratings for interior finish materials are derived from standard tests such as UL 723, Test for Surface Burning Characteristics of Building Materials and NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
The guidelines for these tests require that wall covering materials be mounted to a specific noncombustible substrate. Because the wood paneling in the accommodation areas was mounted to wood framing materials and was in contact with combustible insulation (methods not recognized by current testing procedures), the paneling would have had to be tested in its “as built” configuration to determine if it met the *Life Safety Code* requirements.

**Alarm Systems**

The ship’s fire alarm system alerted the crew members sleeping on the O1 deck of the fire and they were able to take appropriate actions. Recognizing the importance of notifying dormitory occupants of a fire, the *Life Safety Code* requires (Paragraph 17-3.4.1) a fire alarm system that is initiated by manual means and by any required automatic sprinkler systems and any required detection system (Paragraph 17-3.4.2). The fire alarm system aboard the *Alaska Spirit* appeared to have been consistent with these requirements.

**Compartmentation**

In order to protect building occupants, especially during evacuation, the *Life Safety Code* requires that interior corridor walls be fire barriers with a minimum fire resistance rating of 30 minutes (Paragraph 17-3.6.1). The walls that had metal plates extending from deck to deck probably would have met these requirements. The code also requires guest room door openings to have a minimum fire resistance rating of 20 minutes (Paragraph 17-3.6.2), and requires doors to be self-closing (Paragraph 17-3.6.3). None of the doors in the accommodation areas would have met these requirements. Compartmentation consistent with the NFPA requirements would have significantly reduced the initial fire spread and improved the potential for crew members to gain control of the fire in its early stages.


Similar to structural fire suppression operations, information is a key element that can affect fire suppression operations aboard marine vessels. NFPA 1405 provides guidance that land-based fire fighters will find useful and discusses the importance of pre-fire planning and training exercises. Both of these informational sources should be very familiar to land-based fire fighters because they are similar to activities commonly performed in preparation for structural fires. The Seward Volunteer Fire Department did not have pre-fire plans for the *Alaska Spirit*. However, they did perform in-house training with regard to shipboard fire fighting. In fact, just one week before the incident, fire department personnel visited a large passenger vessel for familiarization training. Since many passenger vessels come to Seward, the focus of the fire department’s shipboard fire training was directed to that type of vessel.
Another means for gaining information, discussed in NFPA 1405, is a ship's fire control plan. Land-based fire fighters may not, however, be as familiar with this informational resource. A fire control plan is a set of general arrangement plans showing the fire control stations, and the fire-resisting and fire-retarding bulkheads for each deck. The plan also provides details regarding fire detection, manual alarm and fire extinguishing systems, fire doors, means of access to different compartments, and ventilation systems. Safety of Life at Sea (SOLAS) and the Code of Federal Regulations [46 CFR 78.45-1(a) and 97.36-1(a)] require a fire control plan for all new and existing ships that are either U.S. flagged or foreign flagged and entering U.S. ports. The fire control plan is required to be stored in a prominently marked weather-tight enclosure outside the deck house for the assistance of land-based fire fighting personnel. Experience has shown that a ship's fire control plan is one of the most valuable assets for the land-based fire fighters.

The *Alaska Spirit* did not travel to international ports during its voyages, although it did enter international waters. Because it did not undertake international voyages, the *Alaska Spirit* was not required to meet SOLAS rules. The *Alaska Spirit*, nonetheless, had a fire safety plan that was prominently displayed on a bulkhead in the galley. During this fire, the fire chief worked from a land-based command post. The chief engineer who was extremely familiar with various details of the ship remained in contact with the fire chief and provided him with much of the information that would be contained in a fire control plan.

NFPA 1405 also provides guidance regarding the marine environment, general vessel familiarization, organizational resources, special resource considerations, communications, tactics and strategies, legal issues, and more. This document's diverse information makes it an extremely useful resource for fire departments that may respond to fires aboard marine vessels.
DISCUSSION

The purpose of the Life Safety Code is to provide minimum requirements for the design, operation, and maintenance of buildings and structures for safety to life from fire and similar emergencies. The preservation of property from loss by fire was not considered as the basis for any of the provisions of the Life Safety Code, though such preservation may occur as a collateral benefit of compliance with Life Safety Code requirements.

The code provides the means for occupants in most occupancies to be able to evacuate a structure during a fire emergency. Accordingly, many requirements are intended to protect egress paths and to provide building features that will facilitate successful and safe evacuations. In occupancies and buildings, such as health care occupancies and high-rise buildings, the code recognizes that evacuation can be difficult or impractical so its requirements are tailored to meet the higher challenge posed by these occupancies and building arrangements.

