PB98-916402
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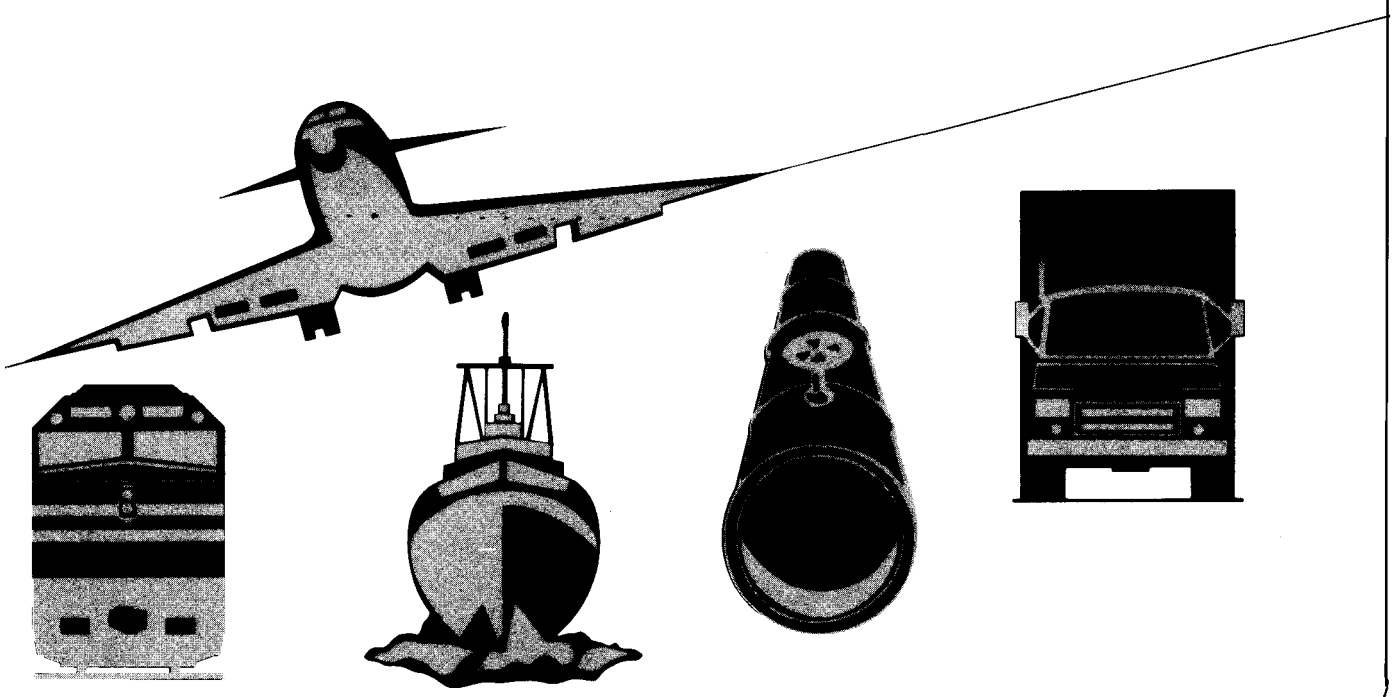
NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C. 20594

MARINE ACCIDENT REPORT

Fire On Board the Panamanian Passenger Ship *Universe Explorer* in the Lynn Canal Near Juneau, Alaska July 27, 1996



Abstract: This report explains the fire on board the Panamanian cruise ship *Universe Explorer* in the Lynn Canal near Juneau, Alaska, on July 27, 1996. Five people were killed and 56 people sustained minor to serious injuries as a result of this fire. The estimated vessel damage exceeded $1.5 million.

From its investigation of this accident, the Safety Board identified the following safety issues: the adequacy of shipboard communications; the adequacy of fire prevention, detection, and control measures; the adequacy of emergency procedures; and the adequacy of oversight. Based on its findings, the Safety Board made recommendations to the U.S. Coast Guard, the New Commodore Cruise Lines, Ltd., V. Ships Marine, Ltd., the International Council of Cruise Lines, and the American Bureau of Shipping.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable cause of accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews. Information about available publications may be obtained by contacting:

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Adopted: April 14, 1998
Notation 6743D

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EXECUTIVE SUMMARY

Early on July 27, 1996, while the Panamanian passenger ship *Universe Explorer* was en route from Juneau, Alaska, to Glacier Bay, Alaska with 1,006 people aboard, a fire started in the main laundry. Dense smoke and heat spread upward to a deck on which crew quarters were located. Five crewmembers died from smoke inhalation, and 55 crewmembers and 1 passenger sustained minor or serious injuries. One passenger required medical treatment as a result of a pre-existing condition. Sixty-nine people were transported to area hospitals, where 13 of the injured were admitted for further treatment. The estimated damage to the vessel was $1.5 million.

The National Transportation Safety Board determines that the probable cause of this accident was a lack of effective oversight by New Commodore Cruise Lines, Ltd., and the predecessor of V. Ships Marine, Ltd. (International Marine Carriers, Inc.), who allowed physical conditions and operating procedures to exist that compromised the fire safety of the *Universe Explorer*, ultimately resulting in crewmember deaths and injuries from a fire of undetermined origin in the vessel's main laundry. Contributing to the loss of life and injuries was the lack of sprinkler systems, the lack of automatic local-sounding fire alarms, and the rapid spread of smoke through open doors into the crew berthing area.

The major safety issues discussed in this report are the adequacy of shipboard communications; the adequacy of fire prevention, detection, and control measures; the adequacy of emergency procedures; and the adequacy of oversight.

As a result of its investigation of this accident, the Safety Board makes recommendations to the U.S. Coast Guard, New Commodore Cruise Lines, Ltd., V. Ships Marine, Ltd., the International Council of Cruise Lines, and the American Bureau of Shipping.

INVESTIGATION

On July 27, 1996, shortly before 0300,[1] a fire started in the main laundry of the Panamanian passenger ship *Universe Explorer* (figure 1), which was en route from Juneau, Alaska, to Glacier Bay, Alaska, with 1,006 people aboard. Dense smoke and heat spread upward two levels from the deck on which the main laundry was located to a deck on which crew quarters were located. Five crewmembers died from smoke inhalation, and 55 crewmembers and 1 passenger sustained minor or serious injuries. One passenger required medical treatment as a result of a pre-existing condition. Sixty-nine people were transported to area hospitals, where 13 victims of serious injuries were admitted for further treatment. The following narrative is based on interviews with crewmembers and surveys with passengers.

Accident Narrative

On July 23, 1996, the *Universe Explorer* departed Vancouver, British Columbia, with 732 passengers and 274 crewmembers on board for a pleasure cruise of Alaskan waters. The cruise itinerary was north, through the Inside Passage, to Ketchikan, Juneau, Glacier Bay, Wrangell, and then back to Vancouver.

About 1030, on July 26, the *Universe Explorer* arrived at the Juneau, Alaska, Municipal Dock, where it remained moored all day. According to the master, the trip from Vancouver was without incident. He received no reports of mechanical problems with the ship or with any equipment aboard the ship, including the machinery in the ship's main laundry. The laundry manager stated that he personally cleaned the clothes dryers' lint traps about 1745 in preparation for shutting down the main laundry for the night at 1800. He said that after shutting off all machinery, the entire laundry crew left the laundry area together. They then ate dinner as a group and went ashore for a sightseeing excursion in Juneau.

Figure 1—The *Universe Explorer*

About midnight, the cruise ship departed Juneau bound for Glacier Bay. The master retired to his cabin about 0240 on July 27, 1996, leaving instructions with the watch officer to call him at 0500 or earlier should any problem occur. The master said that when he left the bridge, no problems of any kind had been reported on the ship. After the master left, the navigation watch consisted of a pilot, the second officer, a helmsman, and a lookout. About this time, the ship had rounded Retreat Point and was entering the Lynn Canal (figure 2).

About 0250, the fire watch returned to the navigation bridge after completing his 0200-round of the ship and reported that everything was "okay" to the watch officer. Shortly before 0300, the fire watch left the bridge on his next

[1] All times are local, based on a 24-hour clock.

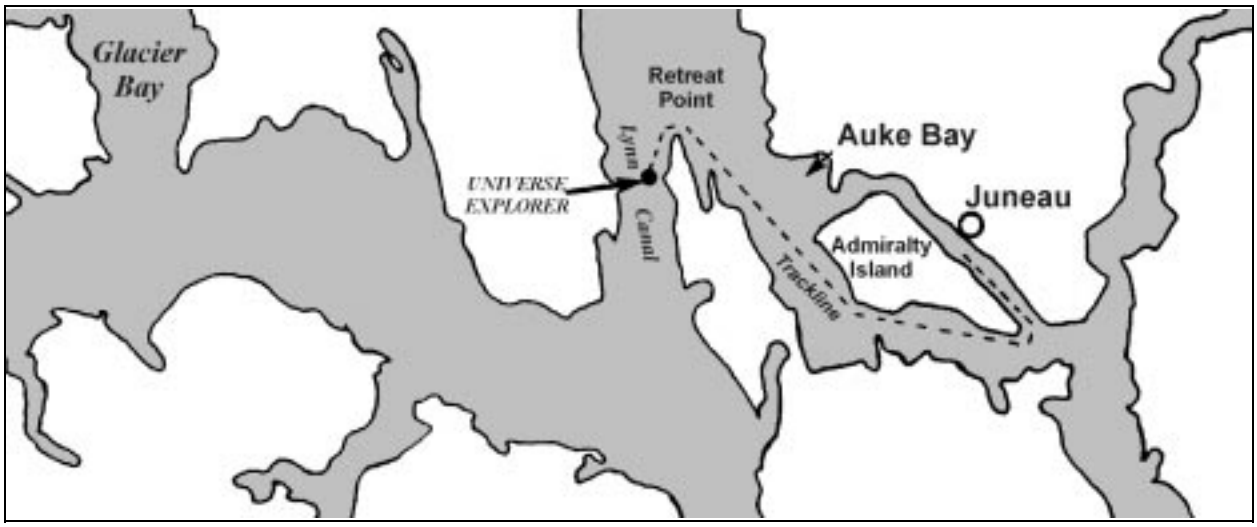


Figure 2—Location of the *Universe Explorer* when the fire occurred.

round. At 0259,[2] an audible heat-detector alarm sounded on the fire alarm panel on the bridge (figure 3). The second officer said he noted that the panel indicated the activated heat detector was in the main laundry on E-deck (figure 4). Thinking it might be a false alarm, he used a UHF radio to call and instruct the fire watch to investigate the alarm source in the main laundry. The fire watch said that he was on the Promenade deck near the swimming pool when he received the call and that, after acknowledging the radio transmission, he started toward the main laundry.

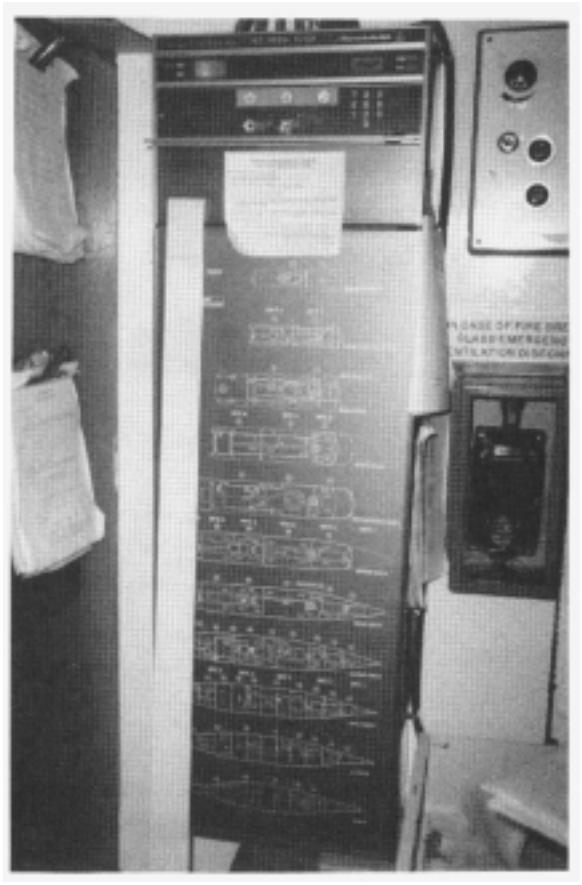
The second officer said that he had started to check the ship's navigational position when a second audible alarm on the fire alarm panel sounded less than a minute later. He said that he became highly concerned because a second alarm typically did not sound in a false alarm situation; he immediately focused his attention on the fire alarm panel. The alarm printout indicated that a smoke detector had activated in the fan room on the Aloha deck near break no. 1 (figure 5). Using a UHF radio, the second officer called the fire watchman, but heard no response, although the fire watch had heard and acknowledged the transmission from the bridge. The second officer then transmitted, "If you can hear me, report [by radio] to the bridge and then go to the Aloha deck fan room." He said that when he did not receive any response, he repeated the message.

The second officer said that multiple fire alarms then began to activate on the fire alarm panel faster than he could read the printout. He immediately telephoned the master, the staff captain, and the safety officer to come to the bridge. He said all three officers arrived on the bridge within a minute. The master said that when he arrived on the bridge, he immediately ordered the engines stopped, the remotely operated fire doors closed, the power ventilation shut down, and the code phrase "Mr. Skylight"[3] announced over the public address system.

Meanwhile, in response to the second officer's second radio call, the fire watch had gone down to the Main deck. The fire watch said he was walking forward, intending to go to the fan room as instructed; however, he could not reach break no. 1 because he encountered thick smoke. He said that he realized his radio was ineffective from his location, so he tried to use the ship's

[2] The fire alarm panel printout indicates that this alarm sounded at 0256. According to the vessel operator, the fire alarm panel clock was about 3 minutes slow.

[3] "Mr. Skylight" was a code phrase broadcast to alert the crew to report to their emergency stations. The *Universe Explorer* had two fire teams, each consisting of 10 people, including a fire team leader. Fire team no. 1 was composed of deck department personnel, and fire team no. 2 was composed of engineering department personnel.



Log of Activated Detectors	
Time of Activation	**Location of Alarm**
0256:42	Main Laundry - E deck
0257:32	Fan Room - Aloha deck
0257:35	Stairwell - Aloha deck
0257:44	Conveyor room - Aloha deck
0257:48	Break no. 1, port side - Aloha deck
0257:53	Main laundry, port side - E deck
0258:01	Spiral stair near break 1 - Aloha deck
0258:26	Corridor near print shop - Aloha deck
0258:41	Main laundry starboard side - E deck
0300:30	Corridor to crew cabins - Aloha deck
Between 0300:31 and 0301.50, 23 smoke detectors activated, of which 11 were in stairways and corridors.	
0301:51	Crew cabin CA 14 - Aloha deck
0301:53	Crew cabin CB 5 - Bali deck
0301:55	Crew cabin CB 14 - Bali deck
A total of 64 smoke alarms sounded within 7 minutes of the first heat detector alarm. Note: Times are based on the tape printout and have not been corrected for a 3-minute discrepancy. Consequently, the times are 3 minutes slow.	

Figure 3—(Left) The fire alarm panel on the bridge showed a plan view of each deck. When an "addressable" fire detector was triggered, a corresponding panel light turned on, indicating the location of the detector. The panel generated a paper log of all activated fire detectors. The tape shown (left of the deck plans) is of the alarms logged during the *Universe Explorer* fire. (Right) Table shows order of alarms.

telephone to inform the watch officer of the smoke. The telephone to the bridge was busy, so he began running to the bridge. He said that before reaching the bridge, he heard the "Mr. Skylight" announcement and immediately went to his emergency station.

After noting the indicated location of the activated fire detectors, the safety officer left the bridge and proceeded to the emergency gear locker at fire station no. 1 on the Boat deck to obtain a breathing apparatus. There he met the junior second officer, who was the leader of fire team no. 1, and instructed him to assemble his team in the foyer near the purser's office.

The safety officer then left fire station no. 1 alone to begin searching for the exact location of the fire. As he was descending the forward passenger stairway, he encountered smoke at the Main deck level, whereupon he radioed the bridge. The master then ordered the general alarm[4] sounded and radioed the Coast Guard 17th District Command Center in Juneau that the vessel had a fire on board.

The safety officer exited the forward passenger stairwell on Aloha deck and proceeded

[4] Seven short blasts and one long blast on the ship's whistle supplemented by the same signal on the ship's general alarm bell. The staff captain stated that he sounded this signal twice to ensure that everyone on board heard it.

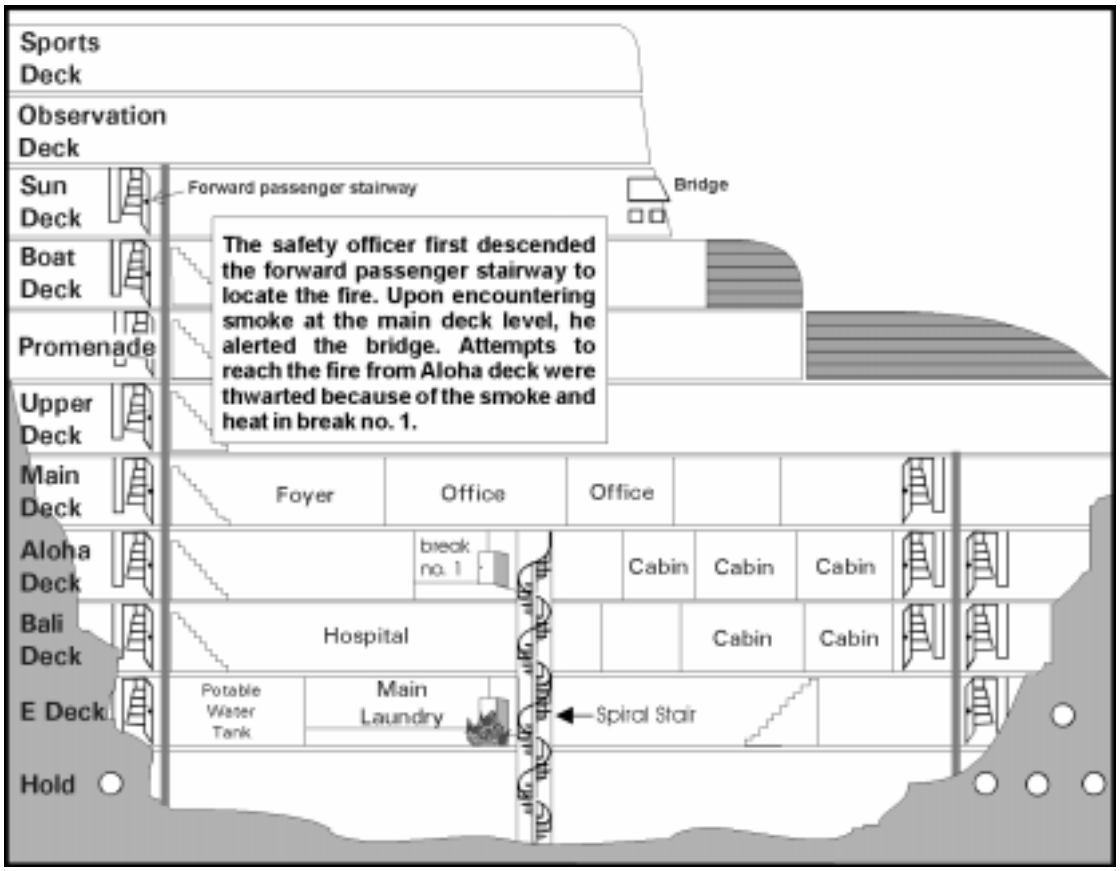


Figure 4—Side cutaway view of the *Universe Explorer*. The fire was in the main laundry on E deck, next to an open door to a spiral stairwell. The electromagnetic fire doors on E deck and Aloha deck remained open until the master ordered all fire doors closed. The crew deaths occurred in cabins and passageways forward of the spiral stairwell on the Aloha deck level.

forward through the port side passageway to the closed fire door at break no. 1. He said that when he opened the fire door, he encountered heavy black smoke and "tremendous" heat. He immediately closed the door and returned to the foyer area where fire team no. 1 had assembled on the Main deck. He instructed the team to prepare to make entry once he had located the fire source and told the team leader to accompany him to find the exact location of the fire.

The safety officer and the fire team no. 1 leader provided different estimates of how long the two of them searched before finding the source of the fire. The safety officer estimated that they discovered the fire about 35 minutes after they began searching; the fire team leader estimated that they found the fire about 45 minutes after they began searching.

The two men first descended to Aloha deck and went forward through the starboard-side passageway. When they opened the closed fire door at break no. 1, they were driven back by "tremendous smoke." They then descended to Bali deck, where they noted high levels of heat, especially near the hospital, but less smoke and no flames. They proceeded to the forward-most stairway on Bali deck and ascended to Aloha deck, where they heard people calling for help. They located 10 crewmembers trapped in their cabins by heavy smoke and led them to safety.

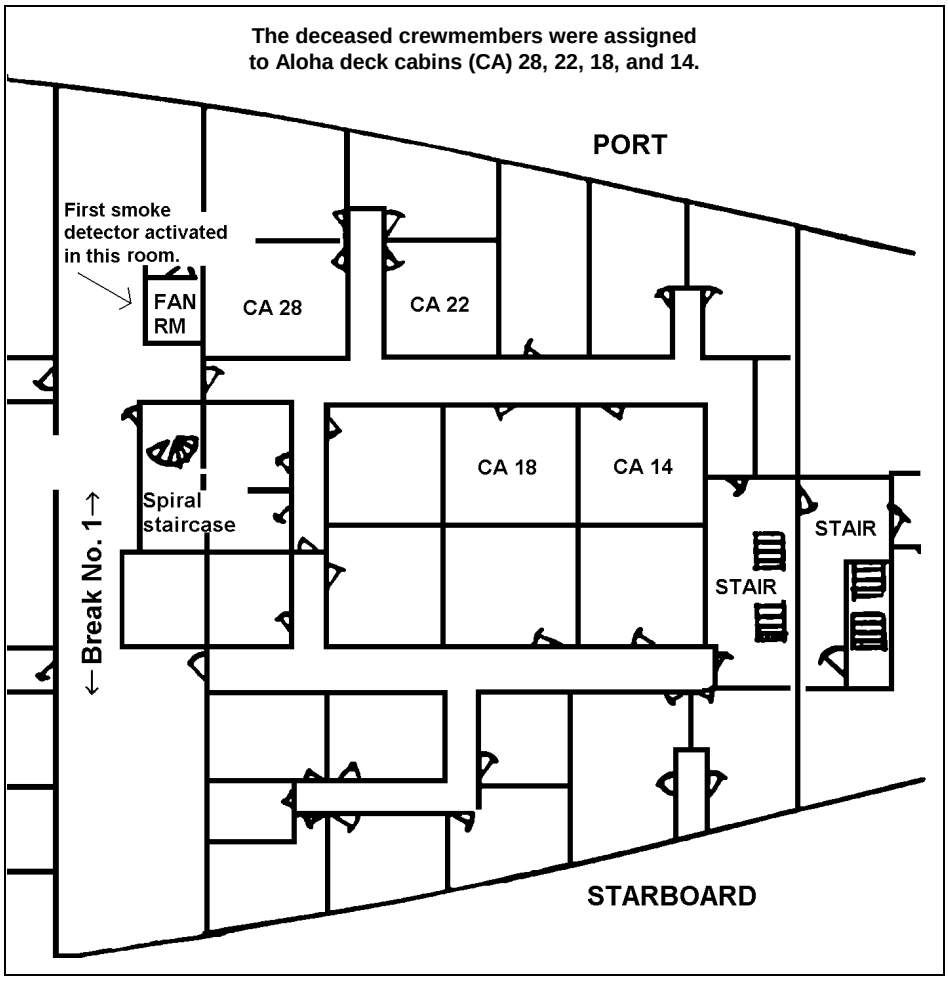


Figure 5—Plan view of Aloha deck. The second fire alarm that sounded on the bridge was triggered by a smoke detector in the fan room near break no. 1, an athwartship passageway. The nearby spiral staircase extended down from the Aloha deck to the Hold deck. On E deck, this stairway accessed the forward portion of the main laundry. The doors to the spiral stairway were remotely operated fire doors that remained open until closed by the bridge.

The safety officer then received a radio call from the bridge to proceed to the crew galley on Bali deck, where fire team no. 2 had assembled.

After complying with the radio call, the safety officer and the leader of fire team no. 1 descended a stairway aft of the galley to E deck and walked forward to the watertight door aft of the main laundry. When they opened the door, they encountered "heavy black smoke," which they walked through. Upon entering the main laundry, they saw flames on the steam napkin press and in laundry bins next to the forward bulkhead of the laundry. The safety officer said that material in the laundry bins was on fire and that there were large volumes of black smoke.

The safety officer and the fire team no. 1 leader began to battle the blaze using extinguishers and charged fire hoses from fire stations near the main laundry. The safety officer radioed a report of the fire location to the bridge, instructing the staff engineer to have the electrician shut off the electricity to the main laundry and to have fire team no. 2 come to the laundry. The safety officer and the fire team no. 1 leader then took turns directing the water from one hose while fire team no. 2 personnel

Table 1—Injuries Sustained in *Universe Explorer* Accident

	PASSENGERS	CREW	TOTAL
FATAL	0	5	5
SERIOUS	1	12	13
MINOR	1	43	44
NONE	730	214	944
TOTAL	**732**	**274**	**1,006**

49 *Code of Federal Regulations* (CFR) 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident" and serious injury as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface."

directed water from the second hose on the fire until they brought it under control, which was between 0410 and 0415. The vessel firefighters extinguished the fire by 0615.