A marine vessel at sea may be similar to a building where evacuation is not possible. When at sea, simply ensuring that the occupants can safely evacuate to the exterior areas on the vessel may not be sufficient to ensure safety to life from fire and other emergencies. Accordingly, the Life Safety Code may serve as an excellent starting point for shipboard fire safety requirements. More rigorous fire provisions may be necessary, however, to protect the ship and ensure that the safety of the vessel's occupants is not threatened by damage to the vessel. These are the kinds of issues that the NFPA and the U.S. Coast Guard will be addressing during their joint project to develop a life safety document for marine vessels.

Based on its success in land-based environments, smoke detection can potentially provide comparable protection aboard marine vessels. However, research projects and hardware design modifications may be necessary to ensure that smoke detection equipment remains as reliable in the challenging marine environment as it is in residential and other land-based settings. Additionally, future editions of NFPA 72 should include requirements for marine applications of smoke detection systems.

Several NFPA technical committees are currently examining their respective documents in terms of marine applications, and other technical committees have already begun the process of introducing marine chapters. For example, the technical committee for NFPA 10, Standard for Portable Fire Extinguishers, and the technical committee for NFPA 12, Standard on Carbon Dioxide Extinguishing Systems, have formed task groups to examine the application of these documents to marine vessels. The technical committee for NFPA 13, Standard for the Installation of Sprinkler Systems, recently proposed a new chapter, Chapter 9, that will apply to merchant vessels. This chapter was adopted by NFPA and will be included in the 1996 edition of NFPA 13. Similarly, NFPA 11, Standard for Low-Expansion Foam has proposed a new Chapter 6 that will cover marine applications. NFPA recently adopted a new standard, NFPA 750, Standard for Installation of Water Mists Fire Protection Systems that will be published in 1996. Chapter 11 of NFPA 750 will apply
to shipboard (water mist) systems. Both types of water-based suppression systems can provide an increased level of fire and life safety in all spaces within a vessel and provide marine designers with many design options.

**POSTSCRIPT**

On June 11, 1996, the NTSB held a public meeting regarding its report on the Alaska Spirit fire. The report was adopted as proposed, and it contained the following recommendations for the U.S. Coast Guard, the company owning the Alaska Spirit, the Commercial Fishing Industry Vessel Safety Advisory Committee, and the National Fire Protection Association:

Recommendations to the U.S. Coast Guard:

1. Develop, in cooperation with the National Fire Protection Association, a national marine fire safety standard for commercial fishing industry vessels, which should include structural fire protection standards and fire detection and suppression systems in accommodation areas, and adopt it into regulations.

2. Promptly seek to change the law to require the phasing in of fire safety regulations to apply to all existing fishing industry vessels that carry more than 16 persons.

3. Publicize the circumstances of this fire to the fishing industry.

Recommendations to the fishing company owning the Alaska Spirit:

4. Develop written guidance for your vessel masters to use to review the fire safety condition of all crew rooms when the occupants disembark from the vessel and the room will be vacant; and implement a procedure whereby the conduct of such reviews may be documented.

5. Install smoke detectors in accommodation spaces on all your vessels, regardless of whether heat detectors are installed.

6. Install automatic fire suppression systems in all your vessel accommodation spaces that are constructed of combustible materials.

7. Direct the masters of all your vessels to check all fire stations on their vessels to ensure that fire hose thread couplers are compatible with vessel fire hydrants and to replace incompatible equipment as appropriate.

8. Develop fire contingency plans that improve the readiness of your vessel personnel and equipment to respond to a fire emergency, and include provisions concerning the duties of security watch personnel and the training

**Marine Accident Report, "Fire on Board the U.S. Fish Processing Vessel Alaska Spirit, Seward, Alaska, May 27, 1995," PB96-916401, NTSB/Mar-96/01, National Transportation Safety Board.**
of crew in fire fighting techniques by the implementation of realistic fire drill procedures.

Recommendation to the Commercial Fishing Industry Vessel Safety Advisory Committee:

9. Inform fishing industry vessel owners of this accident and advise them to:
   - install smoke detectors in accommodation spaces.
   - install automatic fire suppression systems in accommodation spaces that are constructed of combustible materials.
   - develop written guidance for vessel masters to review the fire safety condition of all crew rooms when the occupants disembark from the vessel and the room will be vacant.
   - direct vessel masters to check fire stations to ensure that fire hose couplers are compatible with vessel fire hydrants
   - develop contingency plans that improve the readiness of vessel personnel and equipment, including provisions addressing the duties of security watch personnel and procedures for realistic fire drills.

Recommendation to the National Fire Protection Association:

10. Develop, in cooperation with the U.S. Coast Guard, a national marine fire safety standard for commercial fishing industry vessels, which should include structural fire protection standards and fire detection and suppression systems in accommodation areas.