After examining the main laundry and surrounding areas, the safety officer set up a reflash watch. About 0730, he noticed white smoke emanating from wiring in the overhead. Even though he did not see any sparks or flames, as a precaution, he radioed the bridge to report a reflash of the fire. Meanwhile, the fire team no. 1 leader discharged several portable CO_2 fire extinguishers on the smoking wiring, and the electrician completely shut off all electric power to main vertical zones (MVZs)[5] nos. 1 and 2, except for the emergency lights. Following the discharge of the CO_2 extinguishers, the wires stopped smoking.

As soon as the fire was discovered, the master ordered the vessel to proceed to anchorage in Auke Bay, where passengers and injured crew were transferred ashore. The fire resulted in the death of five crewmembers on Aloha deck. Rescuers found the bodies of three deceased crewmen in the passageway about 0325 and two deceased crewmen in their cabins about 0540. A total of 67 crewmembers and 2 passengers were transported to area hospitals where, after preliminary examination, 57 required treatment.

Injuries

Table 1 is based on the injury criteria of the International Civil Aviation Organization, which the Safety Board uses in accident reports for all transportation modes.

Damages

A representative for the operating company of the *Universe Explorer* estimated the total damages to the vessel at $1.5 million.

Personnel Information

General—According to the official crew list, the *Universe Explorer* was staffed by a multinational crew of 274 individuals. The master was a U.S. citizen; the staff captain was a Norwegian citizen; and most of the other licensed officers were Greek, Philippine, or U.S.

[5] A vessel's hull, superstructure, and deckhouses are sectioned into main vertical zones, which generally do not exceed a mean length of 131 feet on any one deck and which are divided by fire-resisting bulkheads. Additional information about the structural requirements of MVZs appears under *Vessel Information*.

citizens. About half of the crewmembers were Philippine citizens; the rest were of various nationalities. The common language for communication was English. All were properly licensed or certificated under Panamanian law. Information about crew training in emergency response and evacuation procedures appears in the *Survival Factors* section of this report.

The Safety Board examined the certification and work experience for the five licensed officers who had prominent roles in the response.

Master—The *Universe Explorer* master, age 56, began sailing in 1958. He received his original (German) master's license in 1969 and had accumulated 15 years' experience as a master at the time of the accident. He had been most recently licensed as a master of ocean-going vessels of any gross tonnage on August 12, 1993, by the Republic of Panama. His past experience included duty assignments as safety officer and staff captain on various vessels and director of marine operations for Commodore Cruise Lines. Before joining the *Universe Explorer* on July 19, 1996, he served as master of a sister ship, the *Enchanted Isle*, from February to June 1996.

Staff Captain—A duty of the staff captain, age 53, was to serve as rescue coordinator during emergencies. He began sailing when he was 16 years old and received his original (Norwegian) master's license in 1974. He had been most recently licensed as a master of ocean-going vessels of any gross tonnage on October 22, 1992, by the Republic of Panama. He had sailed as chief officer, staff captain, and master of several different types of cargo and passenger vessels. From 1986 to 1992, he was vice president of operations for Palm Beach Cruises. He returned to sea in 1992, serving in succession on the following vessels: the *Enchanted Isle*, the *Crown Dynasty*, the *Crown Jewel*, and the *Universe Explorer*.

Safety Officer—During emergencies, the safety officer, age 34, served as the on-scene commander. He began sailing on cargo ships in May 1982, following his graduation from the Croatian Maritime Academy in September 1981. Between August 1985 and May 1990, he worked ashore. He resumed sailing in 1990 and had served on cruise ships since then. He had been most recently licensed as a first officer of ocean-going vessels of any gross tonnage on January 17, 1995, by the Republic of Panama.

In July 1991, the safety officer completed a 7-day course in Coast Guard-approved basic and advanced shipboard firefighting conducted by Delgado Community College in New Orleans, Louisiana. He had served as the safety officer on the *Universe Explorer* since November 1994, which required that he maintain the lifesaving equipment and train the crew in emergency response procedures.

Senior Second Officer—On the evening of the accident, the senior second officer, age 41, was standing the 0000-0400 watch. He began sailing in May 1980, following his graduation from the California Maritime College. He received his original master's license (U.S.) in 1988 and had sailed for 5 years as master on cruise ships and cargo ships. He had been most recently licensed as master of ocean-going vessels of any gross tonnage on March 24, 1995, by the Republic of Panama. He joined the *Universe Explorer* as senior second officer on July 20, 1996.

Junior Second Officer—A secondary duty of the junior second officer, age 31, was to serve as the leader of fire team no. 1. He graduated from the State University of New York Maritime College in January 1990 with a B.S. degree in electrical engineering and dual licenses as third mate and third assistant engineer. His cadet training also included firefighting training. He had been most recently licensed as first officer of ocean-going vessels of any gross tonnage on July 17, 1996, by the Republic of Panama. Since his graduation from college, he had served in a variety of assignments for several companies. On July 20, 1996, he joined Commodore Cruise Lines as junior second officer on board the *Universe Explorer*.

Vessel Information

History—The *Universe Explorer* was built as a combination passenger/cargo ship in 1958 by Ingalls Shipbuilding Corporation in Pascagoula, Mississippi. Named the SS *Brasil* by its original owner, Moore-McCormack Lines, the vessel sailed under U.S. registry until 1972, when its then new owner, Holland America Lines, placed it under Netherlands Antilles registry and renamed it the *Volendam*.

The ship has been sold and renamed several times. After Holland America, the following companies purchased the vessel in the years indicated: Banstead Shipping Ltd., 1987; Orley Shipping Company, Inc., 1987; Bermuda Star Line, Inc., 1989; Brazil Caribbean Shipping Co., Inc., 1993; and Azure Investments, Inc., 1995. According to the American Bureau of Shipping (ABS), with which the vessel was classed at the time, the ship was placed under Panamanian flag in September 1975. The vessel transferred class to Lloyd's Register of Shipping (LR) in 1976 and returned to ABS class in 1984. In 1990, Bermuda Star Line, Inc., which operated the vessel under the name the *Queen of Bermuda*, consolidated with Commodore Cruise Lines, and the ship was renamed the *Enchanted Seas*. From 1990 until April 1995, Commodore Cruise Lines operated the vessel on weekly pleasure cruises from New Orleans. The vessel was then taken out of service and placed in a lay-up status until it was sold to its present owner.

Before purchasing the vessel, representatives for the prospective owner, Azure Investments, Inc., a Panamanian corporation, and Coast Guard officials discussed its compliance with amendments to *The International Convention for the Safety of Life at Sea, 1974* (SOLAS 74), requirements established by the International Maritime Organization (IMO).[6] Coast Guard files contain a record of a March 29, 1995, telephone conversation with the prospective owner's representative indicating that the vessel would comply with applicable fire safety requirements adopted by IMO in May 1992.

In April 1995, representatives for Azure Investments, met with senior Coast Guard officials to discuss possibly reflagging the vessel under U.S. flag. Toward this effort, they asked that the Coast Guard provide a copy of its complete file of records concerning the *Universe Explorer*, then named the *Enchanted Seas*.

The prospective owner subsequently had inspections of the vessel performed by various marine technical specialists, who determined that the vessel could be returned to U.S. flag, including making upgrades to bring it into compliance with SOLAS requirements effective in October 1997, at a cost that the owner termed a "reasonable expense." The new SOLAS requirements, commonly known as the Retroactive Fire Safety Amendments (RFSAs), are discussed in the *Other* section of this report.

For the project of complying with the RFSAs, Petrochem Marine Consultants (PMC), whose principals were three former Coast Guard technical staff members, was designated as the design agent and point of contact.

On July 15, 1995, Azure Investments, the present owner, purchased the vessel and changed its name to *Universe Explorer*.[7] Some time after purchasing the vessel, the vessel owner elected to put the proposed reflagging project "on hold."

Azure Investments chartered the vessel to New Commodore Cruise Lines, Ltd. (New Commodore), a Bermuda corporation, which operated as Commodore Cruise Lines. New Commodore, in turn, contracted International

[6] The IMO, a United Nations organization comprising 137 member states, establishes international maritime safety standards for the ships of nations that are signatories to the SOLAS conventions.

[7] In addition to the names listed above, the ship has sailed as the *Canada Star*, the *Liberte*, the *Island Sun*, and the *Monarch Sun*.

Marine Carriers, Inc., a New York corporation, to manage and operate the ship.[8]

The *Universe Explorer* remained out of service another 6 months. Between October 1995 and January 1996, it underwent modifications to prepare it for operating under charter to the Institute for Shipboard Education, which operates a college program in association with the University of Pittsburgh. The vessel's casino was converted into a library and computer center, and other areas were partitioned for classrooms.

In November 1995, officials from the Coast Guard Marine Safety Center (MSC) wrote the vessel operator reminding the company that all passenger vessels constructed before October 1, 1994, were subject to the RFSAs. The Coast Guard enclosed a copy of the new requirements and a copy of guidelines for meeting the requirements.

In January 1996, the *Universe Explorer* was returned to service, sailing on a Caribbean pleasure cruise, which ended February 3, 1996. The vessel then departed on its first semester voyage for the Institute for Shipboard Education, which ended in mid-May. On May 21, 1996, the vessel departed Ensenada, Mexico, on a summer semester voyage, which ended on July 19, 1996, in Seattle, Washington.

After disembarking university students, faculty, and administrative staff in Seattle, the *Universe Explorer* went to Canada, from where it departed Vancouver on July 23, 1996, for a pleasure cruise of Alaskan waters. During this cruise, the fire that is the subject of this report occurred in the main laundry on E deck.

General Construction—The steam-turbine-propelled *Universe Explorer* is 617.5 feet long, 84 feet wide, and has a displacement of 22,526 tons. The vessel has 10 decks (figure 4) and is vertically divided by 5 MVZ bulkheads that are "A-class divisions," meaning they are insulated steel barriers designed to prevent the passage of smoke and flame from a fire for 1 hour.

The vessel was built to SOLAS 1948 requirements and to U.S. standards (46 CFR Parts 70 to 89). It was designed according to "Method I" construction, meaning that "noncombustible" materials were to be used and that structural fire boundaries were to be built throughout the vessel to ensure any fire would be restricted to its compartment of origin. The method I standards require strict attention to construction details and certification of the noncombustible nature of the materials used. To maintain the structural fire protection afforded by this method of construction, all modifications to the vessel have to be made either to original construction standards or to higher structural standards in effect at the time of the modification. No structural alteration can be made that may reduce the level of fire safety. A method I-built ship was not required to have, and the original owner of the vessel did not install, automatic sprinkler systems.

Modifications—Coast Guard correspondence indicates the vessel underwent structural modifications in Baltimore, Maryland, between 1962 and 1963 to U.S. standards, in Bremerhaven, Germany, between 1972 and 1973 to SOLAS 60 standards, in Hampton Roads, Virginia, between 1974 and 1978 to SOLAS 60 standards, in Sasebo, Japan, in 1985 to SOLAS 74 standards, and in Avondale, Louisiana, in 1990 to SOLAS 74 standards. The Coast Guard files do not indicate the nature and extent of the modifications.

[8] At the time of the accident, International Marine Carriers, Inc., was in the process of forming a joint venture company with V. Ships Marine, USA. Because International Marine Carriers, Inc., no longer exists, this report henceforth refers to V. Ships Marine, Ltd. (V. Ships) as the vessel operating company. V. Ships is a large ship management company with offices in Europe, the Middle East, and North and South America employing 250 shore-based staff and more than 4,500 seafarers. The company manages various types of merchant ships, including container ships, tankers, bulk carriers, and cruise ships.

A copy of 1964 plans obtained from the U.S. Maritime Administration (MarAd) archives shows that at that time the vessel had two cargo hatches forward of the deckhouse and one hatch aft of the deckhouse. Current plans show that the cargo hatch areas have been converted to offices and crew accommodation spaces on the Main, Bali, and Aloha decks. Structural modifications have been made to the Boat deck, Promenade deck, and Upper deck, the latter of which now has a 75-foot extension. Numerous modifications have been made to interior spaces and furnishings.

In 1989, the *Universe Explorer's* sister ship, which was built to the same method I construction standards, suffered a major fire that damaged 22 cabins while the vessel was undergoing shipyard repairs. As a result of the fire, Coast Guard inspectors determined that both vessels had combustible insulation throughout their interiors. The Coast Guard subsequently required that this insulation be removed from both vessels as a condition of their being allowed to continue embarking passengers in the United States.[9] Further, as an interim measure, the Coast Guard required that additional smoke detectors be installed and that the number of roving fire patrols be increased until the insulation removal was completed. Coast Guard records indicate that the removal project was completed for both vessels in January 1991. However, the records also note that some insulation could not be removed because it was in inaccessible areas.

Main Laundry—The fire on the *Universe Explorer* ignited in the main laundry on E deck within MVZ no. 2. The main laundry area was accessible by two stairways, each of which was enclosed in a vertical A-class trunk. Both stairwells extended from Hold deck to Aloha deck. The stairwell opening onto the aft end of the laundry also opened onto Bali deck and Aloha deck. The spiral stairway opening onto the forward end of the laundry also opened onto the Hold deck and the Aloha deck.

The steel fire screen doors in these stairways were electromagnetically controlled. During normal operations, a magnetic field created by an electric current held the doors open. In the event of an emergency, the fire screen doors could be closed either remotely from the bridge or at the door position by a person shutting off the electrical current switch. The fire screen doors then shut under their own weight, assisted by a spring-loaded closing mechanism.

The aft access to the main laundry had a power-activated sliding watertight door that was operable locally and remotely from the navigation bridge. The laundry manager said that the laundry doors were not locked after the laundry crew went off duty so that crewmembers could bring soiled uniforms and linen to the laundry after operations had ceased for the day. Rooms for linen storage and cleaning and valet service were along the port side of the laundry.

The laundry manager stated that the doors to these linen and service rooms were usually closed when the rooms were not in use. An unused parcel lift and a mail chute were near the spiral stairway. Safety Board investigators found the access hatches to both the lift and the chute tightly closed after the fire.

Missing Bulkhead—Original vessel construction plans show that the main laundry was on the port side of the ship and enclosed by bulkheads (figure 6). The 1958 plans indicate the presence of a bulkhead in the main laundry that created a corridor from the spiral stairway on the forward end to the stairway on the aft end of the compartment, separating the storage and laundry areas from the stairways in accordance with 46 CFR 72.05-20 (f), which states the following:

[9] The type and scope of Coast Guard examinations are discussed in greater detail later in this section.

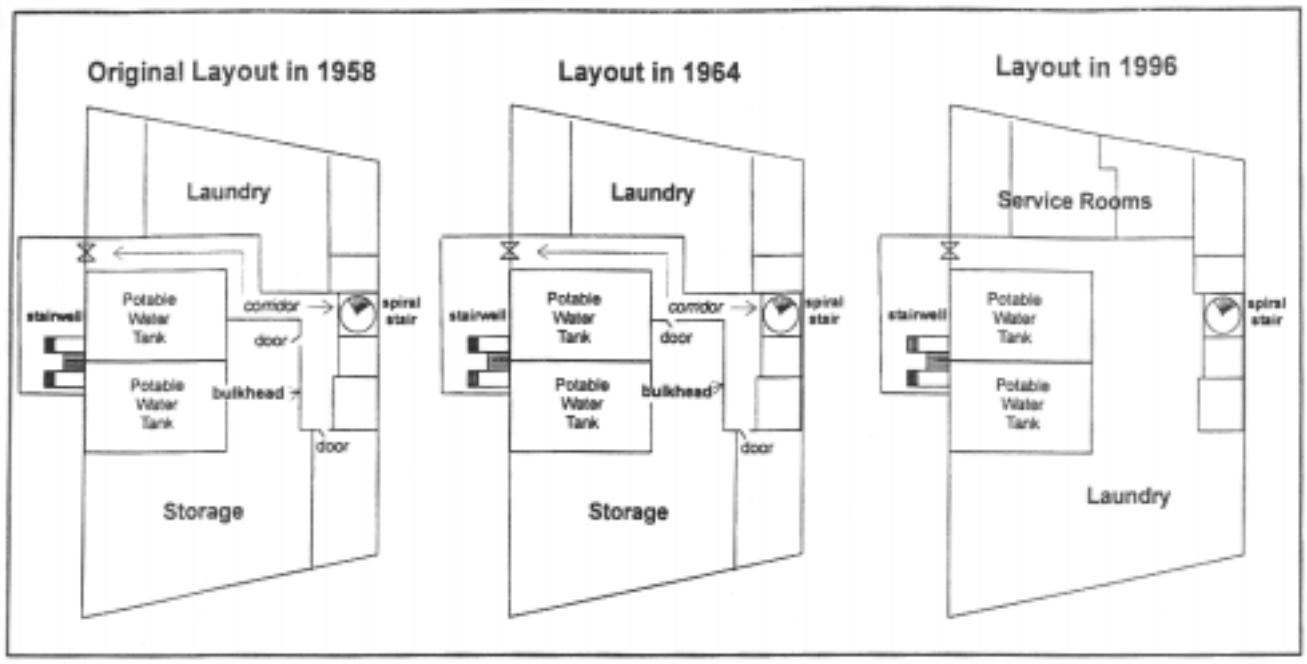


Figure 6—(Left) Main laundry layout as originally designed with a bulkhead forming a corridor between the forward and aft stairways and separating the storage and laundry areas from the stairways in accordance with 46 CFR, the U.S. interpretation of SOLAS 48. (Center) Layout as modified in 1964 and as shown on the vessel control plan. (Right) Layout of the main laundry as found during the postaccident examination.

> Insofar as is reasonable and practicable, Types 1 & 2 stairways[10]…should not give direct access to accommodations or other enclosed spaces in which a fire may originate [footnote added].

The 1964 plans from the MarAd archives, which reflect the structural modifications made in Baltimore, indicate that the main laundry bulkhead forming the corridor between the forward and aft stairways was still in place, although the access door into the storage area had been moved.

The *Universe Explorer*'s fire control plan, which had been approved by the ABS in January 1991, also indicates the presence of the main laundry corridor bulkhead. SOLAS requirements at Regulation 20, "Fire control plans," stipulate, in part:

> In all ships general arrangement plans shall be permanently exhibited for the guidance of the ship's officers, showing clearly for each deck the control stations, the various fire sections enclosed by 'A' class divisions, the sections enclosed by 'B' class divisions together with particulars of the fire detection and fire alarm systems…. Plans…shall be kept up to date, any alterations being recorded thereon as soon as practicable.

During postaccident examination, Safety Board investigators observed that most of the corridor bulkhead had been cut away; only the top 12 to 18 inches of the bulkhead extended down from the overhead structural deck. Vessel officers had no information about when or why this bulkhead had been removed. V. Ships, the *Universe Explorer* operator, subsequently provided information stating that the main laundry area was modified between 1972 and 1974 at the Lloyd-Werft Shipyard, when the ship was being operated by Holland America Lines. The Safety Board found no records showing the nature of the modifications or when they were made. Lloyd's

[10] Type 1 stairways are enclosed stair towers bordering MVZs. Type 2 stairways are enclosed stairways other than type 1.

Register of Shipping (LR) advised the Safety Board that its file records indicate that "the corridor bulkhead was in place during the period of Classification by LR" and that none of its survey reports note its removal. The ABS stated that its files had no correspondence, drawings, or information indicating that it was ever advised the bulkhead was going to be or had been removed and that it did not know when the bulkhead was removed. However, the ABS further advised that the bulkhead was not required to be in place to comply either with the ABS classification requirements or the statutory requirements of the flag administration, Panama, at the time of the casualty. The ABS stated:

> This ship complies…with SOLAS 74/78, as amended, as an existing ship[11] using Method I Fire Protection as a basis when built plus SOLAS amendments, as applicable [footnote added].

After this accident, the *Universe Explorer* owner installed a bulkhead isolating the main laundry from direct access to both stairwells in compliance with the RFSAs.

Laundry Equipment—The laundry machinery, which included five washers and seven dryers (figure 7), was electrically powered industrial equipment. Other machinery included a steam napkin press and a large roller press. According to the laundry manager, the napkin press was not turned on or used the day before the accident occurred. The laundry manager also stated that, in accordance with regular operating procedures, all laundry machinery was turned off at 1800 on the eve of the accident.

Three large, solid-sided cylindrical fiberglass bins, each about 4 feet high and 30 inches in diameter, and four oblong solid-sided aluminum bins, each about 3 feet high, 3 feet wide, and 30 inches deep, were used as hampers for dirty linen, including uniforms, table linens, bed linens, towels, and washcloths. The laundry manager said that when he left the laundry at 1800 on the evening before the fire, all of the bins were piled high with soiled laundry, but no laundry was lying on the deck. During its post-accident examination of the area, the Safety Board was unable to verify whether the linen was clean or soiled or where it had been because firefighters had scattered the unburned linen to ensure that the fire was extinguished.

Welding Machines—To facilitate shipboard maintenance and repair, electric welding machines were stationed at various locations on the *Universe Explorer*. In the weeks before the fire, a welding machine had been in the main laundry for repair of a sewage tank below the main laundry, in the Hold. The welding machine was fastened to the deck and immediately starboard of the spiral stairway. Hot-work permits issued by the staff engineer indicate that welding was performed in the forward sewage tank area between June 26 and July 15, 1996. Various company employees stated that no hot-work permits were issued and no cutting or welding was done in or near the main laundry on the day before the fire.

According to the ship's hotel manager, before the *Universe Explorer* arrived in Seattle, Washington, on July 19, 1996, the main laundry had received a general inspection by the master and was found to be in a satisfactory condition. The hotel manager further stated that no written report was made of these inspections. According to V. Ships, a written report typically is not prepared unless the master notes defects that require correction.

Postaccident Area Inspection—In the forwardmost cleaning room of the laundry, Safety Board investigators observed that the bulkhead had a new coat of paint and that an open can of waterbased paint and nonflammable painting and cleaning materials were on the deck. A description of the fire damage appears in the *Wreckage* section of this report.

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[11] An "existing ship" means a vessel having a keel that is laid on or after the effective date of the particular Convention.

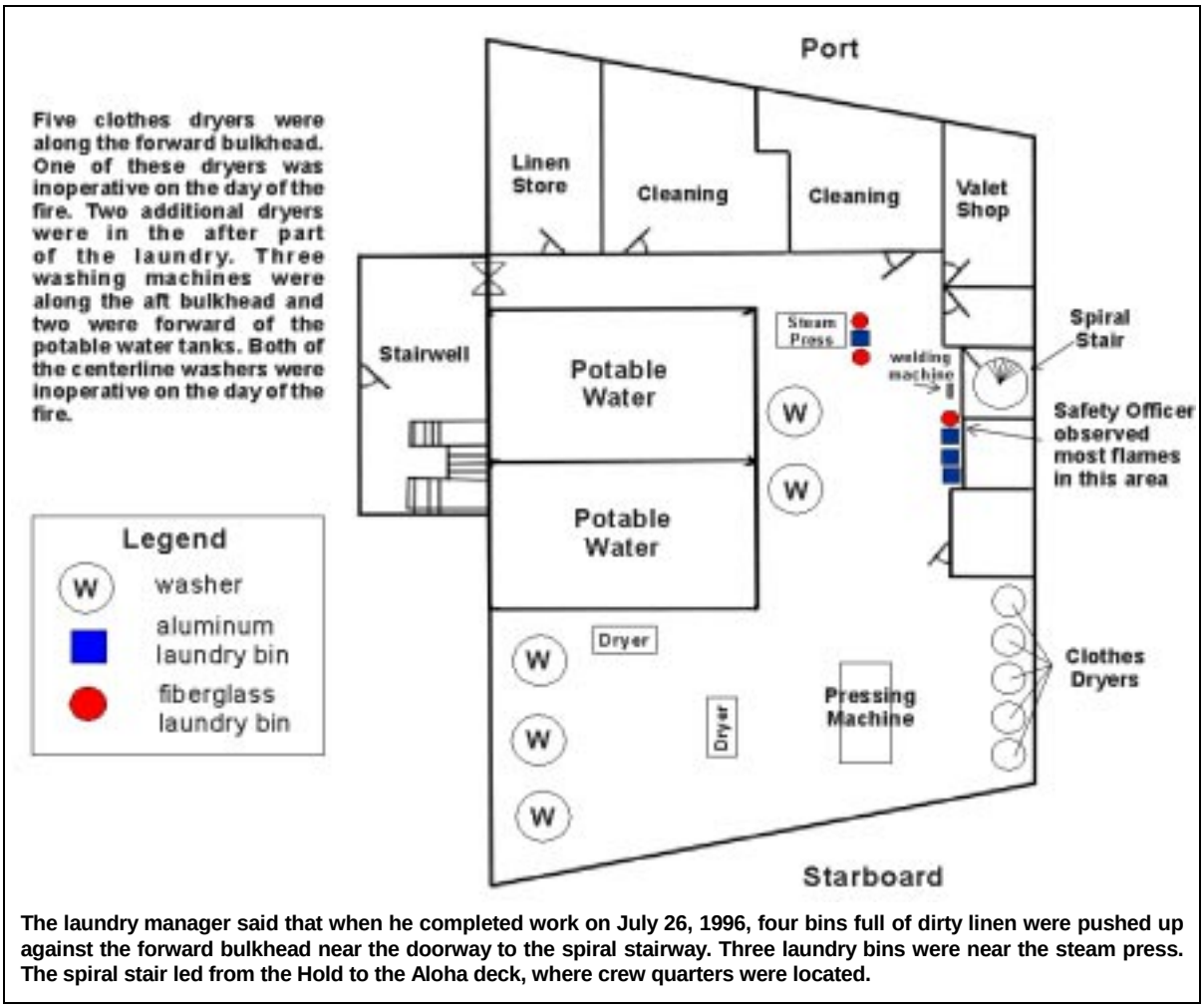

Figure 7—Main laundry area, showing the location of equipment.

Fire Systems and Equipment—The *Universe Explorer* was equipped with a fire detection and alarm system throughout the accommodation and services spaces. Components of the system are described below.

Fire detection system—The vessel's fire detection system used heat-actuated, smoke-actuated, and flame-actuated sensor devices, each of which was depicted on the Fire Detection Plan. Smoke detectors were installed in the crew cabins, crew corridors, and crew service spaces on the Aloha and Bali decks and in the passenger cabins, passenger corridors, and public spaces on all other decks. Heat detectors were in the crew's galley, the main galley, and the main laundry. Flame detectors were in the boiler room, which extends between E deck and Bali deck.

Whenever a detector activated, an indicator light was displayed and an alarm sounded on the fire alarm panel on the bridge; no local alarm automatically sounded in the area of the activated detector. Some detectors were "addressable" devices, which indicate their location; others were "nonaddressable," which indicate only their identification number. To determine the location of an activated nonaddressable detector, one had to refer to the Fire Detection Plan. The fire alarm system recorded the time and location of activated addressable detectors. The bridge also monitored the opening and closing of the fire doors.

During its postaccident investigation of the main laundry, the Safety Board noted that the area not only had addressable heat detectors but also several disconnected smoke detectors in the overhead that were not depicted on either the fire detection plan or the fire control plan. According to the vessel operator, the disconnected detectors were part of the original fire detection system that was replaced by the heat detector system in 1972-1974, when the main laundry was converted from a clean-linen storage area.

Detector limitations—The Safety Board examined fire industry literature and conferred with an electrical engineer specializing in fire detection equipment regarding fire detection devices. The following paragraphs summarize recognized limitations inherent in the heat and smoke detector models installed on the *Universe Explorer*.

Smoke detectors—The *Universe Explorer* had photoelectric (or optical) smoke detectors, which activate when a substance obscures a light beam from reaching the sensory cell. Smoke detectors can detect an early (incipient) fire when it begins to smolder, before it becomes fully developed (free burning). They can be susceptible to false alarms in laundry facilities because water vapor (humidity) or minute solid particles (lint and dust) can act like smoke in blocking the sensor and activating the device. Operators of commercial facilities having smoke detectors typically perform frequent maintenance of the devices to reduce the incidence of false alarms.

Heat detectors—A fixed-temperature heat detector, such as the type installed in the main laundry of the *Universe Explorer*, operates only when the detector itself, not the surrounding air, reaches a preset temperature, in this case 70^0 C (157^0 F). Heat detectors lack the ability to detect a fire during its incipient stage because very little heat emanates from a smoldering fire that has not reached a free-burning stage. If the fire starts on or near the deck and the heat sensor is in the overhead, as was the case with the heat detector in the main laundry, the time it takes for the heat detector to actuate can be considerable.

Generally, heat detectors are less susceptible to false alarms than most smoke detectors. When the main laundry was revamped in the early 1970s, the smoke detectors were replaced with heat detectors. According to the manufacturer's representative, however, the model of heat detector used on the *Universe Explorer* is subject to false alarms if moisture accumulates on the electrical contacts at the base of the device.

Fire alarms—The vessel had manual fire alarms in the passenger and crew accommodation spaces on the vessel. The crew accommodation area forward on the Aloha deck had two pull-cable-type manual alarms that register an audible and visual alarm only on the navigation bridge, and one push-button-type manual fire alarm that activates two local fire alarm bells. None of the manual alarms in the crew berthing area on the Aloha deck was activated by crewmembers during the fire.

Fire doors—All fire doors to the stairways were electromagnetically controlled. Power-actuated watertight doors were installed at each passage through a watertight boundary, including the bulkhead separating the main laundry from the aft stairwell, as required by SOLAS. All fire doors could be controlled remotely from the bridge. The master stated that he ordered the staff captain to close all power-actuated doors when he ordered the sounding of the ship's general alarm at 0305.

On the *Universe Explorer*, fire doors with a spring-closure mechanism were at all entrances to passenger and crew cabins, offices, and service spaces; the junctions of all corridors with public spaces; and the intersections of the longitudinal crew corridors with the breaks on Aloha deck.

During postaccident inspection of the vessel, Safety Board investigators found no soot evidence indicating that smoke entered the cabins from the ventilation system. Investigators observed pieces of twine attached to handrails near the door knobs for the two Aloha deck corridor doors leading forward from the break no. 1 passageway to the crew accommodations area where

the fatalities occurred. The fire alarm printout indicates that a smoke detector in the Aloha deck corridor leading forward from these doors into the crew quarters activated within 4 minutes of the first heat detector fire alarm sounding on the bridge.

Equipment—The *Universe Explorer* was certified as meeting applicable SOLAS requirements for firefighting equipment and lifesaving equipment. When not in use, passengers' lifejackets were stored under the beds in each stateroom

Certification and Inspection of Vessels—Certification of ships and their safety equipment is the responsibility of the government of the country in which the vessel is registered, known as the flag state. The governments of countries that are signatory to the SOLAS convention enact national regulations that conform to IMO requirements. Flag states can and do delegate vessel certification inspections to classification societies.

Given the nature of the regulations, the number of countries signatory to SOLAS, and the number of different organizations that countries authorize to certify compliance with the regulations on their behalf, the interpretation of SOLAS requirements and, consequently, the determination of a vessel's compliance with safety standards, can vary. Therefore, countries have established their own regulatory interpretations and inspections to safeguard their ports and citizens. The Coast Guard, as the U.S. representative, has developed interpretations of SOLAS requirements and submitted them in official position papers to the IMO. These U.S. regulatory interpretations are consolidated into the Coast Guard *SOLAS Guidance Document*,[12] which is used as a reference by Coast Guard examiners to ensure consistency during inspections of foreign flag vessels. The following sections explain the surveys conducted by classification societies, particularly the ABS, which classed the *Universe Explorer* and which last issued a SOLAS Passenger Ship Safety Certificate to the vessel before the casualty, and the control verification examinations (CVEs) performed by the Coast Guard.

Classification Society Surveys—Classification societies, such as the ABS, are paid by vessel owners to survey their merchant ships. The ABS is a not-for-profit organization. The marine insurance industry relies on classification societies to establish and certify a vessel's compliance with hull strength and major engineering systems standards, which are contained in the societies' rules; many marine insurance policies include a provision requiring the insured vessel to be maintained in class with a classification society acceptable to the insurer.

The classification society surveys the major elements of ship design and operation, including the materials used in construction, the size and distribution of structural members, and the vessel machinery for compliance with the society's rules. "Classification" with a society evidences compliance with those rules. One observer has characterized classification as evidencing "the soundness of design for the service for which the vessel is intended."[13]

Quality assurance standards—Since the 1970s, the role of the classification societies in ensuring marine safety has grown. Lord Donaldson's report notes that the demand for services resulted in an increase in the number of classification societies, some of which lacked the resources or expertise to fulfill all the duties expected of them. With the growth in the number of classification societies, some shipowners increasingly put economic pressures on certifying officials, threatening to deal with another society that might not interpret the classification standards as stringently. As a result, in 1994, the International Association of Classification Societies (IACS), which com-

[12] The latest version of the *SOLAS Guidance Document* is revision 1, dated September 1994.

[13] *Safer Ships, Cleaner Seas*—Report of Lord Donaldson's inquiry into merchant shipping pollution prevention. Published by HMSO London, Cm. 2560. May 1994.

prises 11 member and 2 associate societies that class over 90 percent of the world's merchant tonnage,[14] initiated the Quality System Certification Scheme (QSCS) establishing common standards for IACS classification societies. The ABS is a member of IACS.

The American Bureau of Shipping—The *Universe Explorer* was built to ABS classification requirements and classed by ABS upon its delivery in 1958. The vessel transferred to LR classification in September 1976 and transferred back to ABS classification in March 1984. The ABS has technical staff and surveyors stationed in principal U.S. ports and in many ports around the world. Its procedures for the various surveys required to maintain a vessel in class are published annually in its *Rules for Building and Classing Steel Vessels.*

The ABS classification process typically begins when a ship owner submits an ABS Request for Classification Agreement. For a new ship being built to ABS class, the shipyard then submits plans and material specifications for the ABS to review. The ABS technical staff review the plans and specifications and complete calculations to ensure that the proposed ship will be built in accordance with ABS rules.

After the plans and specifications have been approved, they are sent to an ABS field surveyor who travels to the shipyard where the ship will be built to oversee the construction to ensure that the ship is built in compliance with the approved plans and ABS rules. In rare cases, a person qualified in both the plan approval and survey processes may perform both the technical review and approval and the on-board verification.

Surveyors visit the vessel throughout the construction process, periodically checking the ship for compliance. When construction is completed, the vessel and its machinery are assigned an ABS classification, and the vessel then enters into a periodic survey schedule.

The ABS classification survey rules have changed over the years. The ABS surveys applicable to the *Universe Explorer* at the time of this casualty were as follows:

1. *Annual Class Surveys*—ABS Rules 1/3.1.3 stipulate that inspections of hull, machinery, automation, and cargo refrigeration are to be made within 3 months before or after each annual anniversary date of the crediting of the previous Special Periodical Survey or original construction date.

2. *Special Periodical Surveys*—ABS Rules 1/3.1.5 state that these examinations must be completed within 5 years after the date of build or after the previous Special Periodical Survey. Because these surveys include inspecting the scantlings, the ship must be placed in drydock for this type of survey.

3. *Other Surveys*—If an ABS-classed vessel sustains or is suspected to have sustained damage or undergoes modifications that may affect the vessel's classification, the master is responsible for notifying the ABS so that appropriate surveys may be performed.

The ABS checks a vessel's internal arrangements against relevant vessel plans when the ship is taken into ABS classification or when ABS-approved modifications are being made to the vessel. The owner or master is obligated to advise ABS in advance of planned modifications so that necessary reviews, approvals, and surveys may be performed. During subsequent periodic inspections, ABS surveyors are not required to check the vessel's internal arrangements against approved plans to identify any modifications that may have been made without ABS knowledge or approval, although surveyors may identify such modifications in the course of such surveys.

[14] IACS press release, May 1997. The merchant tonnage referred to is self-propelled, sea-going merchant ships of 100 gross tons or greater.

The ABS advised the Safety Board that when the vessel returned from LR to ABS class in 1984, "Initial issuance of SOLAS certificates by ABS in 1985 was based on prior approvals by the previous certifiers," including the Coast Guard, the Netherlands Antilles, and the LR on behalf of Panama, and the ABS plan review of the ship as configured in 1985, and ABS survey.

Between 1985 and the time of this fire, the ABS reviewed and approved a number of operational plans for and conducted a number of surveys of the *Universe Explorer*. A Damage Control Plan approved by the ABS in 1985 and a Lifesaving Plan approved by the ABS in 1990 each show the main laundry without the corridor bulkhead. In 1991, the ABS approved the Fire Control Plan that showed the corridor bulkhead in the main laundry. On May 24, 1995, the ABS, acting on behalf of Panama with respect to statutory certification, issued the *Universe Explorer* a Loadline Certificate, which was valid until January 31, 2000. The ABS conducted an annual loadline survey and issued a Passenger Ship Safety Certificate, which was valid for 1 year from date of issue, on behalf of the Panamanian Government on January 12, 1996, in New Orleans.

According to the present *Universe Explorer* operator, the bulkhead in the main laundry was removed with ABS approval during a conversion completed in the early 1970s while the vessel was being operated by another company. However, the operator has not been able to provide the Safety Board with a copy of any classification society document approving the bulkhead removal. The ABS advised the Board that it has no evidence in its files that it was "informed of, aware of, or approved" the removal of the bulkhead. In correspondence with the Board, the ABS further stated, "This bulkhead was not required to be in place for compliance with ABS classification requirements or the statutory requirements of the flag Administration, Panama, at the time of the casualty." The ABS said that it based its argument on SOLAS 48, Chapter II, Regulation 33(a)(ii), "Protection of Vertical Stairways," which states:

> Stairway enclosures shall have direct communication with the corridors and be of sufficient area to prevent congestion having in view the number of persons likely to use them in an emergency, and shall contain as little accommodation or other enclosed space in which a fire may originate as practicable.

Coast Guard Examinations—As a port state, the United States requires that any foreign cruise ship that is to embark passengers from U.S. ports must be examined by the Coast Guard for "substantial compliance" with the safety, construction, and equipment requirements in applicable conventions.

Current Coast Guard procedures, contained in the agency's *Navigation and Vessel Inspection Circular* (NVIC) *No. 1-93*, effective January 21, 1993, provide guidance regarding necessary Coast Guard examinations for foreign cruise ships operators. Parts A, B, and C provide guidance on the initial CVE process, on annual CVEs, and on quarterly CVEs, respectively.

Initial CVE (Part A of NVIC 1-93)—The Coast Guard conducts a plan review and examinations of foreign vessels meeting one of the following criteria:

1. The vessel (new or existing) intends to embark passengers for the first time from a U.S. port;
2. The vessel has undergone a modification or alteration of a "major character" as defined by SOLAS 74;[15]
3. The vessel returns to service more than 1 year after its annual Control Verification Certificate has expired

[15] SOLAS 74, Chapter II-2, Part A, Regulation 1 defines a modification of a "major character" as being any change that substantially alters the dimensions of a ship, that substantially alters the passenger carrying capacity of a ship, or substantially increases a ship's service life.

and the vessel has not received a plan review by the Coast Guard's MSC within 5 years; or

4. The vessel is selected for such examination by the Commandant of the Coast Guard for some other reason.

The plans submitted to the Coast Guard MSC for review must reflect the "as fitted" condition of the vessel and be approved by the flag state administration or a recognized organization acting on behalf of the flag administration. The submission must include a written summary explaining any special considerations, such as equivalencies or exemptions, approved by the flag administration. The fire control plans must show the location of all MVZ boundaries, the insulation value of bulkheads and decks, and the numerical fire risk designation for applicable areas as required by SOLAS. The MSC examines the plans for completeness and certification and adds the Coast Guard stamp and date of review.

After the MSC has conducted the plan review, the ship owner must next arrange for Coast Guard inspectors to perform a verification examination of the vessel itself. Except for initial CVEs conducted while the vessel is still under construction, the Coast Guard will not examine the vessel unless it has been issued a SOLAS Passenger Ship Safety Certificate attesting compliance with all applicable international treaties by the flag administration or its agent.

The Coast Guard circular advises owners and agents to allow up to 4 days in port for an initial CVE, depending upon the size of the vessel and the complexity of its systems. The primary focus of an initial CVE is on structural fire protection, fire protection systems, means of escape, lifesaving equipment, engineering systems, emergency fire and boat drills, and the resolution of plan review comments. Because the purpose of the examination is to verify "substantial" compliance, Coast Guard inspectors are not required to check 100 percent of the applicable equipment or construction features listed in figure 8; they can check a random sampling. However, if they have reason to believe the vessel's safety equipment or material condition is substandard, they have the option of examining the vessel in greater detail.

1. Enclosed Escape Stairways
2. Escape Routes
3. Division Penetrations
4. Fire and Smoke Damper Arrangements
5. Draft Stops
6. Automatic Sprinkler Systems (if applicable)
7. Fire Pumps and Hydrants
8. Fixed Smoke and Heat Detection Systems
9. Fire Doors and Watertight Doors
10. Engineering Systems
11. Emergency Lighting
12. Proliferation of Combustible Construction
13. Lifesaving Systems
14. Reduced Lifeboat Capacity (where applicable)
15. Passenger Launches
16. Counter Flooding Systems
17. Training and Drills
18. Pollution Prevention
19. Navigation Safety, including tests of equipment and verification of charts and publications
20. Housekeeping

Figure 8—Features and equipment types checked during an initial CVE.

Upon successful completion of the initial examination, the Coast Guard issues a Control Verification Certificate that is valid for up to 1 year; it usually is dated to expire on the expiration date of the Passenger Ship Safety Certificate issued by the flag administration.

As mentioned earlier, the *Universe Explorer* originally was a U.S. flag vessel whose construction was certified by the Coast Guard as complying both with SOLAS 48 requirements and U.S. standards. In 1972, it left U.S. registry and began operating as a foreign flag ship.

Between 1980 and 1985, the Coast Guard did not require that a foreign passenger ship applying to embark passengers from a U.S. port undergo a plan review as part of the initial CVE process. When the *Volendam* (now the *Universe Explorer*) applied for an initial CVE in 1983, the Coast Guard did not conduct a plan review as part of its examination. After adopting a revised NVIC in 1985 requiring a plan review for an initial CVE, the Coast Guard did not require that foreign passenger ships already operating from U.S. ports undergo an initial CVE with plan review.

After the 1996 fire, the Coast Guard MSO-Juneau commanding officer revoked the *Universe Explorer*'s control verification certificate and required that the vessel undergo an initial CVE (with plan review) as a condition for certifying it to embark passengers from U.S. ports.

The vessel proceeded to a shipyard in Vancouver, Canada, where repairs were completed. While the ship was in the Canadian shipyard, Coast Guard inspectors journeyed from the Seattle office to conduct the initial CVE. No record indicates that the company submitted any plans to the MSC for an initial CVE as specified by NVIC 1-93. Examination documentation states that Coast Guard inspectors referred to vessel plans while checking the structural fire protection features of the vessel; the source of the plans is not identified. Inspectors selected overhead panels for removal at random to spot-check MVZ penetrations and penetrations of stair tower boundaries. They found areas where penetrations were not properly insulated to maintain the integrity of the fire boundaries; they required that these areas be corrected. Inspectors noted fire doors that did not operate properly; after being closed, the doors could not be easily opened by one person. Inspectors also noted that a new bulkhead separating the E deck main laundry from the stairways had been installed.

Records indicate that the Coast Guard completed its initial CVE of the *Universe Explorer* on August 13, 1996. After all noted deficiencies were corrected, the Coast Guard inspectors issued the vessel a new control verification certificate and it resumed operations.

Annual CVE (Part B of NVIC 1-93)—In order to continue embarking passengers from U.S. ports, foreign flag vessels are required to renew their verification certificates annually. The NVIC 1-93 stipulates that the purpose of the annual CVE is to "focus on the vessel's firefighting, lifesaving, and emergency systems." It also states:

> The vessel should be checked to ensure no modifications have been made which would affect the vessel's structural fire protection, which have not been approved by the vessel's flag state, and reviewed by the MSC.

The annual certification examination has 13 categories, most of which deal with random testing of systems and with observing the conduct of fire and boat drills. The first check in the examination process is a review of required documents and certificates. The NVIC 1-93 does not stipulate how detailed the review should be. Such detail is left to the inspector's discretion. The procedures dealing with the structural check of the vessel stipulate that the inspector conduct a walk-through of the vessel to ensure that "no new additions have been made without approved plans" and that stairways and escape routes are properly marked and free of blockage.

Upon successful completion of an annual CVE, the Coast Guard issues a new control verification certificate that is good for up to 1 year. Before the accident, the Coast Guard last issued the *Universe Explorer* a control verification examination certificate on January 12, 1996.

Quarterly CVE (Part C of NVIC 1-93)—The stated purpose of the quarterly examination, is "to ensure the vessel is operated in a safe manner." The quarterly examination focuses on the training and knowledge of the ship's officers and crew in regard to the vessel's emergency procedures, firefighting procedures, and lifesaving systems. The

examination includes evaluating the crew's performance during drills and reviewing instructions and manuals for completeness. The extent of the vessel examination is "at the discretion of the attending inspectors" and is determined by the observed condition of the ship. Instructions for a general walk-through state that the inspectors should check the engine room, machinery spaces, and accommodation spaces. The NVIC 1-93 states that any modifications to the vessel since its last examination should be pointed out to inspectors. Upon completion of a quarterly CVE, the inspector records the date of the examination in the Coast Guard data base and on a Vessel Inspection Record maintained on board the vessel.

Records indicate that before the fire, the last quarterly control verification examination of the *Universe Explorer* was performed in Seattle, Washington, on July 20, 1996. During this examination, Coast Guard inspectors witnessed a drill simulating a fire in the main laundry and determined that the drill procedures were satisfactory. The *Universe Explorer* subsequently underwent routine quarterly CVEs in December 1996, May 1997, and August 1997. Table 2 details the date, location of the Coast Guard office conducting the examination, and type of examination conducted on board this vessel from April 1987 to August 1997.

Waterway Information

When the fire was discovered, the *Universe Explorer* had just entered the Lynn Canal, a deep fjord in southeast Alaska that provides a protected waterway inshore of the Chilkat Mountain Range. The canal extends in a roughly northwesterly direction for about 80 miles from Juneau to Skagway, Alaska. In 1996, 36 cruise ships carrying more than 425,000 passengers operated in the waterway.

Operations

General—As mentioned earlier, the *Universe Explorer* alternates between serving as a classroom facility for college students enrolled in the Institute for Shipboard Education and as a cruise ship for passengers on pleasure excursions. V Ships, the vessel operator, states that it allows a transition period between school sessions and cruises for flag state or classification society surveys and needed repairs to be performed, crew changes to take place, new crewmembers to receive required training, and university staff and students to be indoctrinated about shipboard operations. The transition period length varies depending upon the itinerary of the ship. During transition periods, two or three shoreside management representatives typically are on hand to oversee operations.

The V. Ships operations manager said that the *Universe Explorer* is required to maintain communications with shoreside management throughout its voyages. Vessel personnel must transmit via telex and fax daily reports of the vessel's position, speed, and weather. Further, they are required to immediately notify shoreside management of any particular problem on board the vessel. The operations manager stated that when the ship is on an extended voyage of 100 days, V. Ships requires vessel personnel to submit detailed monthly reports, which include such information as engine performance.

Management Oversight—The V. Ships operations manager stated that shoreside management representatives regularly visit the *Universe Explorer* during the vessel's transition periods, at which time they have formal management review meetings with the ship's master and officers. Moreover, shoreside managers are actively involved in ship repairs and maintenance overhauls, and they attend classification society or flag state surveys and Coast Guard verification examinations of the vessel.

Shoreside managers typically travel to and board the vessel during a voyage only if significant repairs have to be made or if a serious problem occurs on the ship while it is at sea. Shoreside managers do not routinely meet the ship at each port of call.

Table 2—Coast Guard Control Verification Examinations of the *Universe Explorer**

Date	Coast Guard Office	Examination Type
August 12, 1997	Seattle, Washington	Quarterly
May 12, 1997	Seattle, Washington	Quarterly
December 23, 1996	Miami, Florida	Quarterly
August 13, 1996	Seattle, Washington	Initial with no plan review
July 20, 1996	Seattle, Washington	Quarterly
May 14, 1996	Seattle, Washington	Quarterly
January 12, 1996	New Orleans, Louisiana	Annual
March 18, 1995	New Orleans, Louisiana	Quarterly
December 17, 1994	New Orleans, Louisiana	Annual
October 8, 1994	New Orleans, Louisiana	Quarterly
April 9, 1994	New Orleans, Louisiana	Quarterly
January 17, 1994	New Orleans, Louisiana	Annual
August 7, 1993	New Orleans, Louisiana	Quarterly
May 1993	New Orleans, Louisiana	Quarterly
February 13, 1993	New Orleans, Louisiana	Quarterly
September 12, 1992	New Orleans, Louisiana	Quarterly
June 13, 1992	New Orleans, Louisiana	**
March 15, 1992	New Orleans, Louisiana	**
July 20, 1991	New York, New York	**
April 6, 1991	New Orleans, Louisiana	**
January 26, 1991	New Orleans, Louisiana	**
October 16, 1990	New York, New York	**
July 20, 1990	New York, New York	**
January 20, 1990	New Orleans, Louisiana	**
December 2, 1989	New Orleans, Louisiana	**
September 2, 1989	New York, New York	**
February 4, 1989	New Orleans, Louisiana	**
September 3, 1988	New York, New York	**
June 25, 1988	New York, New York	**
December 5, 1987	New Orleans, Louisiana	**
September 4, 1987	Providence, Rhode Island	**
April 16, 1987	San Francisco, California	**

* Source: U.S. Coast Guard MSIS Data Base

** Data does not indicate whether the examination was a quarterly or an annual.

V. Ships indicated that it has begun the process for gaining certification under the International Safety Management (ISM) Code, which must be completed by July 1998 for passenger ships. Under the ISM Code, each company must develop a documented safety program that supports and encourages the development of a safety culture to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment and to property.

Ships operated by companies that fail to comply with the ISM Code will be considered in violation of SOLAS and may be prevented from trading. The ISM Code requires each shipowner to establish a safety management system approved by maritime authorities and to receive a Document of Compliance for the shore-based organization and an individual Safety Management Certificate for each ship. Nonconformance with the ISM Code may result in revocation of these certificates.

Fire Response Procedures—The vessel operator provided the Safety Board with the written procedures that the watch officer is to follow in the event of a fire (figure 9).

Fire Watch—SOLAS 74, Chapter II-2, Regulation 40 (6), states:

> For ships carrying more than 36 passengers, an efficient patrol system shall be maintained so that an outbreak of fire may be promptly detected. Each member of the fire patrol shall be trained to be familiar with the arrangements of the ship as well as the location and operation of any equipment he may be called upon to use.

In accordance with SOLAS regulations, the *Universe Explorer* maintained a fire watch, which entailed a crewmember's making hourly rounds of the vessel to check 40 designated locations. Each station had a numbered key permanently attached to it by a chain. The watch carried a recording clock into which he inserted and turned the numbered key. Each key made a unique impression on a paper disk from which the time of insertion could be determined. Each disk contained the fire watch record for 1 day; disks were kept on permanent file for the vessel safety officer to review to ensure that the fire watches were making their rounds correctly.

FIRE ALARM SOUNDS ON BRIDGE.

1. Immediately acknowledge the alarm.
2. Send watch rating or Quartermaster on duty to the place the alarm comes from, equipped with a radio, flashlight, and master key.
3. Check the fire pump is running; if not, start it from the emergency generator room.
4. Upon arrival at the fire zone, the rating reports status of the fire. If possible, he tries to extinguish the fire and rescue any trapped persons. (When the fire groups arrive, the rating can return to the bridge.)
5. As soon as a fire has been confirmed, the Watch Officer announces Mr. Skylight over the P.A., indicating where the fire groups must report.
6. The Watch Officer checks that the fire screen doors are closed.
7. The Master, Staff Captain, Safety Officer, Chief Engineer, Hotel Manager, engine control room, and the front desk are informed of the status of the fire.
8. The Watch Officer takes out relevant safety plans.
9. The Watch Officer directs the firefighting from the bridge until the fire chief (Staff Captain) takes over.
10. When the Master arrives on the bridge, the Watch Officer gives a status report, and when the Command Group is assembled, goes to Mr. Skylight post.

Figure 9—Required response procedures of the bridge watch.

The fire watch route typically began with station no. 1, which was on the navigation bridge, and proceeded in order of numbered stations from the Observation deck to the Sun deck, Upper deck, Main deck, Bali deck, Aloha

deck, E deck, and Hold deck, respectively. Upon inspecting the Hold deck, the watch returned to the bridge. Each tour started on the hour and typically took about 45 minutes. According to the vessel operator, the fire watch's duties (appendix B) included ensuring that fire screen doors were not blocked or lashed open.

The fire watch usually took a staircase aft of the main laundry to descend from Aloha deck to E deck and then walked forward into the main laundry. After checking station no. 36 in the main laundry, he continued forward to the spiral staircase at frame 65 to descend to the Hold deck. After checking the station on the Hold deck, he reversed his route, which meant he walked through the laundry twice within a matter of minutes. Based upon the impression on the paper disk from his clock, the watchman was last in the main laundry about 0229.[16]

Medical Findings

Crewmembers and passengers who were deemed to require additional medical attention initially were transported to Bartlett Memorial Hospital. Four of these patients were taken by medical evacuation flight to either the Virginia Mason Medical Center or the Harbor View Medical Center in Seattle, Washington (table 3).

Fatalities—Records of the general postmortem examinations performed by the State of Alaska Medical Examiner in Juneau, Alaska, on July 28, 1996, indicate that all five men died from "asphyxia due to smoke inhalation."

Toxicological Testing—Regulatory requirements at 46 CFR Part 4 stipulate that the marine employer shall ensure that toxicological specimens are collected as soon as practical from an individual on board the vessel "who is determined to be directly involved in a serious marine incident." The main laundry fire occurred when the area was not staffed. Moreover, the area was not locked and was accessible to everyone on the ship.

When Safety Board investigators arrived at Juneau in the late evening of July 27, 1996, they found that the vessel operator had not arranged for any crewmember to be tested; investigators then asked the operator's representative to have several of the deck and engineering officers submit to routine testing. He agreed and made arrangements to have a technician travel to the scene from Ketchikan, Alaska. The technician arrived aboard the vessel on July 28, 1996, and collected specimens between the hours of 1340 and 1730 on July 28, 1996, from the following officers: master, staff captain, safety officer, senior second officer, junior second officer, third officer, chief engineer, staff chief engineer, and second engineer. The nine specimens were shipped that day to a Federally certified laboratory. Drugs test results were negative in each case. Because more than 34 hours had elapsed since the accident and because some personnel had been off-duty during that time, tests for alcohol were not conducted.

During postmortem examinations on July 28, 1996, the State of Alaska Chief Medical Examiner obtained specimens from the five deceased crewmen, which were sent to the University of Utah's Center for Human Toxicology (CHT) for analysis. All test results for alcohol and illicit drugs were negative. Because the deceased were fire victims, the CHT conducted tests for two toxic combustion products, carbon monoxide (as measured by percentage of carboxyhemoglobin in the blood) and cyanide. All specimens had carboxyhemoglobin saturation levels generally considered to be lethal, from a low of 64 percent to a high of 87 percent.[17] Cyanide was not detected in any specimen.

[16] The disk impression indicated the fire watch checked the main laundry at 0236. According to a representative for the manufacturer of the clock, it may have been 7 minutes fast, which would have made the time closer to 0229. Safety Board investigators found no evidence indicating the Detex clock disk had been altered or fabricated after the fire.

[17] Stewart, R. D. The effect of carbon monoxide on humans. *Journal of Occupational Medicine,* 18:304-309, 1976.

Table 3—Hospitals that Treated *Universe Explorer* Casualties

HOSPITAL	CREW	PASSENGERS	TOTAL
Bartlett Memorial Hospital, Juneau, AK	63	2	65
Virginia Mason Medical Center, Seattle, WA	3	0	3
Harbor View Medical Center, Seattle, WA	1	0	1
TOTAL	67	2	69

Wreckage

Main Laundry—Most fire damage was localized within the main laundry. During its postaccident examination of the *Universe Explorer*, from July 28 through 30, 1996, the Safety Board found that the forward area of the laundry contained heavy charring and soot on the bulkheads and on the ceiling, including the overhead duct work, pipes, and electrical cables. Several overhead electrical cables were charred white and crumbled when touched. The insulation on two cables had holes exposing the copper wires. Small beads of copper were on the edges of the holes and the exposed wires. A dryer exhaust duct had warped upward. Investigators found small bits of charred plywood inside the duct.

The 38-year-old vessel had been painted many times as part of routine maintenance. Much of the paint on the ceiling and bulkhead in the forward part of the laundry was burned off. On other areas of the bulkhead surface, thick pieces of crisp, charred paint had peeled away and were hanging down. The flakes of paint readily crumbled when touched.

Some areas of the forward bulkhead surface had large areas on which the paint was intact or less damaged, as if protected by some object. During later interviews, the Safety Board determined that laundry bins had been against the bulkhead, but had been removed during fire extinguishing operations.

The welding machine in the laundry area sustained extensive exterior heat damage, including the loss of the plastic cover on its control wheel and most of its surface paint. The insulation on a ground wire and on another cable wire had burned off, exposing the wires; however, the bare wires showed no indication of electrical arcing. A large electrical circuit breaker panel was scorched and covered with soot. The Safety Board found all panel switches in the "off" position and covered with soot.

Heavy soot covered the surface of the forward bulkhead. The deck area with the heaviest char and ash was immediately starboard of the welding machine. The forward port corner of the laundry had a narrow-angle "V" soot pattern[18] extending upward from the area where the Safety Officer observed the fire.

Stairways and Aloha Deck—The aft stairway to the main laundry contained heavy soot on the stairway landings and bulkheads on the E deck level. The aft entrance also contained heavy soot on the bulkheads, deck, and ceiling. The enclosure bulkheads to the spiral stairway showed extensive heat and flame damage, with most of the paint burned off the bulkheads. In-

[18] As a general rule, the wider the angle of a V pattern, the longer the burned material has been subjected to heating; however, the angle of a V pattern on a vertical surface is a result of the size of a fire, burning rate, ventilation, and the combustibility of the vertical surface. Tracing the soot lines of the V pattern from higher to lower levels generally leads to the area of origin for the fire. See National Fire Protection Association publication 921, *Guide for Fire and Explosion Investigation,* the Factory Mutual Engineering Corporation's *Guide to Arson and Fire Investigation,* and the *National Fire Academy Training Manual for Fire/Arson Investigation.*

vestigators found heavy soot on the inside jams of the door casing and on the edges of the door. The spiral staircase, railings, and inside surfaces of the enclosure bulkheads also contained heavy soot deposits.

The electromagnetically controlled fire door opening on Aloha deck at the top of the spiral stairway had heavy soot on its edges and sides. The athwartships corridor area near the open fire door to the stairway had heavy soot and fire damage, including charred and peeling paint on ceiling panels.

Two spring-activated fire doors leading from the athwartships corridor to the crew accommodations area had heavy soot on the edges and sides. Investigators found remnants of string or twine tied on the handrails adjacent to each door. The deck, ceiling, and bulkheads in the crew corridors had accumulated soot, the port corridor more so than the starboard corridor. The paint on the port corridor bulkhead near the fire door was burned off.

Survival Factors

The first part of this section contains the standards and regulatory requirements related to emergency training and drills and the on-board provisions and procedures established by vessel or shoreside management. The second section contains a narrative account of the actual events on the morning of the accident, using crewmember statements from interviews and passenger statements from a survey that the Safety Board mailed to a sample of passengers.[19] The last section summarizes the response effort by the Coast Guard and local agencies.

Regulatory Requirements—The SOLAS regulation governing emergency training and drills for passenger and cargo ships requires that vessels conduct musters and drills; it states

> Each member of the crew shall participate in a least one abandon ship drill and one fire drill every month. The drills of the crew shall take place within 24 hours of the ship leaving a port if more than 25 percent of the crew have not participated in abandon ship and fire drill on board that particular ship in the previous month. The Administration may accept other arrangements that are at least equivalent for those classes of ship for which this is impracticable.… Fire drills should be planned in such a way that due consideration is given to regular practice in the various emergencies that may occur depending on the type of ship and its cargo.

Emergency Information and Drills—In accordance with SOLAS, a station bill specifying the emergency stations, assignments, and lifeboat locations for each crewmember on board was posted in crew areas throughout the vessel. In addition to the crew's emergency assignments, the station bill described the whistle signal and alarm bells for different emergencies. Crewmembers were to report to their emergency stations whenever the code word "Mr. Skylight" was broadcast over the public address system. The company also provided each new crewmember with a booklet describing the emergency procedures.

Placards providing directions and safety information were posted throughout the ship. Figure 10 shows the instructions on the placard that was in each passenger cabin. The placard also provided visual and written instructions for donning life jackets. The information provided to passengers contained no instructions about how to open and close the fire screen doors.

Crewmembers indicated they participated in weekly emergency drills, which included reporting to fire stations and performing duties listed on the station bill, mustering crewmembers and passengers, and using firefighting and emergency equipment. A utility crewman stated that during previous drills, he and his

[19] In August 1996, the Safety Board mailed a questionnaire to a sample of 330 passengers. Of those, 283 responded.

Your Lifeboat Station Number IS…

Learn To Find Your Way To Your Lifeboat Station.

This symbol shows you the way to the lifeboat stations…

The general alarm signal is seven or more short blasts followed by one long blast of the ship's whistle and general alarm system as represented by this signal…

When the general alarm sounds, prepare to report to your lifeboat station:

1. Under no circumstances use the elevators.
2. Go to your cabin.
3. Dress warmly.
4. Put on your life jacket according to instructions.
5. Take a blanket with you.
6. Leave your luggage behind.
7. Follow the symbols…to your lifeboat station.
8. If smoky, the best air is at floor level.
9. Further instructions will be given by the crew at your lifeboat station.

Figure 10—Information on the placard in each passenger cabin.

roommate always had used the passageway toward the galley. They had never practiced using an alternate escape route.

Crewmembers and passengers stated that they participated in an "abandon ship" drill before leaving Vancouver on July 23, 1996. The ship's master stated that passengers were advised what the signal would be for an emergency and that they were to don their life jackets and proceed to muster stations when they heard the alarm. He indicated that they were told how to follow the arrows in the passageways to locate their muster stations. Passengers were also told when the abandon ship drill would be conducted and instructed not to use elevators during an actual emergency.

Vancouver Drill—Passengers stated that upon boarding the *Universe Explorer*, they received an announcement that a drill would be conducted to provide information about what to do in the event of an emergency. They said they were instructed to read the notice in their cabins, don the life jackets stored in their cabins, and report to their assigned lifeboat stations.

About 70 percent of the passengers responding to the Safety Board survey stated that the instructions given during the drill were of great value and prevented panic and chaos during the actual fire. About 65 percent of the passengers characterized the drill as very realistic. One passenger said that the emergency made her realize how important to her personal safety the drill had been.

Thirty percent of the respondents said that the drill instructions were inadequate because they were disorganized and incomplete, lacking information such as how to operate the fire screen doors. About 25 percent of the responders described the drill as minimally realistic because many passengers who knew the scheduled time of the drill went in advance to their lifeboats, using the elevators to reach their stations. Several passengers characterized the drill as unrealistic because the crew had laid out the passengers' life jackets on their beds in preparation for the drill; whereas they had to hunt for their jackets, which were stowed under beds or in closets, during the actual emergency.

Only 50 passengers responding recalled seeing a placard explaining what to do in the event of an actual fire. Most responders—219 passengers—said the oral instructions they received during the drill did not include information on what they should do if they saw a fire, smelled smoke, or had to open a fire screen door. One passenger said, "We were never even told about the fire screen doors or that, in the case of a fire, the fire screen doors would close, and we might have our passage to the boat station blocked by them."

General Response by Crew—The station bill for the *Universe Explorer* lists all crewmember positions and their respective assignments in the event of an emergency. The ship's hotel manager is responsible for coordinating the passenger evacuation effort. He was

not wearing or carrying a breathing apparatus when he attempted to go forward on the Main deck to begin a search of the cabins. Upon opening a door on the port side, he encountered "a lot of black smoke" that stung his eyes and made it difficult for him to breathe. He then went aft on the port side and was joined by other crewmembers.

As the crew searched passenger staterooms, they put a towel on the knob of each exterior door to indicate that the cabin had been checked. They next wrapped towels around their faces to protect them from the smoke and proceeded to the Aloha deck to check the accommodations areas. They found a crewman overcome by smoke, put him on a stretcher, and carried him to the Promenade deck.

Passenger Notification—More than 270 passengers surveyed said they were in their cabins when they became aware of the fire. Some smelled smoke in their cabins; others saw smoke in the passageways when they opened their doors in response to the sounds of a commotion in the corridors, the ringing of the emergency alarm, or someone yelling "fire."

Within minutes of being notified about the fire, the cruise director reported to the bridge, where he began making announcements over the public address system to keep passengers calm and to instruct them in reporting to their muster stations. Several survey respondents stated that they did not hear a public address announcement. Others reported hearing the cruise director announce that there was a fire and that passengers should report to their muster stations. Many of those passengers who recalled the announcement were already at their muster stations, while others were just leaving their cabins. One respondent said, "There was no communication from the ship's captain or any officer of the crew until several passengers challenged an official from the cruise line to inform us of the situation, 4 to 5 hours after the initial fire."

More than half of the passengers reported that they saw a "slight" or "moderate" amount of smoke or smelled smoke in the corridors; other passengers reported that they saw no smoke. Passengers who had cabins in the lower and forward sections of the ship reported that hallways were filled with "thick, heavy, and very black" smoke and that visibility was "low" or "about 40 feet." Respondents described the hallway lighting as adequate.

Forty-eight passengers stated that during the emergency, they had difficulty moving to and opening fire screen doors. One handicapped passenger could not open the door by herself and had to be assisted by another passenger. One passenger said that he encountered another passenger who panicked when the fire screen door closed; together they read the instructions on the door and were able to open it. Several passengers on the Observation deck reported having problems with the fire screen doors. An elderly couple and a young couple said they could not open either the port or aft fire screen door for about 10 minutes. Another couple encountered two sets of closed fire doors and a man yelling, "We're trapped and can't get out!" The woman who was able to open the door recalled that because the handle was recessed, it was difficult to see how it worked. On the Bali deck, a passenger reported having trouble opening the fire doors because no instructions were on or near them. Another passenger said that when she encountered a closed fire door, she proceeded through a "crew exit" door and encountered a vessel firefighter, who directed her to the lifeboat station.

Most survey respondents characterized the overall behavior of passengers as disciplined and civil and praised the crewmembers' diligent and professional concern for the passengers, describing them as very efficient, reassuring, helpful, and understanding.

Muster leaders took roll and were able to account for all passengers but not all crewmembers. The master said that passengers remained calm and that after the fire was extinguished, they were allowed to return to their cabins to pack in preparation for leaving the vessel.

Response by Hospital Staff—The medical staff on the *Universe Explorer* comprised a doctor and two nurses, whose cabins were located near the ship's hospital on the Bali deck. Because the hospital was located directly above the main laundry, it was subjected to high levels of heat during the fire.

The doctor stated that because of the thick blue-black smoke, he could not reach any medical equipment; he was only able to "grab" the medical staff's one portable radio before going to his boat station on the Main deck. The vessel's medical staff assisted passengers and crew with smoke inhalation injuries in various locations throughout the ship. The doctor stated that because they only had one radio, the nurses had to report in person to him to determine where their assistance was most needed. The doctor was able to obtain one additional radio, which he gave to one of the nurses, to coordinate their response.

The doctor said that he retrieved the extra medical kit that is maintained on the bridge, but found it of marginal use because it lacked the oxygen needed to treat smoke inhalation victims. Because the hospital was filled with smoke, the medical staff set up a triage area in the lounge on the Promenade deck. Three passengers with medical training—a firefighter and two nurses—assisted the ship's medical staff in attending to the passengers with heart problems and the crewmembers suffering from smoke inhalation. When Coast Guard personnel boarded the *Universe Explorer* about 0657, the medical officer and three emergency medical technicians (EMTs) from the Coast Guard cutter *Woodrush* provided oxygen for the smoke inhalation victims. The ship's doctor stated that he was able to obtain medical supplies from the hospital after the fire had been extinguished, about 5 or 6 hours after the initial alarm.

Crew Escape—Safety Board investigators interviewed a number of crewmembers who escaped from Aloha deck cabins near the sites where fatalities occurred. All survivors interviewed said that they were asleep when they were awakened by people shouting and knocking on cabins doors. One crewman said that when he heard a knock, he checked his watch and the time was shortly before 0300.

All Aloha deck survivors indicated that passageways were filled with black smoke before the bridge made the "Mr. Skylight" announcement or sounded the general alarm. An assistant cook said that he had already climbed up an escape hatch and was pausing to catch his breath on the Upper deck when he heard the "Mr. Skylight" announcement. He estimated that about 5 or 6 minutes elapsed between the time he was awakened and the time he reached the open deck. A sanitation operator said that he had started to move aft through the port side passageway when he stumbled over someone lying on the deck. He said that he then heard the "Mr. Skylight" announcement.

A utility man stated that when he was awakened about 0300 and opened his cabin door, he panicked at the sight of the thick smoke. He and his roommate first tried to move toward the main galley, but the heat was too intense, so they turned around. They then became separated. The utility man said he was in the crew laundry when he heard "Mr. Skylight" and the general alarm. He then found a stairway to the upper decks. Rescue teams later found the roommate dead on the floor of a cabin, a victim of smoke inhalation.

Another crewman said that he tried to follow other people, but the smoke was too thick to see them. He tried to walk aft toward the main galley; but because of the heat and smoke, he had to turn around and proceed forward. He said he stumbled around in the dark passageway and into the crew laundry and then heard the "Mr. Skylight" announcement. He said he was trying to feel his way forward to an exit when he found a cabin in which five crewmembers were gathered near an open porthole taking turns breathing fresh air from it. He said as he was breathing out the porthole, he saw a Coast Guard vessel and tried to get its attention by waving a towel out the porthole. He estimated

that about 3 hours passed before he heard people searching for survivors. He said that when he and the other five crewmembers heard searchers nearby, they began pounding on the bulkhead and yelling for help to get their attention, but no one immediately came to their aid.

Rescue Efforts—In response to the general alarm, shipboard firefighters reported to the fire station at the forward part of the Boat deck. About 0320-0325, the staff captain instructed a member of fire team no. 1 to don equipment, which included a self-contained breathing apparatus (SCBA) and protective gear,[20] and search the crew berthing area on Aloha deck. He said that after descending to Aloha deck, he opened the fire door to the berthing area and encountered intense and blinding smoke. He saw three crewmembers lying in the passageway and heard people pounding on bulkheads and calling for help. He shined his flashlight down the passageway and yelled in the direction of the noise, but could see nothing but smoke. He went into the passageway to check the three crewmen lying on the deck; they showed no signs of life. He estimated that he returned to the Main deck about 0335-0340 and reported his findings to the staff captain, who told him to return to Aloha deck and bring back the fallen crewmen. The team member told the staff captain that he could not do it alone because of the smoke from the raging fire. The staff captain instructed a second crewmember to accompany the team member. The second crewman obtained an SCBA about 0350, and the two firefighters and the staff captain returned to Aloha deck to recover the three bodies in the corridor.

The leader of fire team no. 1 said that he was informed about 0540 that a crewman was in cabin CA-22. He stated that when he and other rescuers checked the cabin, which was full of smoke, they found the crewman "curled up in a fetal position under the sink." They then heard someone pounding on the bulkhead of the cabin next door. Upon checking the cabin next door, they found a trapped crewman who had opened a porthole to get air. The fire team leader said they then moved the CA-22 occupant, who showed no signs of life, to the cabin with the open porthole and began administering cardiopulmonary resuscitation (CPR); however, they could not revive him. Fire team members then carried the surviving crewman to the Main deck for medical treatment.

Response by Local Agencies—Eight local, State, and Federal agencies from surrounding areas responded to the accident on board the *Universe Explorer*. They included the Coast Guard, the Capital City Fire and Rescue of Juneau, the Juneau Police Department, the Department of Public Safety for the State of Alaska, the Alaska State Troopers, the State Fire Marshal, the Coroner's Office for the State of Alaska, and the State Medical Examiner's Office. Their response actions are summarized below.

Coast Guard—About 0300, while monitoring channel 16, the navigation watch on the Coast Guard cutter *Sweetbrier* overheard the *Universe Explorer* reporting the fire and the vessel location to the Coast Guard's 17th District command center Search and Rescue (SAR) Coordinator in Juneau. The *Sweetbrier* then notified the SAR Coordinator that it was en route to the *Universe Explorer* to assist. At the same time, the Liberian passenger ship *Star Princess* overheard the radio transmissions and proceeded en route to assist. About 0321, the SAR Coordinator notified the Juneau Coast Guard station to stand by until the SAR command center had received an update about the fire. At 0324, a Coast Guard 41-foot patrol boat (41328) departed Station Juneau for the scene.

About 0341, the *Universe Explorer* master radioed the SAR Coordinator that vessel firefighters were unable to enter the laundry space and were directing fire hoses on the outside of the compartment to cool the bulkhead so they could enter the space. The SAR command center

[20] A firefighter's outfit consists of protective clothing, boots, helmet, flashlight, axe, and an approved breathing apparatus, such as an SCBA.

arranged for a commercial tugboat and a Coast Guard helicopter to respond to the scene.

The *Sweetbrier* arrived on scene about 0413; its commanding officer assumed responsibility as the on-scene commander. Patrol boat 41328 arrived on scene about 0437. The Coast Guard vessels then escorted the *Universe Explorer* to Auke Bay, where the Coast Guard cutter *Woodrush* relieved the *Sweetbrier* and took command of the on-scene response. At 0657, the medical officer and three emergency medical technicians from the *Woodrush* boarded the *Universe Explorer* to assess passenger and crew injuries. Coast Guard personnel then provided security for the *Universe Explorer* and transportation for passengers, crewmembers, firefighters, and equipment until about 1800.

Capital City Fire and Rescue—About 0500, the Capital City Fire and Rescue (CCF/R) fire chief was at home when he was notified of the *Universe Explorer* fire. He proceeded to the CCF/R-Glacier District, about 4 miles from Auke Bay, where he assumed the role of incident commander, established a command post, and implemented the local contingency plan. He had all local fire departments alert their personnel who had had shipboard firefighting training to assemble with their equipment at the CCF/R-Auke Bay District, where they were briefed by a fire training specialist and formed into three teams based on their past experience. The incident commander ordered the fire teams to report to the Auke Bay Harbor parking lot, where, at 0845, they boarded a tugboat that transported them to the *Universe Explorer*. When they arrived on board, CCF/R fire team leaders met with the master, who told them that the fire was already extinguished and that the area was secured. The CCF/R firefighters proceeded to the laundry to examine the fire scene and to ensure that the fire was completely out. While checking for "hot spots" in the laundry, CCF/R firefighters found still-smoldering debris, which they extinguished. The CCF/R fire team leaders kept the incident commander informed of the activities onboard the ship via radio and cellular telephone.

The CCF/R firefighters remained on board the *Universe Explorer* until late in the afternoon. While on board, they maintained a reflash watch, monitored the air quality in smoke-affected areas, and provided condition assessments to the Coast Guard and the ship's master. About 1645, the CCF/R firefighters departed the vessel and returned to shore.

Juneau Police Department—The CCF/R notified the Juneau Police Department of the fire at 0506, whereupon the department's operations commander reported to the incident command post at CCF/R-Glacier District, arriving about 0535. He and the incident commander discussed transporting the cruise ship's passengers to shoreside hotel accommodations and decided to bus passengers to Centennial Hall, a civic center in Juneau. Police officers provided security, controlled traffic, managed the shelter, and oversaw bussing until the last passenger left Centennial Hall at 1800.

Department of Public Safety—The Alaska Department of Public Safety dispatch center notified the State Troopers Office of a cruise ship fire about 0605 and the State Fire Marshal's office at 0720. Shortly after 0800, a state trooper and a fire marshal arrived at Auke Bay, where the *Universe Explorer* was anchored, and boarded the vessel to begin their investigation. A Coast Guard representative advised them that a marine chemist was scheduled to arrive from Seattle, Washington, about 1730 to certify that the air in fire areas was safe to breathe. Pending the chemist's arrival, the state trooper and fire marshal helped firefighters identify the deceased crewmen and prepare the bodies for transport to the Alaskan Park Mortuary for examination.

Hospital Response—Upon being advised of the number and scope of injuries, the staff of Bartlett Memorial Hospital in Juneau implemented the hospital disaster plan about 0745 and dispatched ambulances to Auke Bay. Five ambulances and three buses transported 69 patients from Auke Bay, about 9 miles from the

hospital. The first patient arrived at 0925 by ambulance, and the last patient arrived at 1210. Four of the more seriously injured casualties were evacuated by medical flight to Seattle.

Contingency Plan—As required by the Coast Guard's *Marine Safety Manual*, the MSO had developed a Fire Contingency Plan for the Port of Juneau. At the time of the *Universe Explorer* fire, the medical and evacuation sections containing procedures for responding to a shipboard fire had not been developed. Local Coast Guard port officials stated that they had conducted numerous discussions with local emergency agencies about procedures to follow in the event of a shipboard fire. After this accident, Coast Guard personnel met with local responders several times to identify ways to improve their emergency response capability and to complete the unfinished sections of the plan. Participants discussed the need to update the Fire Contingency Plan annually, to purchase more cellular telephones, and to maintain a list of translators who could conduct crew interviews, if necessary. They also scheduled future meetings.

Before the *Universe Explorer* accident, the 17th Coast Guard District had last held a disaster drill simulating a passenger vessel fire and grounding on March 19 and 20, 1996. The exercise, which was a table-top drill conducted at the Federal Building in Juneau, was divided into two phases, SAR and oil spill response. About 200 people participated, including personnel from the Coast Guard, the State of Alaska, local emergency response agencies, and six cruise lines. During a debriefing on March 21, an evaluation team critiqued the exercise and made several recommendations for improvement, one of which was that a working group consisting of representatives from all agencies with a medical role during a major marine incident establish a plan to deal with medical issues during an emergency. The evaluation team further recommended that "this [medical] plan should be considered for incorporation in the Unified Plan."

Other Information

Vessel Smoking Policy—According to the vessel operator, smoking on the *Universe Explorer* is restricted. The crew is allowed to smoke only in a designated area in the crew lounge. Cruise passengers are allowed to smoke in their own rooms, on the open deck, and in a designated smoking area in each of the two cocktail bars. The ship's officers enforce the crew smoking policy. Crewmembers accused of violating the vessel smoking rules are subject to fines or, depending upon the circumstances, such as repeated violations, discharge from service.

FBI Case—On August 1, 1996, the Federal Bureau of Investigation (FBI), under its authority to investigate crime on the high seas, began a preliminary arson/homicide investigation of the *Universe Explorer* fire. The Safety Board provided the FBI with samples of debris from the fire scene for laboratory analysis. The FBI laboratory tests found no presence of an ignitable liquid or other material that could be used as an accelerant. The FBI investigation did not find sufficient evidence on which to base a criminal prosecution, and on February 13, 1997, the agency released copies of its investigation records to the Safety Board to assist in the Board's investigative process.

New Certification Requirements for Crews—The Standards for Training Certification and Watchkeeping (STCW) 1995 Convention adopted amendments establishing new training and certification requirements for seafarers that went into effect on February 1, 1997.[21] The STCW Convention requires that ship companies document the training and certification of crewmembers employed on their ships. Moreover, the amendments require that before being assigned to shipboard duties, all crewmembers who are *new* to a seagoing ship must receive familiarization training in personal survival techniques including identifying emergency escape routes and muster and embarka-

[21] Chapter VI, Section A-VI/1.

tion stations, or receive sufficient information and instructions to be able to perform certain tasks depending on their job titles, such as advanced firefighting, medical care, and operating a survival craft or rescue boat.

Retroactive Fire Safety Amendments—Since at least 1980, the Safety Board has repeatedly identified such issues as equipment operations, personnel training, and fire safety deficiencies on existing cruise ships in its major marine accident reports.[22] In addition, the Board's 1989 Safety Study, *Passenger Vessels Operating from U.S. Ports* (NTSB/SS-89/01), called for additional fire safety improvements on cruise ships operating from U.S. ports.

In 1990, the IMO's Subcommittee on Fire Protection was reviewing the need for additional fire protection requirements for new ships when, on April 12, the passenger ship *Scandinavian Star* suffered a fire that resulted in the deaths of 158 people. The IMO's Maritime Safety Committee subsequently revised chapter II-2, "Construction—Fire Protection, Fire Detection and Fire Extinction" of the SOLAS Convention in May 1992. These amendments, which were to be phased in over a 16-year period beginning in October 1994, applied to both new and existing passenger vessels and addressed many safety recommendations issued by the Safety Board in its accident reports and studies.[23] The portion of the requirements applicable to existing vessels are the RFSAs. Among other safety measures, the RFSAs require that existing passenger ships have fixed automatic sprinkler systems, fixed automatic smoke detection systems, and low-location lighting systems by specified dates. Further, spaces containing combustibles, including accommodation areas and service spaces, such as laundries, are not permitted to have direct access to stairway enclosures. Appendix C contains some of the RFSAs applicable to existing passenger vessels such as the *Universe Explorer*.

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[22] *Fire Onboard the Italian Passenger Ship* Angelina Lauro, *Charlotte Amalie Harbor, St. Thomas, U.S. Virgin Islands, March 30, 1979* (NTSB/MAR-80/16); *Fire Onboard the Bahamian Passenger Vessel* M/V Scandinavian Sea, *Cape Canaveral, Florida, March 9, 1984* (NTSB/MAR-85/03); *Fire Onboard the Bahamian Passenger Ship* M/V Scandinavian Sun, *Port of Miami, Miami, Florida, August 20, 1984* (NTSB/MAR-85/08); *Fire and Explosions Onboard the Panamanian Passenger Ship* Emerald Seas *in the Atlantic Ocean near Little Stirrup Cay, Bahamas, July 30, 1986* (NTSB/MAR-87/04); and *Fire Onboard the Bahamian Passenger Ship* Scandinavian Star *in the Gulf of Mexico, March 15, 1988* (NTSB/MAR-89/04).

[23] The Safety Board also outlined needed safety measures in its 1993 Special Investigation Report, *Accidents Involving Foreign Passenger Ships Operating from U.S. Ports, 1990-1991* (NTSB/SIR-93/01), which contained information from prior Safety Board reports of the following cruise ship fires: *Regent Star* (DCA90MM037), *Sovereign Of The Seas* (DCA91MM023), *Britanis* (DCA92MM007), and *Song of America* (DCA92MM008).

ANALYSIS

General

This analysis is divided into three main sections. In the first part, the Safety Board identifies factors that can be readily eliminated as causal or contributory to the accident. In the second section, the Board provides a synopsis of the accident and considers where and how the fire may have started. In the final section, the Board discusses the following major safety issues, which were identified during this investigation:

- Adequacy of shipboard communications;
- Adequacy of fire prevention, detection, and control measures;
- Adequacy of emergency procedures; and
- Adequacy of oversight.

The analysis also discusses toxicological testing criteria, the emergency response effort by Coast Guard, State, and local agencies, and the Coast Guard contingency plan.

Exclusions

Neither the navigation or propulsion systems nor the personnel qualifications of the officers and crew had a bearing on the cause of the fire. The ship experienced no mechanical difficulties of any type during its voyage. From documents and statements, the Safety Board determined that all officers were properly licensed and certificated by the Panamanian government and were qualified to serve in their positions.

Toxicological test results show that drugs did not affect the performance of the nine officers who were tested and that drugs and alcohol did not affect the performance of the five deceased crewmembers. However, the Board has concerns about the conduct of postaccident toxicological testing, which will be addressed later in this report. The Safety Board therefore concludes that factors related to the vessel navigation system, propulsion system, and mechanical equipment neither caused nor contributed to the accident; that all officers were properly licensed and qualified to serve in their positions, and that no available evidence indicated that drugs or alcohol affected the performance of those officers and crewmembers tested.

Accident Synopsis

Available evidence indicates the fire in the main laundry originated near the spiral staircase, was fast burning, and generated a tremendous amount of smoke that was drawn into the spiral stairway and up to the decks above, where crew cabins were located. The system of electromagnetic fire doors was not wired so that local smoke or heat detectors would automatically close the fire doors in an affected area. The electromagnetic fire doors could only be closed universally from the bridge, which meant that they were not closed until personnel on the bridge became aware of the emergency. Some fire doors near crew areas were tied open, a safety hazard that was not corrected by the fire watchmen. Although the bridge watch initiated vessel fire response procedures immediately upon receiving the second alarm, a lethal amount of smoke probably had already spread through the open doors and filled the crew area on the Aloha deck. The smoke alarms in the area did not sound locally to alert sleeping crewmen to the emergency. Further, the crew cabins had no telephones or means by which crewmembers could either alert the bridge of the fire or that they were trapped by smoke or fire conditions. As a result of the crew berthing area's filling with smoke, 5 crewmembers died

and 55 crewmembers sustained minor or serious injuries from smoke inhalation.

During its on-scene investigation, the Safety Board determined that overhaul[24] operations by shipboard and municipal firefighters and other factors adversely affected investigators' efforts to identify the exact cause of the fire. The following section discusses the Board's findings and conclusions about the area of origin, possible causes, and nature of the fire.

The Fire

Area of Origin—From examination of the fire damage and information provided by the vessel's crew, the Safety Board determined that the fire started next to the bulkhead in the forward portion of the main laundry, close to the doorway to the spiral stairway. A "V"-shaped soot pattern was in this immediate area. Burn patterns on the forward bulkhead matched the outlines of laundry bins that had been next to the forward bulkhead before firefighters moved them. Further, the vessel's safety officer, who first witnessed the fire scene, stated that he observed most of the fire in this area. Two laundry bins, one of which was aluminum and one fiberglass, that had been closest to the welding machine were severely damaged in the blaze, indicating prolonged exposure to fire. Safety Board investigators found melted aluminum on the deck only in this area of the laundry, an indication that the hottest burning occurred there. Investigators also observed severe localized heat damage in the overhead and a heat-distorted dryer duct in the area. The Safety Board concludes that the fire on board the *Universe Explorer* originated in one of the laundry bins that had been against the forward bulkhead of the main laundry.

Type of Fire—All available evidence suggests that the fire developed rapidly. Damage to the overhead was localized in one area—the forward part of the main laundry—rather than evenly distributed throughout the laundry. The narrow angle of the "V"-pattern on the bulkheads in the forward area of the laundry also indicates a fast-burning fire. Further, the time that elapsed between the watch's checking the main laundry and the first heat detector fire alarm sounding on the bridge was at most 27 minutes, which does not support the scenario of a slow-developing fire.

Cause of Fire—The Safety Board examined whether several conditions were present that could have resulted in the fire: discarded smoking material, electrical short circuit, contact of combustible material with a hot surface, spontaneous combustion, and a deliberate human act.

Discarded cigarette—According to documentation from the National Fire Academy, for a discarded cigarette to ignite a furniture item or bedding, the smoking material must be insulated against air that normally dissipates the heat. If a lit cigarette becomes wrapped and thereby insulated within a layer of combustible material, such as linen, an open flame can develop within 20 minutes to a couple of hours. In addition, fire development can be accelerated if the insulating material is soiled with an ignitable substance, such as food grease, candle wax, or other substances that are frequently spilled on table linen.

The *Universe Explorer*'s operating company has a policy restricting smoking to selected areas of the ship, which does not include the main laundry. Moreover, the vessel hotel manager stated that all laundry workers were nonsmokers. The main laundry is neither a high traffic area when operations are shut down nor a desirable place to loiter or to grab a quick smoke. Between the time laundry operations were shut down for the day at 1800 and the heat detector actuated—about 9 hours—the fire watches observed no one smoking in the laundry and no evidence of smoke or fire. The Safety Board found no physical evidence, such as cigarette butts or cigarette packages, that indicated discarded smoking material caused the

[24] Overhaul is the process of moving and separating burned material to locate any hot or smoldering debris and to cool it or wet it down to prevent a reflash of the fire.

fire. However, these materials could have been present at the time of the fire and dispersed or inadvertently removed from the laundry during fire extinguishing and overhaul operations.

Despite the statements of the fire watch and the lack of physical evidence, a burning cigarette as the source of ignition cannot be discounted. The main laundry area was not locked or staffed after 1800. A waiter, another crewmember, or a fire watch could have been smoking in the laundry and carelessly disposed of a burning cigarette, which ended up in a pile of linen. Had it become insulated within the material, whether the linen was soiled or clean, the burning cigarette could have smoldered for a while without emitting observable amounts of smoke. Between the time the fire watch was last in the main laundry and the time of the first fire alarm (20 to 27 minutes), a burning cigarette could have ignited the linen, and the open flame could have grown into a fully developed fire.

Electrical short circuit—During postaccident examination of the overhead near the fire's area of origin, the Safety Board found an electrical cable with holes covered with beads of copper,[25] indicating the wires had been energized. Molten copper falling into a laundry bin could have ignited the linen. At the request of the Safety Board, the vessel's chief electrician traced the overhead cable and found that it powered the general alarm bell in the main laundry space. This wiring is energized by manual activation of the general alarm, which occurred only after the fire was discovered.

The laundry manager stated that he shut off all laundry machinery at 1800 on the eve of the fire. The fire watch stated that no machinery was operating when he passed through the laundry shortly before the fire. During postaccident examination, investigators found the circuit breakers to electrical laundry equipment and the power control switch to the electric welding machine in the "off" position. The Safety Board found no indication that faulty electrical wiring or equipment shorted out, causing enough heat to start a fire that spread to the linen stored in laundry bins and the paint on the bulkheads.

Hot air or surface—While examining the distorted dryer exhaust duct, investigators determined that access covers to the duct had been made of plywood that was burned away in the fire. The presence of small bits of charred wood inside the duct holes indicated that the plywood most likely was burned from the outside and that small pieces of the plywood were sucked into the duct by smoke-filled air drafting into and through the exhaust duct. Because the clothes dryers were off at the time of the fire, the Safety Board discounted the possibility that hot air from the dryers ignited the plywood access covers on the dryer exhaust duct.

The Safety Board considered whether the fire may have occurred from linen coming in contact with hot operating machinery or steam pipes. The welding machine that was near the bins that burned had not been used for several days before the accident and, therefore, would not have presented a hot surface. The laundry machinery was shut off about 1800 on July 26, 1996, allowing more than sufficient time for the machinery to cool before the fire began almost 9 hours later. The steam presses were not near the fire's area of origin. Further, one of the steam presses was not used the day before the fire. No steam pipes were near where the fire originated.

The Safety Board concludes that accidental ignition sources, such as faulty electrical equipment, wiring arcing, or contact with a hot surface or air, did not cause the fire aboard the *Universe Explorer*.

Spontaneous combustion—According to a senior investigator of hotel fires, spontaneous combustion fires are not uncommon in industrial laundry facilities. Today's detergents often contain an oxidant. The linen to be laundered often is soiled with organic substances, such as animal fat or grease, that may not completely wash out, leaving an organic residue. When a washed linen load of mostly organic material,

[25] The melting point of copper is 1,981° F.

such as cotton or natural fiber, is dried and stacked, the heat absorbed by the material becomes concentrated and insulated. This can result in the organic residue reacting chemically with the oxidant, creating an increase in heat. When insulated with a natural fiber material, which has a thicker thread, the heat builds until the material gets hot enough to ignite. The oxidant then continues to feed the flame.

Spontaneous combustion fires typically are slow to ignite. However, once ignited they can burn rapidly. The first heat detector activated on E deck at 0256:42. Within a minute (0257:32), smoke detectors were activating on Aloha deck. The fire watch had made hourly rounds of the ship, including the main laundry area, and detected no signs of smoke or fire. The Detex clock used to record the times at the fire stations reportedly was 7 minutes fast. However, even allowing for the time discrepancy, the watch probably passed the fire's point of origin three times within the 20 minutes before the first fire alarm sounded on the bridge.

National Fire Academy documentation indicates that a free-burning fire can develop quickly from the spontaneous ignition of grease and other organic material that is well insulated by tightly packed cotton or natural fiber linen that has been washed and dried and placed into a laundry bin. The fire that erupted in the *Universe Explorer* main laundry originated in an uncovered solid-sided aluminum laundry bin. Although crewmembers stated that all material in the bins was soiled laundry to be washed, investigators could not verify this during the on-scene investigation. However, the Safety Board doubts that shipboard staff would have mixed soiled linen with clean linen. Postaccident investigation could not verify whether washed and dried linen had been in the laundry bins; therefore, spontaneous combustion cannot be eliminated as a possible cause of the fire.

Deliberate act—The Safety Board considered factors that may have led to someone deliberately setting the fire. The FBI conducted an arson investigation of this accident and found insufficient evidence of criminal action. FBI laboratory tests of a fire debris sample showed no presence of an ignitable liquid or other material that could be used as an accelerant. Safety Board investigators also found no evidence that the fire was deliberately set.

Nevertheless, conditions existed that were conducive to an undetected, deliberately set fire. The main laundry was located in an isolated area that was not locked or staffed after 1800. The time that elapsed between the fire watch last checking the laundry area and the heat detector actuating would have been sufficient for someone to start a fire. The laundry contained large quantities of readily combustible materials. Due to the flammability of most linen, no accelerant would have been needed to start a fire in the material. However, had the residue of an accelerant existed, it could have been destroyed during firefighting operations.

The Safety Board concludes that neither discarded smoking material, spontaneous combustion, nor a deliberate act can be ruled out as possible causes of the *Universe Explorer* fire.

The Aftermath

When audible alarms sounded on the fire alarm panel on the navigation bridge, the officer on watch initiated actions in accordance with company emergency procedures, dispatching the fire watch to investigate and telephoning the master, the staff captain, and the safety officer, who, in turn, began procedures for evacuating passengers and crew and for determining the location of the blaze. Fire teams reported to their muster stations in a timely manner, and, once a path to reach the fire was identified, quickly brought the blaze under control and extinguished it.

Despite what might seem to have been timely alert and response actions, 5 crewmembers died, and 55 crewmembers sustained injuries from smoke inhalation. One passenger was injured, and another passenger with a preexisting medical condition required treatment.

The Safety Board examined factors contributing to the injuries and identified several safety issues in the areas of communications, fire detection and control measures, and emergency procedures that affected survivability.

Adequacy of Communications

Ineffective communications affected every phase of this accident, including fire detection, crew escape, and medical treatment of casualties.

Contact Between Bridge and Fire Watch—When the second officer initially contacted the fire watch by UHF radio, the fire watch was on the open deck. He acknowledged the transmission, which the second officer heard, and started to descend to E deck to check in the main laundry. After the second alarm, the second officer again radioed the fire watch but heard no response, although the fire watch did receive and acknowledge the transmission. The second officer then transmitted in the blind, beginning his statement with "If you can hear this, go …." When the fire watch heard the second officer transmit in this manner, he realized that his radio transmissions were ineffective from his location. He therefore tried to telephone the bridge watch officer when he, the fire watch, encountered heavy smoke on the Main deck. However, the telephone line was busy. The fire watch then started to run to the bridge to make his report, but, upon hearing the "Mr. Skylight" announcement, instead went to his emergency station, never reporting his observations about the smoke conditions on the Main deck to the bridge watch officer.

The communications between the bridge and the watch on the *Universe Explorer* represent a breakdown in two ways: the instrument used was ineffective in the environment, and the procedures followed did not result in the bridge receiving timely information about shipboard conditions. The adequacy of the company operating procedures for emergency response will be examined later in this analysis.

Inadequate equipment—The *Universe Explorer* is typical of vessels whose steel structure results in "dead spots" where UHF radios become ineffective. In an emergency situation, it is absolutely essential that personnel who may be going into harm's way be able to receive and transmit messages. Had the fire watch, who was acting alone, been seriously injured or trapped and in need of assistance, he could not have notified the bridge. Additionally, had he had vital information about the progress of the smoke, the fire, the safety of the crew, or the safety of the passengers, he could not have transmitted it to the watch officer. The Safety Board concludes that the UHF radio alone did not provide the communications capability to ensure the safety of the fire watch, which, in turn, was needed to ensure the safety of passengers and crewmembers.

The Safety Board is aware that the U.S. Navy has addressed the problem of effective internal shipboard radio communications by installing an internal radio antenna network throughout its vessels. This type of system eliminates blind spots, enabling crewmembers to carry out communications with no interruptions during an emergency. The Safety Board concludes that if the *Universe Explorer* had been equipped with an internal radio antenna network system, radio communications would have been more effective during the fire emergency. The Board believes that New Commodore, and its operating company, V Ships, should provide a reliable means of internal radio communications between the shipboard command and emergency responders and between the separate groups of emergency responders on board company-operated passenger ships.

The Safety Board also believes that the Coast Guard should propose that the IMO require passenger ships to institute procedures, install upgraded equipment, or do both to ensure that reliable two-way internal radio communications may be maintained throughout a vessel during an emergency. In the interim, the International Council of Cruise Lines (ICCL)

should advise its member companies of the circumstances of this accident, recommend that they examine their shipboard procedures and communications equipment, and, if necessary, make improvements to ensure that reliable two-way internal radio communications can be maintained throughout their passenger ships during an emergency.

Inadequate procedures—During this emergency, when the second officer received no response to his transmissions, he did not initiate measures to determine what had happened to the fire watch. For his part, the fire watch did not advise the bridge about his status or the conditions on the Main deck and left his fire patrol post without first communicating with and obtaining permission from the watch officer. The Safety Board concludes that the communication procedures between the bridge officer and the watchman during the emergency were inadequate. The Safety Board believes that New Commodore, its operating company, V. Ships, and the *Universe Explorer* master should review and improve communications procedures used during shipboard emergency responses, particularly the communication between the bridge watch and fire watch when the latter is sent to investigate a fire alarm.

Means of Communication in Crew Cabins—The crew berthing areas lacked telephones or other means of communication with which crewmembers could signal their locations or call for help. Crewmen tried to signal their need for assistance by waving a towel out of a porthole, by banging on walls, and by yelling for help; however, their efforts were ineffective. Because of the vessel's steel construction, noises either migrated or were not audible, making it difficult for rescuers to accurately determine where trapped crewmen were located. Had some stranded crewmen not found a room with a porthole through which they could take turns breathing fresh air, the number of fatalities would have been higher.

Rescuers did not locate several trapped crewmen until about 0540, more than 2 ½ hours after the fire started. Had the stranded men had a means by which they could signal their location, rescuers could have determined that location and helped them sooner, thereby reducing the number and severity of injuries to the trapped crewmen and exposing the search teams to fewer risks.

As a result of past investigations, the Safety Board has been a proponent of emergency call systems in passenger staterooms on cruise ships for several years. In a 1993 special investigation report concerning passenger ship accidents,[26] the Board made the following safety recommendation to the Coast Guard:

> M-93-39
>
> Analyze the desirability and feasibility of equipping passenger staterooms with an emergency call system by which trapped passengers can signal their plight.

On October 18, 1993, the Coast Guard responded that it was not convinced that incorporating an emergency call system into the existing telephone system would provide a significant benefit:

> The majority of passenger vessels have telephone systems in staterooms which passengers may use in the event of an emergency. The proposed call system would not improve passenger-to-crew communications, but would be redundant and require additional, unnecessary maintenance. Furthermore, during an emergency, passengers are required to go to an assigned muster station and crew members search all passenger staterooms. This procedure is an effective, reliable method to identify passengers that may be trapped in their staterooms.

On February 10, 1994, the Safety Board wrote the Coast Guard, stating: "The point of the

[26] For additional information, read Special Investigation Report—*Accidents Involving Foreign Passenger Ships Operating from U.S. Ports 1990-1991* (NTSB/SIR-93/01).

recommendation was not to require a redundant system, but to require a means whereby passengers trapped in their staterooms can summon help." The Board advised that Safety Recommendation M-93-39 was classified "Open—Unacceptable Response," pending the Coast Guard's reconsideration of its position.

On August 6, 1996, the Coast Guard advised the Safety Board that it had discussed the desirability and feasibility of installing emergency call systems in passenger staterooms with the U.S. SOLAS Working Group on Fire Protection and, based upon that discussion, determined that "an additional emergency call system would not improve passenger-to-crew communications and would require additional maintenance." The letter further stated, "Since the Coast Guard has completed the recommended analysis, we request that the status of the recommendation be changed to Closed, Acceptable Action."

On May 21, 1997, the Safety Board wrote that it was disappointed with the Coast Guard's actions, stating:

> The Safety Board disagrees with the Coast Guard position that telephones in staterooms will serve in an emergency situation, because telephone systems do not easily accommodate simultaneous multiple calls. If passengers are trapped in a stateroom and get a busy signal when they call for help, they may panic and could take inappropriate action.
>
> Because the Coast Guard has only discussed this recommendation with the SOLAS Working Group on Fire Protection and has not done any analysis as requested, Safety Recommendation M-93-39 has been classified 'Closed—Unacceptable Action.'

The Safety Board notes that the *Universe Explorer* had telephones in passenger staterooms. The *Universe Explorer* fire watch got a busy signal when he tried to contact the bridge by telephone. Had passengers been trapped and tried to use their telephones, they likely would have had similar difficulties. As this accident demonstrates, all accommodation areas should have a means by which individuals can signal their locations during a fire emergency to facilitate rescue operations. Even a simple system, such as the flight attendant call button system used on commercial airlines, would probably be sufficient to signal a location. The Safety Board concludes that the lack of a means to call for help delayed the rescue of trapped crewmen and contributed to the severity of their injuries. The Safety Board believes that New Commodore, and its operator, V. Ships, should equip the passenger and crew cabins on company cruise ships with an emergency call system so that trapped individuals can signal their location.

The Safety Board also believes that the Coast Guard should recommend that the IMO require passenger ships to equip passenger and crew cabins with emergency call systems so that trapped individuals can signal their location. Further, the ICCL should propose that its member companies install emergency call systems in passenger and crew cabins.

Radios for Medical Staff—The doctor and two nurses had to treat passengers and crew located throughout the ship who were suffering from various injuries, some very serious. The *Universe Explorer* medical staff had only one radio, which meant that the nurses repeatedly had to go to the doctor to determine where their assistance was most needed. The doctor was able to obtain one additional radio, which he gave to one of the nurses, to coordinate their response, but the lack of effective communications interfered with their ability to render treatment to injured passengers and crewmembers. Had each member of the medical staff had a radio and a separate frequency on which to communicate so as not to interrupt other emergency transmissions, the doctor and nurses could have conferred over the radio without having to leave patients; as a result, more injury victims could have received better care by virtue of being treated sooner. The Safety Board

concludes that the inability of the shipboard medical staff to communicate by radio negatively affected the timeliness of the care provided to people injured in this accident.

The Safety Board believes that New Commodore, and its operator, V. Ships, should provide each medical staff member on company passenger vessels with a portable radio for use in shipboard emergencies. In addition, the Safety Board believes that the Coast Guard should propose to the IMO that passenger ship companies be required to equip each on-board medical staff member with a portable radio that has a dedicated radio frequency for use during emergencies. Further, the ICCL should propose that its member passenger ship operators provide each shipboard medical staff member with a radio and communications training for emergencies.

Adequacy of Fire Prevention, Control, and Detection Measures

The Safety Board determined that several measures affecting the fire safety of the vessel were either lacking, inadequate, or compromised. Any one of these factors could affect or contribute to the migration and propagation of smoke in the crew berthing area; together, they allowed a lethal amount of smoke to quickly accumulate in the crew quarters. This section discusses the following problems identified by the Safety Board:

- Bulkhead removal;
- Effectiveness of fire detectors;
- Lack of a sprinkler system;
- Effectiveness of electromagnetic fire doors;
- Misuse of fire doors; and
- Lack of automatic local fire alarms.

Bulkhead Removal—The vessel now known as the *Universe Explorer* was built in 1958 to SOLAS 48 requirements as interpreted by 46 CFR. The CFR states, "Insofar as is reasonable and practicable, Types 1 and 2 stairways … should not give direct access to accommodations or other enclosed spaces in which a fire may originate." Original plans indicate a bulkhead that essentially creates a corridor isolating the laundry work area from the stairways (figure 6). Later plans, including the fire control plan on the ship at the time of the fire, also indicate the presence of the bulkhead. During postaccident examination of the laundry, Safety Board investigators observed that the bulkhead had been removed.

The presence of the bulkhead itself would not necessarily have prevented a fire from starting; however, had the structure been in place, conditions would have been present that would have affected the timely detection of the fire and the propagation of smoke and heat. Had this bulkhead been in place and the corridor been maintained properly, no or few combustible items would have been in the walkway. Had the fire started in the laundry area, the bulkhead would have mitigated the effects of the fire. Even if the doors to the corridor and the stairways were open, the amount of smoke entering the stairways would have been less, resulting in proportionately less smoke migrating to the Aloha deck berthing area. The Safety Board concludes that removing the corridor bulkhead in the main laundry was an alteration to the vessel that seriously degraded the fire safety condition of the *Universe Explorer*. Further discussion of the bulkhead removal and the oversight by the owner, the flag state, and the Coast Guard appears later in this analysis.

Effectiveness of Fire Detectors—When Safety Board investigators examined the main laundry after the fire, they noted that the smoke detectors were not connected to the fire detection system. The only active fire detection devices in the area were heat detectors. Records do not indicate why the smoke detectors were disconnected. However, from discussions with

people experienced in laundry operations, fire experts, and detector manufacturers, the Safety Board determined that moisture, dust, and lint in the air of a laundry facility can trigger smoke detector sensors, resulting in false alarms, unless the devices are properly maintained. Heat-actuated detectors require more time than smoke detectors to actuate because a minimum level or minimum rate of heating must occur in the area of the device's sensor before the detector activates.

The limitations of each type of detector could be reduced by establishing systems using both types of devices. Moreover, combining the system of detection with an automatic sprinkler system, which is discussed in the next section of this report, would provide a greater measure of safety by limiting the spread of fire. The Safety Board concludes that greater fire protection can be attained in laundry facilities by using a combination of different types of detection devices, as well as an automatic suppression system.

The Safety Board is aware of other fire detection systems that are in development, including infrared and ultraviolet flame detectors and carbon monoxide detection systems. Some of these systems are currently available, and others are still being tested. Research at the National Fire Academy has shown that alarm verification and cross zoning of fire detectors are design features used in buildings to significantly reduce random false alarms. Alarm verification utilizes a time (15-30 seconds) to reset and verify a detector once it goes into alarm; if the activated detector does not reset, the alarm is processed as a valid alarm.

Cross zoning is another self-verification feature using adjacent detectors on independent zones or circuits. In a cross-zoned system, if one fire detector activates and an adjacent detector does not, the probability is high that a false alarm has occurred. If both detectors activate, the probability that a false alarm has occurred is low, and the alarm is processed as a valid alarm. Any type of fire detection system can be designed to reduce false alarms by employing either of these features.[27]

Given the high fire risk in laundry operations, improved methods of monitoring such areas are essential. Augmenting smoke and heat detectors with better surveillance measures, including installing video cameras in high-risk areas, may increase the level of safety aboard the *Universe Explorer*. The Safety Board concludes that improved surveillance of high-fire-risk areas would enhance the fire safety condition on board the *Universe Explorer*. The Safety Board therefore believes that the New Commodore, and its operator, V. Ships, should review the adequacy of the fire detection systems presently protecting high-fire-risk areas, including laundries, on company passenger ships, and, based on that review, install improved detection systems or institute improved surveillance procedures to improve fire detection capability.

Further, the Coast Guard should conduct research with the passenger ship industry and the National Fire Protection Association on the adequacy of heat and smoke detectors for use in high-fire-risk areas, including laundry spaces, and, based on the findings, propose to the IMO equipment or procedural guidelines for improving fire alarm reliability. In the interim, the ICCL should advise member companies of the possible need to improve surveillance measures for high-fire-risk areas on their ships.

Lack of a Sprinkler System—At the time of this accident, the main laundry on the *Universe Explorer* was not equipped with, and was not required by SOLAS to have, an automatic fire sprinkler system. In this fire a tremendous, lethal amount of smoke was produced when the many layers of paint on the stairwell

[27] W. Nelson, "Methods of Reducing False Alarms in Fire Alarm Systems," Applied Research Project, National Fire Academy, RR No. 14213, November 1989. J. Boccio, I. Asp, and R. Hall, "Acceptance and Verification for Early Warning Fire Detection Systems," Reactor Engineering Analysis Group, Department of Nuclear Energy, Brookhaven National Laboratory, Upton, New York. Prepared for U.S. Nuclear Regulatory Commission, May 1980.

bulkheads ignited. If the main laundry had been equipped with automatic sprinklers, they probably would have activated and extinguished the fire during its early development, preventing or at least mitigating the spread of smoke into the spiral stairway. The Safety Board concludes that if the *Universe Explorer* had been equipped with an automatic sprinkler system, the large quantities of smoke and resulting loss of life may have been avoided.

Effectiveness of Electromagnetic Fire Doors—The *Universe Explorer* had electromagnetic fire doors on all stairway enclosures and main vertical zone boundaries, including the forward bulkhead of the main laundry. These fire doors did not close automatically; they had to be released either by someone pushing a local switch or by someone on bridge remotely closing them.

According to the laundry manager, the fire door leading to the spiral stairway forward of the main laundry was always kept open. The fire watch stated that the forward and aft fire doors of the main laundry were open when he passed through on his rounds and that no one had ever instructed him to close them. Soot on the doors, door jambs, and adjacent bulkheads indicate that the fire doors were open during the fire.

Records indicate that on the morning of the accident, all fire doors, including the spiral stairwell access doors on E deck and Aloha deck, were closed within less than 10 minutes of the first fire alarm. Nevertheless, during postaccident examination of the vessel, Safety Board investigators found soot and debris patterns indicating that the fire doors, while open, had allowed the smoke and heat from the fire to enter the stairway, which then served as a flue, transmitting smoke and hot gases upward to other decks. The open fire door at the top of the spiral stairway on the Aloha deck allowed massive quantities of smoke to enter the break no. 1 passageway and migrate into the crew accommodation area forward of the break.

Had the doors leading from the main laundry to the stairways automatically closed when the fire started, the smoke and heat of the fire would probably have been contained within the main laundry long enough for the crew to have been warned of the fire and to have escaped from their cabins. The Safety Board concludes that had automatic closure of the fire doors been incorporated in the fire detection system, the fire doors in the area where the fire broke out would have shut immediately when nearby detectors activated, thereby restricting the spread of lethal amounts of smoke to the crew berthing areas on the Aloha deck.

The Safety Board has identified the need for automatic closure of fire doors since the mid-1980s, following its investigation of the August 20, 1984, fire on board the Bahamian passenger ship *Scandinavian Sun* while it was docked at the Port of Miami, Florida. At the time the fire erupted, the fire control system was in manual mode, rather than automatic mode, meaning that a person on the bridge had to activate the controls to shut down the ventilation system and to close the fire doors. When the detection system signaled the fire, the bridge was not staffed. By the time a staff officer arrived on the bridge and closed the fire doors, smoke from the fire had entered a stairwell and spread onto two decks where passengers were gathering to disembark. Of the 731 people on board, 1 passenger and 1 crewman died from smoke inhalation, 4 people suffered minor injuries, and 58 people needed treatment for smoke inhalation.

As a result of its investigation of the *Scandinavian Sun* fire, the Safety Board concluded, in part, that the fire could have been isolated earlier had the fire control system, including the fire doors, activated automatically. Based on its findings, the Safety Board issued the following safety recommendations to the Coast Guard:

M-85-60

Propose to the IMO an amendment to SOLAS 74 to require that heat or smoke detectors be made a part of each auto-

matic fire door release switch on passenger ships so that the door will close when the detector is activated.

M-85-61

Propose to the IMO an amendment to SOLAS 74 to require that all passenger ships carrying more than 36 persons on international routes have an automatic manual fire control system in the pilothouse that integrates the fire detectors, the automatic fire door controls, the ventilation system controls, and the general alarm into a unified system.

In response, the Coast Guard concurred with Safety Recommendation M-85-60, stating that such systems were currently available commercially for land-based installations.

The Coast Guard further stated that while it concurred with the intent of Safety Recommendation M-85-61, such a system was not commercially available; however, "The technical feasibility of such a system is well within the realm of available technology and has the potential for improving shipboard safety." The Coast Guard said that it would present Safety Recommendations M-85-60 and -61 at the February 1986 meeting of the IMO Fire Protection Subcommittee for discussion. Based upon the Coast Guard response, the Board placed both recommendations in an "Open—Acceptable Response" status. The IMO subsequently took no action on the proposals.

The Safety Board revisited the issue of improved fire protection measures in a 1989 safety study, *Passenger Vessels Operating from U.S. Ports*. In the study report, the Safety Board superseded Safety Recommendations M-85-60 and -61 with Safety Recommendations M-89-124 and -125, asking the Coast Guard to propose that the IMO, in part, require passenger ships operating from U.S. ports and embarking U.S. passengers to have the following fire protection measures:

M-89-124

A centralized automatic/manual fire control system on the navigation bridge that integrates the fire detector, automatic fire door controls, the ventilation systems controls, and general alarm into a unified system.

M-89-125

Integrated heat and/or smoke detectors with automatic fire door release switches so that the doors will close automatically when the detectors are activated.

In 1992, the IMO enacted amendments to the SOLAS 74 fire safety regulations that included improved measures for fire doors. Requirements contained in chapter II-2 stipulate that new passenger ships must have fire doors capable of remote and automatic release from a continuously staffed central control station, as well as from a position at both sides of each individual door. The release mechanism must be designed so that a door will automatically close should a disruption of the control system or central power supply occur. Further, Regulation 41-2 requires that the stairway enclosures, MVZ bulkheads, and galley boundaries on existing passenger vessels be fitted with self-closing fire doors capable of being released from a central control station and from each door.

The Safety Board reviewed the amendments to SOLAS 74, considered the measure requiring remote release from a centrally manned location to be in compliance with the intent of the recommendations, and classified Safety Recommendations M-89-124 and -125 "Closed—Acceptable Alternate Action." Following its investigation of the fire on the *Universe Explorer*, the Board has reconsidered its opinion. As this accident demonstrates, having a central station initiate the closure of fire doors does not afford the maximum measure of safety and can result in delays that prove fatal. The Safety Board believes that New Commodore, and its operating company, V. Ships, should modify the fire con-

trol systems on company passenger vessels, integrating heat and/or smoke detectors with automatic fire door release switches. Further, the Coast Guard should propose to the IMO that passenger ships be required to integrate heat and/or smoke detectors with automatic fire door release switches so that the doors in the immediate area of the fire will close automatically when the detectors are activated. Also, the ICCL should recommend that member companies integrate heat and/or smoke detectors with automatic fire door release switches.

Compromise of Fire Door Effectiveness—During postaccident examination, Safety Board investigators found evidence, including soot on the door jambs and remnants of string on the corridor handrails near the doors, that the fire doors opening into the berthing area corridors on Aloha deck had been tied open during the fire. Investigators noted that these doors were on a direct route between the crew cabins, a galley, and various job sites. The Board surmised that the crew had to open and close these doors repeatedly, which probably became at least an annoying chore and perhaps a difficult task if they were carrying items. By tying the doors open, they gained freer movement to and from commonly used areas.

The soot markings and fire damage indicated that when the smoke and heat rose in the spiral stairway forward of the main laundry, it exited through the open stair door on Aloha deck into the break no. 1 area, from which it spread into the corridors of the crew accommodations area. The fire doors to the crew berthing corridors were the last barrier between the sleeping men and the deadly smoke. Had these fire doors been closed instead of tied open, they would have blocked the entry of smoke into the berthing area, and the crew could have escaped by alternate routes. The Safety Board concludes that the effectiveness of the fire doors to the crew corridors on Aloha deck was compromised by their being tied open, degrading crew safety and permitting lethal amounts of smoke to spread to the crew berthing areas.

One of the specific duties assigned to the fire watch was to ensure that all fire doors were not blocked or lashed open. Because some fire doors were lashed open during the fire, the fire watch's execution of assigned duties and the safety officer's oversight of the fire watch were obviously less than adequate. The Safety Board therefore concludes that improved oversight of the fire watch is needed to improve the level of fire safety on board the *Universe Explorer*. The Safety Board believes that the New Commodore, and its operating company, V. Ships, should institute procedures to improve the oversight of the fire watch on board company passenger ships.

Effectiveness of Alarms—When the heat detector in the main laundry detected the fire, it activated an alarm on a panel on the navigation bridge. No alarm automatically sounded in the area of the activated heat detector. When smoke from the fire traveled up the spiral stair and into the Aloha deck berthing area, it also triggered smoke detectors, setting off alarms on the bridge fire alarm panel. However, no smoke alarm automatically sounded on Aloha deck, where the crew was sleeping.

To warn the sleeping crewmen on Aloha deck of the fire, the alarm had to be manually sounded from the bridge, or a manual push button alarm had to be activated from a location in break no. 1. The lack of an automatic alarm system in the crew berthing area delayed the notification and hindered the safe evacuation of crewmembers. Smoke had already entered and filled the Aloha deck berthing area before bridge personnel sounded the alarm. A number of surviving crewmen stated that they stumbled over crewmembers who had collapsed in the passageway before the "Mr. Skylight" announcement was made. One crewman said that he had already escaped to an open deck and was pausing to breathe fresh air when he heard the "Mr. Skylight" announcement. Had the crew been alerted earlier, they would have encountered less smoke and had less risk of being overcome by smoke during their escape.

The bridge watch officer, following company procedures, wanted to verify the existence of a fire before sounding the general alarm. He therefore dispatched the fire watch to verify the alarm panel indication and then called the master to the bridge. While these actions were taking place, no fire alarm was sounded in the crew berthing area. The general alarm was not sounded until the master arrived on the bridge and ordered it sounded. Crewmembers in the Aloha deck berthing area could not activate the manual alarm because it was located in the break no. 1 area, which was inaccessible because of high levels of heat and smoke. The Safety Board concludes that the lack of an automatic smoke alarm that sounded locally in the crew berthing area delayed prompt notification to the crew of the fire and the need to evacuate. Had the crewmembers who died received earlier warning, they may have escaped.

Less than 9 months after this accident, the Safety Board investigated another fatal cruise ship fire in which the smoke from a minor blaze caused multiple injuries and death. On April 6, 1997, a fire broke out on board the Bahamian flag passenger ship, *Vistafjord*, which was underway from Fort Lauderdale, Florida, to the Azores with 569 passengers and 422 crewmembers. The ship's crew was able to control and extinguish the fire; however, one crewman died as a result of smoke inhalation while trying to escape from the crew berthing area. Six other crewmembers and four passengers received smoke inhalation injuries during the fire.

As a result of the *Universe Explorer* and *Vistafjord* accidents, the Safety Board issued the following urgent safety recommendations on April 24, 1997:

To New Commodore Cruise Lines, Inc., and to Cunard Lines Ltd.:

M-97-35

Without delay install automatic smoke alarms that sound locally in crew accommodation areas so that crews will receive immediate warning of the presence of smoke and will have the maximum available escape time during a fire.

M-97-36

Without delay install automatic smoke alarms that sound locally in passenger accommodation areas so that passengers will receive immediate warning of the presence of smoke and will have the maximum available escape time during a fire.

To the ICCL:

M-97-37

Without delay advise members to install automatic smoke alarms that sound locally in crew accommodation areas so that crews will receive immediate warning of the presence of smoke and will have the maximum available escape time during a fire.

M-97-38

Without delay advise members to install automatic smoke alarms that sound locally in passenger accommodation areas so that passengers will receive immediate warning of the presence of smoke and will have the maximum available escape time during a fire.

To the Coast Guard:

M-97-39

Propose that the IMO require all passenger vessels to have automatic smoke alarms that sound locally in the crew berthing areas so that crews will receive immediate warning of the presence of smoke and will have the maximum available escape time during a fire.

M-97-40

> Propose that the IMO require all passenger vessels to have automatic smoke alarms that sound locally in the passenger accommodation areas so that passengers will receive immediate warning of the presence of smoke and will have the maximum available escape time during a fire.

In May 1997, the ICCL wrote that it had distributed information related to the accidents and the resulting recommendations to its members for review and consideration. Further, the ICCL Technical Committee was including the recommendations for discussion on the agenda for its August 1997 meeting. New Commodore also responded in May, indicating it believed that the safety recommendations had merit and that its vessel manager would be discussing the recommended actions at the ICCL Technical Committee's meeting. The Safety Board therefore classified Safety Recommendations M-97-35 and -36 to New Commodore and M-97-37 and -38 to the ICCL "Open—Acceptable Response" in June 1997. After the Safety Board sent a follow-up letter to the cruise line on December 17, 1997, Cunard responded on February 2, 1998, stating,

> We do not feel that your recommendations add substance to the international regulations imposed by IMO. On the contrary, we believe that smoke detectors sounding locally in crew and, much worse, in passenger areas risk panic in a disorganised evacuation ….We feel that hurried unilateral reactions to specific incidents might, in fact, damage rather than improve safety onboard.

The Safety Board is disappointed by Cunard's position and has subsequently classified Safety Recommendation M-97-35 and -36 to the cruise line "Closed—Unacceptable Response."

In a letter dated July 25, 1997, the Coast Guard Commandant stated:

> We concur with these recommendations. The IMO Sub-Committee on Fire Protection at its 36th Session discussed the possibility of requiring audible smoke alarms on passenger vessels during the development of the 1992 Fire Safety Amendments, but decided to require that all fire alarms panels be placed in a continuously manned control station instead. Concern had been expressed, by several member governments and the industry, that activated smoke detectors are frequently false alarms, and therefore the bridge should always investigate a smoke alarm first before any emergency alarms are sounded. However, this is exactly what happened aboard the *Universe Explorer*, and by the time the roving patrol arrived at the scene to investigate, several crew members had already been overcome by smoke.
>
> The Coast Guard will revisit the issue of requiring audible smoke alarms in the passenger and crew areas at a future meeting of the IMO Sub-Committee on Fire Protection. We will submit a paper on this issue to the next session of the IMO Maritime Safety Committee in May 1998, looking toward consideration of an appropriate fire safety amendment at the 453rd Session of the Sub-Committee on Fire Protection in early 1999. In the meantime, we will work with industry through the SOLAS working group to develop the proposal and draft text. Our initial contacts with industry representatives after the *Universe Explorer* incident indicate some concerns with false alarms, passenger and crowd control, and panic with respect to locally sounding automatic smoke alarms. We will keep the Board informed of our progress on this issue.

In a September 11, 1997, letter to the Coast Guard, the Safety Board wrote that it was pleased with the actions taken and that, pending completion of the projects, Safety Recommendations M-97-39 and -40 were classified "Open—Acceptable Response."

Adequacy of Emergency Procedures

Most passengers were asleep in their staterooms when the fire was discovered. The master ordered the emergency signal sounded on the ship's whistle and the general alarm system sounded within about 7 minutes of the first sensor alarm. Survey respondents generally had high praise for crewmembers' efforts to alert passengers and evacuate all staterooms. The cruise director arrived on the bridge shortly after the initial sensor alarm and began making announcements instructing the passengers to remain calm and to proceed to their muster stations. Meanwhile, crewmembers proceeded in an orderly and efficient manner from stateroom to stateroom, knocking on cabin doors to ensure that passengers were awake and to inform them to go immediately to their muster stations. Survey respondents described the crew as helpful and caring. The follow-up action of crewmembers to ensure each stateroom had been vacated was particularly noteworthy. After checking a stateroom, they closed the stateroom door and placed a towel around the exterior door knob to indicate to other crewmembers that the room had been checked and was empty.

The Safety Board concludes that the crewmembers' implementation of evacuation procedures was effective in maintaining calm and order and in ensuring that passengers vacated their cabins and assembled at their muster stations.

Despite the efficient actions of crewmembers in evacuating passengers, the Safety Board identified a number of deficiencies in onboard emergency procedures.

Watch Officer's Initial Response—In accordance with the operating company's written procedures, the watch officer acknowledged the fire alarm when it sounded on the navigation bridge and sent the fire watch to the area of the activated alarm to investigate. The procedures further called for the watch officer to wait until after the fire watch confirmed the fire before closing the fire screen doors from the bridge. In this case, however, when the watch officer began to receive multiple fire alarms on the bridge, he did not wait for the fire watch to report back. He immediately called the master to the bridge but he did not immediately close the fire doors. The fire screen doors were not closed until 0305, after the master had arrived on the bridge and ordered them closed.

The method of ship construction used in building the *Universe Explorer* is designed to confine a fire to its compartment of origin by use of structural fire boundaries. Fire screen doors are an important feature of these fire boundaries because they maintain the fire integrity when closed. In the Board's view, closing the fire doors ought to be the first action taken on a method I constructed ship when a fire alarm activates. To do otherwise allows more time for the heat and smoke of a fire to escape from its compartment of origin and to spread to other parts of the vessel. In this instance, the first alarm sounded at 0259, and the doors were not closed until 0305. During this 6-minute interval, smoke and heat from the fire in the main laundry continued to flow outward and upward through the laundry stairwells to other decks of the ship. If the fire screen doors had been immediately closed when the fire alarm was received, the amount of smoke that ultimately reached the Aloha deck crew berthing area may have been significantly reduced. The Safety Board concludes that the *Universe Explorer*'s operating procedures that the watch officer is supposed to follow when a fire alarm activates are less than adequate to ensure the timely establishment of fire boundaries restricting the spread of heat and smoke. Consequently, the Safety Board believes that New Commodore and its operating company, V. Ships, should re-

vise their passenger ship operating procedures to require that the navigation watch officer immediately close the fire screen doors upon receipt of a fire alarm.

Passenger Drill—The *Universe Explorer* conducted a passenger fire drill in a timely manner; that is, shortly after everyone had boarded the vessel in Vancouver. Because a fire can occur at any time, the sooner passengers are provided with emergency instructions and participate in a drill, the better.

After the fire, most passengers surveyed indicated that they found the drill to have been very helpful. Based on the passengers' comments, the Safety Board identified several ways in which the drill could be improved. Some survey respondents stated that the drill consisted of providing them with instructions on how to don a life preserver and on how to locate their muster stations. A large majority of those responding indicated that passengers were not told what to do should they see a fire or smell smoke. Passengers were particularly critical of the lack of information provided about the fire doors. About one-fourth of the responders characterized the drill as unrealistic because many passengers who knew the scheduled time of the drill went in advance to their lifeboats, using the elevators to reach their stations. One passenger complained that the drill did not prepare him to locate his life preserver because it had been placed on his bunk for the drill, whereas it was stowed in his room when he needed it during the actual emergency.

To have the maximum effectiveness, fire drills should be as realistic as possible. When dealing with a large group—in this case, 732 passengers—undoubtedly some individuals will become agitated or frightened during an actual emergency. When events occur for which passengers are not prepared, such as magnetic doors suddenly slamming shut, the likelihood increases that they will panic. Such reactions clearly support the need for passenger fire drills and for placards in staterooms that contain adequate instructions about fire emergencies.

The content of the *Universe Explorer* drill left many passengers unprepared to meet the demands of the actual fire emergency. Allowing passengers to use elevators to reach their assembly stations during a drill does not prepare them to identify a safe route of escape. Further, not requiring passengers to observe approved safety procedures during drills may lead them to attempt the same shortcuts during the actual emergency, perhaps with tragic results. To be effective, a drill must provide passengers with the basic information, including:

- how to report a fire;
- what to expect if a fire occurs, such as typical announcements, actions of the crew, operation of the emergency lights, and operation of fire doors;
- the location and meaning of emergency signs;
- the description of emergency signals;
- if incapacitated, how to call for assistance; and
- the route to take from their stateroom to their assembly area.

As this accident demonstrated, information about remotely operated fire doors is particularly important during a drill because the sudden closing of these doors may lead uninformed passengers to conclude erroneously that escape avenues are blocked and that they are trapped. Passengers need to be advised that the doors will close in the event of a fire, to be informed that the heavy doors are not locked, and to be shown how to open a closed magnetic door.

The Safety Board concludes that although the passenger fire drill held on the *Universe Explorer* was conducted in a timely manner, the content of the exercise did not fully prepare many passengers to meet the demands of an actual fire emergency. The Safety Board believes that New Commodore and its operating company, V. Ships, should revise the required content of passenger fire drills to include infor-

mation about what to expect in the event of a fire, with particular emphasis on the operation of fire doors. The Safety Board also believes that the ICCL should advise its member companies to review and, if necessary, revise their passenger fire drill procedures to ensure that they include information about what to expect in the event of a fire, with particular emphasis on the operation of fire doors.

Status Announcements—Passengers indicated that although announcements were made over the public address system asking them to remain calm while they were at their muster stations, they were not adequately informed about the progress of the situation. They said they were never told how long they might have to remain at the assembly areas. Further, they felt that someone in authority, such as the master or another officer, should have given them status updates. One passenger stated, "There was no communication from the ship's captain or any officer of the crew until several passengers challenged an official from the cruise line to inform us of the situation, 4 to 5 hours after the initial fire."

During an emergency, it is vital to passengers' peace of mind to receive periodic information about the status of the situation, particularly any progress in overcoming a threat to safety. Further, receiving such reports from a recognized authority figure, such as the ship's master, is more reassuring. Understandably, the master's and officers' primary concern was to extinguish the fire. Nonetheless, providing periodic assurances to passengers during prolonged emergencies is important so that order and discipline can be maintained. The Safety Board concludes that the *Universe Explorer* crew did not adequately address passenger concerns about the fire and the seriousness of the situation while they were assembled at their muster stations. The Safety Board believes that New Commodore, and its operating company, V. Ships, should revise company procedures regarding muster assemblies to improve periodic announcements made to passengers about the status of an ongoing shipboard emergency.

Crew Drills—The *Universe Explorer* conducted weekly shipboard emergency drills as required by SOLAS. The drills did not include, and were not required to include, identifying alternate escape routes from cabins and work sites. The Aloha deck berthing area where the fatalities occurred is forward of the crew galley and most work areas; therefore, crewmembers routinely walked aft every day to eat meals and report to work. When alerted to the fire, they reacted according to habit in attempting to escape.

Survivors from Aloha deck said they first tried to walk aft in the port corridor but could not continue because the intensity of the heat and smoke increased as they neared break no. 1, forcing them to turn around to find alternative escape routes. They said the heavy smoke stung their eyes and severely limited their visibility, requiring that they feel their way along the corridors until they found an exit. Although the crew had several other means of escape 50 to 60 feet away, locating an exit quickly was difficult. The position of the three deceased crewmen's bodies in the passageways indicates that they probably were overcome by the heavy, toxic smoke while trying to find an escape route.

The Safety Board identified a similar situation during its investigation of the October 8, 1994, engineroom fire on board the Liberian tankship *Seal Island*.[28] In that accident, a spray of lubricating oil was ignited and immediately erupted into a large blaze, generating a tremendous amount of thick smoke that completely obscured visibility. Of the nine crewmembers in the engineroom, three died and six were seriously injured. Several of the casualties resulted from the crewmen becoming disoriented in the smoke and not being able to immediately locate an exit. Two of the crewmembers who escaped attributed their survival to special training that familiarized them with alternative emergency exit routes on the tankship.

[28] For additional information, read Marine Accident Report *Engineroom Fire on Board the Liberian Tankship* Seal Island *While Moored At the Amerada Hess Oil Terminal In St. Croix, U.S. Virgin Islands, October 8, 1994* (NTSB/MAR-95/04).

The 1995 amendments to the STCW Convention that became effective February 1, 1997, recognize the need for improved survival training. The amendments require that before crewmembers who are *new* to a seagoing ship are assigned to shipboard duties, they must receive familiarization training in personal survival techniques or receive sufficient information to be able to perform certain tasks, including identifying emergency escape routes and muster and embarkation stations.

As the *Universe Explorer* fire and other accidents demonstrate, knowledge of alternate escape routes is critical to the survival of crewmen during a fire emergency. While the Safety Board is pleased with the IMO's initiative to improve survivability training for new seafarers, it is concerned that comparable instruction and refresher training is not available for all crewmembers. The Safety Board recognizes the impracticality of requiring today's passenger ships to drill their entire crews weekly on identifying and using alternate escape routes from work and berthing areas. Nevertheless, crewmembers need more than a one-time training session in survivability, especially if, as new employees, they receive such instruction while having to familiarize themselves with other vessel operations.

The Safety Board concludes that some of the deceased crewmembers on the *Universe Explorer* may not have survived the fire because they lacked sufficient knowledge of alternate escape routes from their berthing area.

While the 1995 amendments to the STCW Convention will ensure that new seafarers are familiar with escape routes on vessels at the time they first come on board, these requirements do not provide a mechanism for periodic reinforcement of the initial training. Without periodic reinforcement of the training through further instruction or drills, the value of the initial training will degrade over time. The Safety Board therefore believes New Commodore, and its operating company, V. Ships, should provide periodic instruction or drills to all crewmembers on company passenger vessels to reinforce the familiarization training required of new seafarers by the 1995 amendments to the STCW Convention. Moreover, the ICCL should recommend that its member companies conduct such reinforcement training for crews as described. Lastly, the Coast Guard should propose to the IMO that vessel owners and operators be required to conduct periodic reinforcement training and/or drills in survivability to ensure that the crewmembers are familiar with infrequently used alternate avenues of escape. Conduct of the training could be facilitated by designating fire wardens for each berthing area who would be responsible for providing periodic survivability training, including routes of escape, to each individual assigned to the area.

Fire and Rescue Search—Following the "Mr. Skylight" announcement, the ship's two fire teams assembled, donned protective gear, and marshaled firefighting equipment. The safety officer took charge of the search for the fire while the staff captain directed the search of the crew berthing area. Despite the prompt action, the searches did not result in timely location of either the fire or the trapped men.

Fire search—After donning an SCBA, the safety officer began searching alone for avenues of approach to the fire, leaving the fire teams standing by. He first tried to proceed forward on Aloha deck along the portside passageway, but when he opened the portside door at break no. 1, the smoke and the heat prevented him from continuing. He returned to Main deck and instructed the fire team leader to accompany him. Together, they went back to Aloha deck and tried the starboard side door to break no.1 and were driven back by the smoke and the heat. They then went down to Bali deck and went forward until they reached a stairway to Aloha deck. When they ascended to Aloha deck, they found trapped crewmen, whom they directed to safety. They then received a radio call from the bridge to go to the crew galley. They next descended a stairway aft of the galley to E deck and proceeded forward on E deck until they entered the crew laundry and saw the fire.

The safety officer's attempt to locate the fire alone was ill-advised. Had he run into difficulty while searching for the fire, he had no backup with him who could have either aided him or obtained additional help. Although he was carrying a portable UHF radio with which he could have summoned help, the radio's capability to transmit from different parts of the ship was suspect, as the breakdown in communications between the second officer and the fire watch demonstrated. After finding his initial route to the fire location blocked by heat and smoke, the safety officer wisely returned to the Main deck and had the fire team leader accompany him on subsequent attempts to locate the fire. The two men continued using a trial-and-error method to locate the fire. On this ship, even the most stoutly constructed fire boundary is designed to prevent the passage of heat and smoke for only 60 minutes; therefore, timely location of a fire is paramount. Although ultimately successful, the men did not find the fire for 30 to 45 minutes. During this time, the fire continued to burn freely, producing increasing amounts of toxic smoke.

Given his knowledge of the ship's layout, the safety officer could have organized a more methodical approach to locating the fire by assigning one or more search teams to check out possible avenues simultaneously. The Safety Board concludes that using this approach, the officers might have located the fire sooner.

The Safety Board has investigated a number of passenger ship fires in which the on-board firefighters' speed in locating the source of the fire was an issue. The most recent case involved an August 19, 1994, fire on board the *Regal Empress*, which was carrying 1,394 passengers and crewmembers and was en route from Canada to New York, New York. About 0630, a crewman discovered light smoke coming from a cleaning gear room. The safety officer tried to find the source of the fire himself but was unsuccessful. About 0707, the master activated the ship's firefighting teams and initiated measures to isolate the fire. By the time the ship docked more than a hour later, the vessel fire teams still had not found the fire. The fire was not located and extinguished until 0953, after Fire Department of New York personnel had boarded the vessel and joined the search. The "small" fire ultimately resulted in almost $250,000 damage because of the protracted time required to identify the seat of the fire.

Had the smoke and fire conditions in the *Universe Explorer* accident been different, speed in locating the fire could have had far greater importance. The Safety Board believes that New Commodore, and its operating company, V. Ships, should institute improved procedures for locating fires to improve survivability aboard their vessels.

Rescue efforts—The staff captain directed one fire team member to don breathing equipment and search the crew berthing area on Aloha deck. Upon opening the fire screen door to the berthing area, he encountered intense and blinding smoke. He saw three fallen crewmembers who showed no signs of life and heard people pounding on bulkheads and calling for help. He yelled out to the trapped people and shined his flashlight down the corridor, but saw nothing but smoke. He estimated that he returned to the Main deck between 0335 and 0340 to brief the staff captain, who told him to go back and recover the fallen crewmen. The team member told the staff captain that he could not do it alone because of the smoke and nearby fire. Shortly after 0350, the staff captain, the first searcher, and a second fire team member together went down to the Aloha deck and removed the fallen crewmen. No one rescued the crewmen who were trapped in cabins until about 0540.

As noted in previous sections of this report, having a lone individual—in this case the fire team member—search an area of a vessel during a fire was ill-advised and dangerous. The searcher could have needed help himself or could have encountered people who needed assistance that was beyond the ability of one person to provide. Despite reports as early as 0335 that crewmen were yelling and pounding

on bulkheads, no organized, systematic search of crew cabins on Aloha deck took place then or after the bodies of the fallen men had been retrieved. The crewmembers remained trapped for 2 ½ more hours. Fortunately, some crewmen had access to an open porthole from which they were able to breathe fresh air. During their period of entrapment, the men frantically but unsuccessfully tried to signal nearby vessels for help by waving towels out the porthole.

The Safety Board concludes that efforts to locate and rescue trapped crewmembers were not initiated in a timely manner. The delayed search of Aloha deck crew cabins prolonged the trapped crewmen's exposure to smoke and contributed to the severity of their injuries.

The delay and lack of systematic effort in rescuing trapped crewmembers demonstrates that the *Universe Explorer* crew was not adequately prepared to conduct rescue operations. The Safety Board concludes that if the *Universe Explorer* had had a properly equipped rescue team that was trained in locating and recovering people trapped in smoke-filled areas, the crewmen probably would have been rescued sooner and would have sustained less severe injuries; moreover, fewer crewmen may have died. The Safety Board believes that New Commodore and its operating company, V. Ships, should establish for each company vessel a team dedicated to locating trapped crewmembers or passengers and provide the team with recurrent search and rescue training.

The 38-year-old *Universe Explorer* is a small vessel by current industry standards. Larger passenger vessels typically carry hundreds of crewmen and thousands of passengers. With so many people on board, the probability is relatively high that some passengers or crewmembers will become trapped during a fire emergency. Without properly trained and equipped search and rescue teams, such trapped persons may well become fatalities. The Safety Board considers dedicated rescue teams necessary on all passenger ships. The Safety Board therefore believes that the ICCL should encourage its member companies to establish specially trained and equipped shipboard rescue teams. Further, the Coast Guard should propose to the IMO that specially trained and suitably equipped rescue teams be required on board all passenger ships. Members of such teams should be provided with specialized equipment, such as SCBAs, radios, lifelines, and so forth, and be properly trained in its use. They also should be required to become familiar with all areas of the ship so that they can conduct a safe rescue in any section. Further, the training should include drills simulating rescues in smoke-filled areas.

Availability of Medical Supplies—The fire occurred below the hospital, forcing the ship's doctor and nurses to evacuate immediately. Fire conditions prevented anyone from accessing the medical supplies stored in the hospital. The bridge maintained an emergency medical kit, but it did not contain oxygen to treat the crewmembers who sustained smoke inhalation injuries. The Safety Board concludes that the lack of a secondary supply of oxygen limited the medical staff's ability to treat the injured.

Although inadequate medical supplies did not cause or contribute to loss of life in this accident, insufficient medical stocks could have determined whether an injured person lived or died had the casualties been more severe. The Safety Board believes that the New Commodore and its operating company, V. Ships, should ensure that all emergency medical kits on company passenger ships contain adequate medical supplies to handle emergency conditions, such as those experienced during the *Universe Explorer* fire. Further, the ICCL should, in consultation with member passenger ship operators, determine the amount and type of medical supplies needed during an emergency and recommend that such supplies be maintained in suitable locations outside the ship's hospital in the event it becomes inaccessible.

Adequacy of Oversight

Earlier in this analysis, the Safety Board discussed how the removal of the corridor bulkhead in the main laundry seriously degraded the fire safety condition of the *Universe Explorer*. In the course of determining when and who might have authorized the removal of a bulkhead that was required by U.S. standards and SOLAS regulations as part of the ship's original method I construction design, the Safety Board identified problems in oversight, not only by the owner and operating company, but also the ABS and the Coast Guard, who were responsible for certifying the safety of the vessel.

Company Oversight—Copies of original construction plans, 1964 plans, and the 1991 vessel fire control plan, which were approved by the ABS, all indicate a corridor bulkhead in the main laundry. According to the present owner, the bulkhead was removed by a previous owner in the 1970s; after discussing the missing bulkhead with Safety Board staff, the owner's agent wrote the Board that the bulkhead was not "pivotal" in the case in that it was "not required by flag, class, or IMO rules." In another letter, the ship's operator stated, "This vessel has been repeatedly and routinely inspected by its owners, flag state, ABS, USCG and other port states, and found in regulatory compliance regarding structural fire protection …."

The Safety Board finds this argument distressing. SOLAS requirements at regulation 20 stipulate that general arrangement plans indicating bulkhead divisions are to be permanently exhibited for the guidance of the ship's officers and that the plans should be kept up to date with any alterations being recorded thereon as soon as practicable. Having an inaccurate fire control plan compromises the ability of officers to direct operations during a fire emergency, which, in turn, places crewmembers and passengers at risk. Given the time and opportunity that the present owner had to either reinstall the bulkhead or correct the fire plans, the Safety Board questions the company's commitment to maximizing fire safety.

Months before Azure Investments purchased the ship, company representatives discussed its compliance with the RFSAs with Coast Guard officials. Coast Guard files contain a record of a March 29, 1995, telephone call from the prospective owner's agent indicating the vessel would comply with the RFSAs.

In April 1995, the prospective owner's representatives met with senior Coast Guard officials and "knowledgeable inspectors" to discuss possibly reflagging the vessel under U.S. flag. Toward that effort, they asked that the Coast Guard provide them with a copy of the agency's entire file on the *Universe Explorer*. The Coast Guard also provided copies of its examination findings of a 1989 fire on board the vessel's sister ship; the findings indicated that, contrary to method I construction standards, both ships had combustible insulation material, some of which could not be removed.

In May 1995, the prospective owner had various marine technical specialists, including marine engineers and naval architects, perform extensive onboard inspections of the Universe Explorer to determine its condition. About the same time, the vessel's operating company contracted with a consulting company whose principals included former Coast Guard technical staff members for the project of bringing the ship into compliance with the RFSAs. One RFSA that was scheduled to become effective in October 1997 prohibited any space containing combustibles from opening directly into a stairway. A thorough examination of the vessel by expert consultants would have included the main laundry and, therefore should have identified that the laundry layout was not in accordance with the fire control plan. The *Universe Explorer* remained out of service between July 1995 and January 1996, while company officials had it modified for operating under charter to the Institute for Shipboard Education. Thus, the company had ample time, documentation, and technical expertise with which to identify and correct unsafe conditions, including either replacing the bulkhead or correcting the fire control plan.

The 7-month period that the vessel was out of service also afforded the company ample opportunity to develop effective fire safety policies and procedures, yet, as this case demonstrates, the *Universe Explorer* did not have them in place at the time of the fire. As described earlier in this analysis, the company had poor policies and procedures in the following areas:

- **Alert—**Activated alarms first sounded on the bridge, delaying early emergency notification to those endangered.

- **Fire doors—**Emergency procedures required that the presence of a fire be verified in person by a watchman before closing the fire doors.

- **Communications—**The UHF radios provided to emergency responders did not provide the communications capability to ensure the safety of the fire watch and fire teams, which, in turn, was needed to ensure the safety of passengers and crewmembers.

- **Tracking of Responders—**The fire watch and the safety officer did not have a person assigned to back them up, placing them at increased risk if they were injured during response activities.

- **Fire Locating—**The officers directing the fire search did not use a methodical approach employing more than one search team, resulting in a delay in locating the fire.

- **Search and Rescue—**Vessel management did not have a systematic method for locating trapped crewmembers and thus prolonged their exposure to smoke and contributed to the severity of their injuries.

- **Fire Watch Supervision—**The shipboard manager did not properly monitor the work of the fire watch, who was required to ensure that fire doors were not tied open.

- **Fire Drills—**Crew emergency drills did not stress using alternate routes; as a result, panicking crewmen failed to locate an alternate egress timely or at all. Passenger drills were not realistic and did not include information about safety features, such as the fire doors, causing some passengers to panic.

According to the company, its shoreside officials periodically visit the ship to confer with vessel officers and attend classification society surveys and Coast Guard examinations. In the Board's opinion, these actions alone are not sufficient to provide adequate management oversight and to ensure effective fire safety aboard the vessel. These meetings typically exclude personnel who are not in upper shipboard management. Effective management oversight must extend beyond upper shipboard managers to include personnel from all levels in the shipboard organization. Only through inclusion may commitment to safety be attained in all levels of the shipboard organization. If more effective management oversight of safety had been exercised on the *Universe Explorer*, crewmembers would not have compromised the effectiveness of the fire doors by tying them open, the fire watch would have been more mindful that he needed to report his findings to the watch officer, and the watch officer would have been more concerned about the safety of the fire watch. The company needs to foster the attitude among its crews that fire safety is preeminent in its vessel operations and that their actions directly affect the safe operation of the ship.

The Safety Board concludes that shoreside management did not exercise effective oversight of fire safety on the *Universe Explorer*.

V. Ships, the operator of the *Universe Explorer*, has advised the Safety Board that it is developing a safety management system for its passenger ships as required by the ISM Code. The Board questions whether this system will address the safety management deficiencies noted in this report. The Safety Board therefore believes that the New Commodore, through its

operator, V. Ships, should address the safety issues identified in this report in its ISM system. Moreover, it should increase the management oversight of fire safety on board company vessels by initiating, at a minimum, the following measures: establishing procedures for periodic fire safety vessel examinations by shoreside management officials, revising fire alarm response procedures to require immediate closing of remotely activated fire doors, and periodically instructing ships' crews on maintaining a fire-safe vessel.

Class and Coast Guard Oversight—This accident raises questions about the adequacy of the ABS survey and Coast Guard control verification procedures and the resulting thoroughness of their inspections.

ABS reviews—The ABS checks an ABS-classed vessel's approved plans against its internal arrangements when a new owner initially applies for classification or after a structural modification authorized by the ABS has been made to the vessel, but not during its routine annual surveys. The ABS exercised the primary inspection responsibility over the *Universe Explorer*. Not only did it conduct annual and special surveys for the purpose of confirming that the vessel met classification rules for insurance purposes, it also acted in a regulatory capacity on behalf of the flag administration (Panama) to ensure that the vessel complied with applicable SOLAS requirements.

In 1991, the ABS approved a fire control plan for the *Universe Explorer* that incorrectly showed a corridor bulkhead in the main laundry. The Safety Board is concerned that the ABS approved a vessel plan, especially a plan as critical as the fire control plan, that did not accurately depict the ship's configuration. If the classification society's survey procedures were efficient, its surveyors should have found this discrepancy and, at a minimum, required the fire control plan be corrected in 1991. In correspondence with the Safety Board after the fire, the ABS stated that it had no documents on file regarding the bulkhead and did not know when it had been removed. The Safety Board concludes that the ABS's process for approving a plan or for verifying that submitted plans are accurate is not as rigorous as it ought to be. The Board therefore believes that the ABS should evaluate its plan review procedures and institute improved safeguards to ensure that ship plans submitted for approval accurately depict the actual vessel configuration.

In postaccident communication with Safety Board staff, the ABS stated that the laundry bulkhead did not have to be in place for the vessel to comply with ABS classification requirements or the statutory requirements of the flag administration, Panama, at the time of the casualty. The ABS cited SOLAS 48 as the basis for its contention. In fact, SOLAS 48, as interpreted by CFR 46, stipulates that type 2 stairways should not give direct access to enclosed spaces in which a fire may originate. The original owner and the Coast Guard considered the main laundry corridor bulkhead not only practicable but necessary to achieve an adequate measure of fire safety on the vessel. The ABS classed the newly constructed vessel. With the exception of the 8-year period when the ship was classed by LR, the ABS surveyed and classed the ship throughout its life, reviewing and approving various fire control plans, all of which indicate that the main laundry had a corridor bulkhead. After the fire, when advised that the bulkhead had been removed, an ABS official maintained that the bulkhead was not required by SOLAS 48. The Safety Board is disturbed by the ABS's postaccident interpretation of the international requirements. Removing the bulkhead reduced the level of fire safety, which is not permitted by SOLAS. For the ABS to interpret that the laundry bulkhead once required by SOLAS 48 can be removed indicates that the classification agency has effectively accepted the degradation of fire safety on this passenger vessel.

Coast Guard reviews—The Coast Guard currently checks a foreign-registered passenger vessel's approved plans when the vessel first enters service in the United States or when it undergoes a major structural modification. In

the case of the *Universe Explorer*, the vessel happened to first enter U.S. service as a foreign passenger ship during a 5-year period when the Coast Guard did not require a plan review as part of the initial CVE. Since the late 1980s, the Coast Guard had regularly conducted annual and quarterly CVEs of the *Universe Explorer*. NVIC 1-93, which contains the procedures that Coast Guard inspectors are to follow when conducting CVEs, does not specifically describe how and to what extent they should check fire boundaries. For example, instructions for the quarterly CVE state that the extent of the vessel examination is "at the discretion of the attending inspectors" and is determined by the observed condition of the ship. Instructions for a general walk-through stipulate only that the inspectors should check the engine room, machinery spaces, and accommodation spaces.

On July 20, 1996, one week before the fatal fire, Coast Guard inspectors conducted a quarterly CVE during which they held a fire drill in the main laundry, yet they did not notice that the bulkhead shown on the fire control plan was not in place. This raises the question of whether the inspectors even referred to the plan in the course of conducting the drill. The Safety Board concludes that the Coast Guard plan review and examination procedures of foreign passenger vessels do not adequately address the need to verify structural fire protection boundaries. The Safety Board therefore believes that the Coast Guard should revise its control verification procedures to include a more detailed review of structural fire protection features on board foreign passenger ships. The Board further believes that the Coast Guard should require that foreign passenger ships operating from U.S. ports undergo a periodic structural fire protection plan review and vessel examination. Further, the ICCL should remind member passenger ship operators of the degradation to structural fire protection that results from removing or altering fire control boundaries and of their responsibility to maintain the fire safety of their vessels in accordance with approved fire control plans.

Toxicological Testing

As mentioned earlier, crewmembers who were tested showed no indication of having used drugs or alcohol. In this case, the fire watch, who was known to have been in the main laundry within 20 minutes of a fire detector activating in the area, was not tested for either drugs or alcohol. Company officials did not designate any crewmember for testing until late July 27, 1996, and only then at the request of Safety Board investigators. Specimens were not collected from the designated individuals until at least 34 hours after the accident.

In reviewing the regulatory requirements for testing, the Safety Board found that the wording in the CFR regarding who should undergo postaccident toxicological testing is not specific. The regulations at 46 CFR Subpart 4.06 state that following a serious marine incident, "the marine employer shall take all practicable steps to have each individual engaged or employed on board a vessel who is directly involved in the incident chemically tested for evidence of drug and alcohol use" and to ensure that specimens are collected "as soon as practicable." The term *individual directly involved in a serious marine incident* is defined at 46 CFR 4.03-4 as "an individual whose order, action or failure to act is determined to be, or cannot be ruled out as, a causative factor in the events leading to or causing a serious marine incident." The Safety Board concludes that, in the absence of specific criteria, an immediate determination of the individual(s) directly involved in a serious marine incident who should be considered for drug and alcohol testing is sometimes difficult.

The Board has long been concerned about the timeliness and adequacy of postaccident drug and alcohol testing in the maritime industry and will address those issues in its forthcoming report of the *Julie N* tankship collision with a highway bridge in Portland, Maine. In the interim, the Board believes that the Coast Guard should meet with maritime industry representatives to establish specific criteria for identifying those individuals who should undergo drug and

alcohol testing after a serious marine incident and to establish procedures to ensure that such identification is made and subsequent testing is conducted in a timely manner.

Emergency Actions by Local Responders

Coast Guard Response—The *Universe Explorer* radioed the 17th Coast Guard District within minutes of discovering the fire. Coast Guard vessels were dispatched expeditiously and arrived in time to be effective during the emergency. The Coast Guard cutter *Sweetbrier*, which had overheard the emergency transmission and had radioed the SAR coordinator that it was immediately proceeding to assist, reached the passenger ship within about 1 hour. The *Sweetbrier* commanding officer assumed the role of on-scene coordinator for the Coast Guard. The cutter then escorted the *Universe Explorer* to Auke Bay, where the *Sweetbrier*'s crew assisted in transporting breathing apparatus and oxygen to the passenger vessel. Meanwhile, shoreside Coast Guard personnel coordinated the response of local agencies to the emergency.

Local Agency Response—Upon receiving notification of the fire emergency on board the *Universe Explorer*, area police, fire departments, and rescue agencies responded promptly. The CCF/R fire chief implemented the local contingency plan and arranged for area firefighters trained in marine firefighting to receive a briefing about the fire on the *Universe Explorer* before the vessel reached Auke Bay Harbor. When the local firefighters arrived on board the passenger ship, they examined the fire scene and verified that the fire was completely out. They then briefed Coast Guard and vessel officers about their findings, monitored the air quality in smoke-affected areas, and maintained a reflash watch.

The resources involved in the response were adequate to meet the needs of the emergency. All injured people were treated and transported in a timely manner to appropriate medical facilities in Juneau or Seattle. Uninjured passengers were safely and efficiently transported to lodgings or to alternative transportation ashore.

The Safety Board concludes that the response by the Coast Guard and the local authorities to the *Universe Explorer* fire was timely and appropriate.

Coast Guard Fire Contingency Plan—At the time of this accident, the Coast Guard Fire Contingency Plan was incomplete. Although committees had been formed to prepare certain parts of the plan, the sections dealing with the evacuation and treatment of multiple casualties from a major cruise ship accident had not been developed. Consequently, the evacuation and treatment of injured people from the *Universe Explorer* were conducted in an ad hoc manner. However, about 4 months before the *Universe Explorer* fire, the Coast Guard had held a command post exercise designed to test and evaluate existing plans, procedures, systems, and interactions. This exercise, which Federal, State, local, and cruise industry officials attended, simulated a fire on and the grounding of a large foreign cruise vessel, with resulting injuries and pollution. The March 1996 table-top exercise gave the Coast Guard and emergency responders an opportunity to consider and discuss what assistance was needed should a major cruise ship accident occur in the local area. This exercise may have prepared responders to perform effectively in this incident, even though their formal response plan had not been set in writing.

CONCLUSIONS

Findings

1. Factors related to the vessel navigation system, propulsion systems, and mechanical equipment neither caused nor contributed to the accident. All officers were properly licensed and qualified to serve in their positions. No available evidence indicated that drugs or alcohol affected the performance of those officers and crewmembers tested.

2. The fire on board the *Universe Explorer* originated in one of two laundry bins that had been against the forward bulkhead of the main laundry.

3. Accidental ignition sources, such as faulty electrical equipment, wiring arcing, or contact with a hot surface or air, did not cause the fire aboard the *Universe Explorer.*

4. Neither discarded smoking material, spontaneous combustion, nor a deliberate act can be ruled out as possible causes of the fire on board the *Universe Explorer*.

5. The UHF radio alone did not provide the communications capability to ensure the safety of the fire watch, which, in turn, was needed to ensure the safety of passengers and crewmembers.

6. If the *Universe Explorer* had been equipped with an internal radio antenna system, radio communications would have been more effective during the fire emergency.

7. The communication procedures between the bridge officer and the watchman during the emergency were inadequate.

8. The lack of a means to call for help delayed the rescue of trapped crewmen and contributed to the severity of their injuries.

9. The inability of the shipboard medical staff to communicate with each other by radio negatively affected the timeliness of the care provided to people injured in this accident.

10. Removing the corridor bulkhead in the main laundry was an alteration to the vessel that seriously degraded the fire safety condition of the *Universe Explorer*.

11. Greater fire protection can be attained in laundry facilities by using a combination of different types of detection devices as well as an automatic suppression system.

12. Improved surveillance of high-fire-risk areas would enhance the fire safety condition on board the *Universe Explorer*.

13. If the *Universe Explorer* had been equipped with an automatic sprinkler system, the large quantities of smoke and resulting loss of life may have been avoided.

14. Had automatic closure of the fire doors been incorporated in the fire detection system, the fire doors in the area where the fire broke out would have shut immediately when nearby detectors activated, thereby preventing the spread of lethal amounts of smoke to the crew berthing areas on the Aloha deck.

15. The effectiveness of the fire doors to the crew corridors on Aloha deck was compromised by their being tied open, degrading crew safety and contributing to the number of deaths in the accident.

16. Improved oversight of the performance of the fire watch is needed to ensure an acceptable level of fire safety on board the *Universe Explorer*.

17. The lack of an automatic smoke alarm that sounded locally in the crew berthing area delayed prompt notification to the crew of the fire and the need to evacuate. Had the crewmembers who died received earlier warning, they may have escaped.

18. The crewmembers' implementation of evacuation procedures was effective in maintaining calm and order and in ensuring that passengers vacated their cabins and assembled at their muster stations.

19. The *Universe Explorer*'s operating procedures that the watch officer is supposed to follow when a fire alarm activates are less than adequate to ensure the timely establishment of fire boundaries restricting the spread of heat and smoke.

20. Although the passenger fire drill held on the *Universe Explorer* was conducted in a timely manner, the content of the exercise did not fully prepare many passengers to meet the demands of an actual fire emergency.

21. The *Universe Explorer* crew did not adequately address passenger concerns about the fire and the seriousness of the situation while they were assembled at their muster stations.

22. Some of the deceased crewmembers on the *Universe Explorer* may not have survived the fire because they lacked sufficient knowledge of alternate escape routes from their berthing area.

23. Had the officers directing the fire search used a more methodical approach employing more than one search team, they might have located the fire sooner.

24. Efforts to locate and rescue trapped crewmembers were not initiated in a timely manner. The delayed search of Aloha deck crew cabins prolonged the trapped crewmen's exposure to smoke and contributed to the severity of their injuries.

25. If the *Universe Explorer* had had a properly equipped rescue team that was trained in locating and recovering people trapped in smoke-filled areas, the crewmen probably would have been rescued sooner and would have sustained less severe injuries; moreover, fewer crewmen may have died.

26. The lack of a secondary supply of oxygen limited the medical staff's ability to treat the injured.

27. Management did not exercise effective oversight of fire safety on the *Universe Explorer*.

28. The American Bureau of Shipping's process for approving a plan or for verifying that submitted plans are accurate is not as rigorous as it ought to be.

29. The Coast Guard procedures used in conducting control verification examinations of foreign passenger vessels do not adequately address the need to verify structural fire protection boundaries.

30. In the absence of specific criteria, an immediate determination of the individual(s) directly involved in a serious marine incident who should be considered for drug and alcohol testing is sometimes difficult.

31. The response by the Coast Guard and local authorities to the *Universe Explorer* fire was timely and appropriate.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was a lack of effective oversight by New Commodore Cruise Line, Ltd. and the predecessor of V. Ships Marine, Ltd. (International Marine Carriers, Inc.), who allowed physical conditions and operating procedures to exist that compromised the fire safety of the *Universe Explorer*, ultimately resulting in crewmember deaths and injuries from a fire of undetermined origin in the vessel's main laundry. Contributing to the loss of life and injuries was the lack of sprinkler systems, the lack of automatic local-sounding fire alarms, and the rapid spread of smoke through open doors into the crew berthing area.

RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board makes the following recommendations:

—To the U.S. Coast Guard:

Propose to the International Maritime Organization that passenger ships be required to institute procedures, upgrade equipment, or do both to establish reliable internal radio communications from anywhere inside a vessel during an emergency. (M-98-31)

Recommend to the International Maritime Organization that passenger and crew cabins on cruise ships be required to be equipped with an emergency call system so that people trapped during a fire emergency have a means of signaling their location. (M-98-32)

Conduct research with the passenger ship industry and the National Fire Protection Association on the adequacy of heat and smoke detectors for use in high-fire-risk areas, including laundry spaces, of passenger ships; and, based upon your findings, propose to the International Maritime Organization equipment or procedural guidelines for improving the reliability of fire alarms. (M-98-33)

Propose to the International Maritime Organization that passenger ships be required to integrate heat and/or smoke detectors with automatic fire door release switches so that the doors in the immediate area of a fire will close automatically when the detectors are activated. (M-98-34)

Propose to the International Maritime Organization that periodic instruction or drills be provided to all crewmembers on passenger ships to reinforce the familiarization training required of new seafarers by the 1995 Amendments to the Standards for Training Certification and Watchkeeping Convention. (M-98-35)

Propose to the International Maritime Organization that specially trained and suitably equipped rescue teams be required on board all passenger ships. (M-98-36)

Recommend to the International Maritime Organization that passenger ship companies be required to equip each onboard medical staff member with a portable radio with a dedicated frequency for use during an emergency. (M-98-37)

Revise your control verification examination procedures to include a more detailed review of structural fire protection features on board foreign passenger ships. (M-98-38)

Require that each foreign passenger vessel operating from U.S. ports periodically undergo a periodic structural fire protection plan review and vessel examination to verify that it is being maintained in accordance with approved plans. (M-98-39)

In cooperation with maritime industry representatives, establish specific criteria for identifying those individuals who should undergo drug and alcohol testing after a serious marine incident, and establish procedures to ensure that such identification and subsequent testing is conducted in a timely manner. (M-98-40)

Submit a copy of the National Transportation Safety Board's report of the fire on board the *Universe Explorer* to the International Maritime Organization for distribution and discussion. (M-98-41)

—To New Commodore Cruise Lines, Ltd. and to V. Ships Marine Ltd.:

Improve the means of radio communications between shipboard command and emergency responders and among emergency response groups on board your passenger ships. (M-98-42)

Review and, if necessary, revise shipboard communication procedures to ensure that watch officers and the fire watch maintain effective communications at all times, especially when the fire watch enters a suspected fire area. (M-98-43)

Equip crew cabins on company passenger ships with an emergency call system so that people trapped in their cabins during a fire emergency can signal their location. (M-98-44)

Modify the fire control systems on company passenger vessels, integrating heat and/or smoke detectors with automatic fire door release switches. (M-98-45)

Provide each member of the medical staff on board company passenger ships with a portable radio for use in shipboard emergencies. (M-98-46)

Review the adequacy of the fire detection systems presently protecting laundry spaces on board company passenger ships, and, based on that review, install improved detection systems or institute improved surveillance procedures to improve fire detection capability. (M-98-47)

Implement procedures to improve the oversight of the fire watch on board company passenger ships. (M-98-48)

Review and revise as necessary the operating procedures followed by the navigation watch officer to ensure that fire screen doors are closed immediately upon receipt of a fire alarm. (M-98-49)

Revise passenger fire drills and stateroom placards to advise passengers what to expect in a fire emergency. Include an explanation that fire doors shut automatically and instructions for opening them. (M-98-50)

Revise procedures for announcing emergency status updates to passengers assembled at muster stations so as to assuage their concerns. (M-98-51)

Provide periodic instruction or drills on alternate escape routes to all crewmembers on company passenger vessels to reinforce the familiarization training required of new seafarers by the 1995 Amendments to the Standards for Training Certification and Watchkeeping Convention. (M-98-52)

Establish improved procedures for crewmembers to follow in locating fires on board company passenger ships. (M-98-53)

Establish for each company vessel a rescue team dedicated to locating trapped passengers and crew during a fire emergency, and provide the team members with recurrent search and rescue training. (M-98-54)

Review the contents of passenger vessel emergency medical kits to ensure they contain adequate medical supplies to meet an emergency, such as the fire on board the *Universe Explorer.* (M-98-55)

Address the safety issues identified in this report in the safety program that you are developing for compliance with the International Safety Management Code. Further, increase the shoreside management's oversight of fire safety conditions on board your vessels by initiating the following measures, at a minimum: periodic fire safety vessel examinations and periodic instruction for the ships' crews on maintaining a fire-safe vessel. (M-98-56)

Immediately install automatic sprinkler systems in accommodation areas, stairway enclosures, and corridors on company ships. (M-98-57)

—To the International Council of Cruise Lines:

Advise member companies of the circumstances of this accident and recommend that they institute procedures and, if necessary, upgrade equipment to establish reliable internal radio communications from anywhere inside a vessel during an emergency. (M-98-58)

Recommend that member passenger ship companies install emergency call systems in passenger staterooms and crew cabins so that people trapped during a fire emergency will have a means of signaling their location. (M-98-59)

Inform member companies of the importance of providing each member of the shipboard medical staff with a reliable radio and communications training for emergencies. (M-98-60)

Remind member companies of the possible need to institute improved surveillance measures for high-fire-risk areas on their ships. (M-98-61)

Recommend that member companies integrate heat and/or smoke detectors with automatic fire door release switches so that the doors in the immediate area of a fire will close automatically when the detectors are activated. (M-98-62)

Recommend that member companies review and, if necessary, revise passenger fire drills and stateroom placards to advise passengers what to expect in the event of a fire emergency. (M-98-63)

Recommend that member companies provide periodic instruction or drills on alternate escape routes to all crewmembers on passenger ships to reinforce the familiarization training required of new seafarers by the 1995 Amendments to the Standards for Training Certification and Watchkeeping Convention. (M-98-64)

Encourage member companies to establish specially trained and equipped shipboard rescue teams to conduct rescue operations from smoke-filled areas. (M-98-65)

In consultation with member passenger ship operators, determine the amount and type of medical equipment and medicines needed during an emergency and recommend that such supplies be

maintained in suitable locations outside of the ship's hospital in case the hospital becomes inaccessible. (M-98-66)

Remind member companies of the degradation to structural fire protection that can result from altering fire control boundaries and of their responsibility to maintain the accuracy of vessel fire control plans. (M-98-67)

—To the American Bureau of Shipping:

Analyze your plan review procedures and improve them to ensure that a ship plans submitted for approval accurately depict the configuration of the vessel. (M-98-68)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JAMES E. HALL
Chairman

ROBERT T. FRANCIS II
Vice Chairman

JOHN A. HAMMERSCHMIDT
Member

JOHN J. GOGLIA
Member

GEORGE W. BLACK
Member

April 14, 1998

APPENDIX A

INVESTIGATION

The Safety Board was notified of this accident on the morning of July 27, 1996. Five investigators from the Safety Board's Washington, D.C., headquarters were dispatched to Juneau, Alaska, arriving that same night. Investigators immediately met with representatives of local emergency response agencies, the U.S. Coast Guard, and the operator of the *Universe Explorer* and made arrangements to board the vessel early the next morning to begin interviewing witnesses and examining the fire scene. The on-scene investigation continued until August 3, 1996.

The following organizations were parties in the investigation:

New Commodore Cruise Lines, Ltd., representing the owner of the *Universe Explorer*;

International Marine Carriers, Inc., which was the operator of the *Universe Explorer* at the time of the accident;

U.S. Coast Guard;
National Institute of Occupational Health & Safety (NIOSH);
State of Alaska;
City of Juneau; and
Republic of Panama.

The Safety Board investigated this accident under the authority of the Independent Safety Board Act of 1974.

The report is based on the information developed as a result of the investigation and on additional analysis done by the Safety Board. The Safety Board has considered all facts in the investigative record that are pertinent to its statutory responsibility to determine the cause or probable cause of the accident and to make recommendations.

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APPENDIX B

DUTIES OF THE *UNIVERSE EXPLORER* FIRE WATCH

1. Work directly under the command of the Safety Officer/Watch Officer.

2. Ensure the completion of all fire rounds within the specified periods, punching the clock at all assigned locations. (Each round should take about 50 minutes.) Any divergence from the usual round (or missing checkpoints) should be recorded in the Fire Patrol log.

3. Use the UHF radio provided to communicate with the bridge, the Safety Officer, or the Security Officer. Perform "radio checks" with the watch officer on each round, from different locations throughout the vessel. The radio carried by the patrolman must be set on channel 4 at all times, and have its volume set to a level at which the patrolman will not miss any communication from the bridge.

4. Be alert and vigilant at all times; use all senses to try to detect smoke or fire (e.g. from the smell of smoke or other unusual odors, feeling excessive heat or hearing strange sounds).

5. Report to the bridge directly following each round. Keep the watch officer informed of any problems encountered. The following situations should be immediately reported to the Safety Officer/Watch Officer:

   - Fights, brawls, or vandalism;
   - Passengers/crew involved in suspicious/illegal activities, such as drugs or lethal weapons;
   - Passengers/crew in off-limits areas;
   - Crewmembers in passenger cabins;
   - Discrepancies in safety equipment (ensure that all fire screen doors, including permanently closed doors, are not blocked or lashed open).

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APPENDIX C

RETROACTIVE FIRE SAFETY AMENDMENTS FOR EXISTING PASSENGER SHIPS

Resolution MSC.24(60)
(adopted on 10 April 1992)

Adoption of amendments to chapter II-2 of the International Convention for the Safety of Life at Sea, 1974

Fire safety measures for existing passenger ships

The MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING FURTHER Article VIII(b) of the International Convention for the Safety of Life at Sea, 1974, hereinafter referred to as "the Convention," concerning the procedures for amending the annex to the Convention, other than the provisions of chapter I,

BEING CONCERNED about recent serious fire casualties resulting in the loss of human life,

RECOGNIZING that there is a compelling and urgent need to improve the fire safe measures for existing passenger ships,

HAVING CONSIDERED at its sixtieth session amendments to the Convention proposed and circulated in accordance with article VIII(b)(i) thereof,

1. ADOPTS, in accordance with article VIII(b)(iv) of the Convention, the amendments to the Convention, the text of which is set out in the annex to the present resolution;

2. DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the amendments shall be deemed to have been accepted on 1 April 1994 unless, prior to that date, more than one third of the Contracting Governments to the Convention, or Contracting Governments the combined merchant fleets of which constitute not less than 50 percent of the gross tonnage of the world's merchant fleet, have notified their objections to the amendments;

3. INVITES Contracting Governments to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 October 1994 upon their acceptance in accordance with paragraph 2 above;

4. REQUESTS the Secretary-General, in conformity with article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5. FURTHER REQUESTS the Secretary-General to transmit copies of the resolution to Members of the Organization which are not Contracting Governments to the Convention.

Annex

Amendments to chapter II-2 of the International Convention for the Safety of Life at Sea, 1974

Regulation 1

Application

1 *Existing paragraph 3 is renumbered as paragraph 3.1 and the following new paragraph is inserted after paragraph 3.1:*

"3.2 Notwithstanding the provisions of paragraph 3.1, passenger ships carrying more than 36 passengers when undergoing repairs, alterations, modifications and outfitting related thereto shall comply with the following:

.1 all materials introduced to these ships shall comply with the requirements with regard to material applicable to

ships constructed on or after 1 October 1994; and

.2 all repairs, alterations, modifications and outfitting related thereto involving the replacement of material of 50 tonnes or above, other than that required by regulation 41.1, shall comply with the requirements applicable to such ships constructed on or after 1 October 1994."

Regulation 3

Definitions

2 *The following new paragraphs 22-1 and 22-2 are inserted after paragraph 22:*

"22-1 Central control station is a control station in which the following control and indicator functions are centralized:

.1 fixed fire detection and alarm system

.2 automatic sprinklers, fire detection and alarms system;

.3 fire door indicator panel;

.4 fire door closure;

.5 watertight door indicator panel;

.6 watertight door opening and closing;

.7 ventilation fans;

.8 general/fire alarm;

.9 communication systems including telephones; and

.10 microphone to public address system.

22-2 Continuously manned central control station is a central control station which is continuously manned by a responsible member of the crew."

Regulation 17

Fireman's Outfit

3 *The following sentence is added at the end of existing paragraph 1.2.2:*

"In passenger ships carrying more than 36 passengers, at least two spare charges for each breathing apparatus shall be provided, and all air cylinders for breathing shall be interchangeable."

4 *The following sentence is added at the end of existing paragraph 3.1.1:*

"In passenger ships carrying more than 36 passengers, two additional fireman's outfits shall be provided for each main vertical zone."

5 *The following sentence is added at the end of existing paragraph 4:*

"At least two fireman's outfits shall be stored in each main vertical zone."

6 *The following new regulations are inserted after existing regulation 41:*

"Regulation 41-1
Upgrading of passenger ships carrying more than 36 passengers constructed before 1 October 1994

1 This regulation shall apply to passenger ships carrying more than 36 passengers constructed before 1 October 1994.

2 Passenger ships which do not comply with all the requirements of chapter II-2 applicable to ships constructed on or after 25 May 1980 (requirements of chapter II-2 of SOLAS 1974, as adopted by the International Conference on Safety of Life at Sea, 1974, applicable to new passenger ships) shall comply with the following:

.1 paragraph 1 of regulation 41-2 not later than 1 October 1994; and

.2 paragraphs 2, 3, 4 and 5 of regulation 41-2 not later than 1 October 1997; and

.3 paragraph 6 of regulation 41-2 not later than 1 October 2000; and

.4 all the requirements of chapter II-2 applicable to ships constructed on or after 25 May 1980 (requirements of chapter II-2 of SOLAS 1974, as adopted by the International Conference on Safety of Life at Sea, applicable to new passenger ships) not later than 1 October 2010.

3 Passenger ships which comply with all the requirements of chapter II-2 applicable to ships constructed on or after 25 May 1980 (requirements of chapter II-2 of SOLAS 1974, as amended by resolutions MSC.1(XLV),

MSC.6(48), MSC.11(55), MSC.12(56), MSC.13(57) and MSC.22(59) shall comply with the following:

.1 paragraph 1 of regulation 41-2 not later than 1 October 1994; and

.2 paragraphs 2 and 4 of regulation 41-2 not later than 1 October 1997; and

.3 paragraph 6 of regulation 41-2 not later than 1 October 2000; and

.4 paragraph 5 of regulation 41-2 not later than 1 October 2005 or 15 years after the date of construction of the ships, whichever is later.

4 For the purpose of this regulation, passenger ships complying in their entirety with all the requirements of part H of chapter II contained in amendments to the International Convention for the Safety of Life at Sea, 1960, adopted by the Assembly of the Organization by resolution A.122(V), may be regarded as passenger ships complying with the requirements applicable to passenger ships constructed on or after 25 May 1980 (requirements of chapter II-2 of SOLAS 1974, as adopted by the International Conference on Safety of Life at Sea, applicable to new passenger ships).

"Regulation 41-2
Requirements for passenger ships carrying more than 36 passengers constructed before 1 October 1994

1.1 Plans and booklets required by regulation 20 shall provide information regarding fire protection, fire detection and fire extinction based on the guidelines developed by the Organization.*

1.2 Each member of the fire patrol shall be provided with a two-way portable radiotelephone apparatus.

1.3 Water fog applicators shall be provided as required in regulations 7.6, 17.3.2 and 37.1.5.1.

1.4 Portable foam applicators shall be provided as required in regulations 7.1, 7.2.2. and 37.1.5.2.

1.5 All hose nozzles provided shall be of an approved dual-purpose type (i.e. spray/jet type) incorporating a shutoff.

2 All accommodation and service spaces, stairway enclosures and corridors shall be equipped with a smoke detection and alarm system of an approved type and complying with the requirements of regulation 13. Such system need not be fitted in private bathrooms and spaces having little or no fire risk such as voids and similar spaces. Detectors operated by heat instead of smoke shall be installed in galleys.

3 Smoke detectors connected to the smoke detection and alarm system shall also be fitted above ceilings in stairways and corridors in the areas where ceilings are of combustible construction.

4.1 Hinged fire doors in stairways enclosures, main vertical zone bulkheads and galley boundaries which are normally kept open shall be self-closing and be capable of release from a central control station and from a position at the door.

4.2 A panel shall be placed in a continuously manned central control station to indicate whether the fire doors on stairway enclosures, main vertical zone bulkheads and galley boundaries are closed.

4.3 Exhaust ducts from galley ranges where grease or fat is likely to accumulate and which pass through accommodation spaces or spaces containing combustible materials shall be constructed of "A" class divisions. Each galley range exhaust duct shall be fitted with:

.1 a grease trap readily removable for cleaning, unless an alternative grease removal process is fitted;

.2 a fire damper located in the lower end of the duct;

.3 arrangements operable from with the galley for shutting off the exhaust fans;

.4 fixed means for extinguishing a fire within the duct; and

* Refer to the guidelines to be developed by the Organization.

.5 suitably located hatches for inspection and cleaning.

4.4 Only public toilets, lifts, lockers of noncombustible materials providing storage for safety equipment and open information counters may be located within the stairway enclosure boundaries. Other existing spaces within the stairway enclosure:

.1 shall be emptied, permanent closed and disconnected from the electrical system; or

.2 shall be separated from the stairway enclosure by the provision of "A" class divisions in accordance with regulation 26. Such spaces may have direct access to stairway enclosures by the provision of "A" class doors in accordance with regulation 26, and subject to a sprinkler system being provided in these spaces. However, cabins shall not open directly into the stairway enclosure.

4.5 Spaces other than public spaces, corridors, public toilets, special category spaces, other stairways required by regulation 28.1.5, open deck spaces and spaces covered by paragraph 4.4.2 are not permitted to have direct access to stairway enclosures.

4.6 Existing machinery spaces of category (10) described in regulation 26.2.2 and existing back offices for information counters which open directly into the stairway enclosure may be retained, provided that they are protected by smoke detectors and that back offices for information counters contain only furniture of restricted fire risk.

4.7 In addition to the emergency lighting required by regulations II-1/42 and III/11.5, the means of escape including stairways and exits shall be marked, at all points of the escape route including angles and intersections, by lighting or photoluminescent strip indicators placed not more than 0.3 m above the deck.

4.8 A general emergency alarm system shall be provided. The alarm shall be audible throughout all the accommodation and normal crew working spaces and open decks, and its sound pressure level shall comply with the standard developed by the Organization.[**] The alarm shall continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system.

4.9 A public address system or other effective means of communication shall be available and audible throughout the accommodation, public and service spaces, control stations and open decks.

4.10 Furniture in stairway enclosures shall be limited to seating. It shall be fixed, limited to six seats on each deck in each stairway enclosure, be of restricted fire risk, and shall not restrict the passenger escape route. The Administration may permit additional seating in the main reception area with stairway enclosures, if it is fixed, non-combustible, and does not restrict the passenger escape route. Furniture shall not be permitted in passenger and crew corridors forming escape routes in cabin area. In addition to the above, lockers of non-combustible material, providing storage for safety equipment required by regulations, may be permitted.

5 Accommodation and service spaces, stairway enclosures and corridors shall be fitted with an automatic sprinkler, fire detection and fire alarm system complying with the requirements of regulation 12 or the guidelines developed by the Organization* for an approved equivalent sprinkler system. A sprinkler system need not be fitted in private bathrooms, and spaces having little or not fire risk such as voids and similar spaces.

6.1 All stairways in accommodation and service spaces shall be of steel frame construction except where the Administration sanctions the use of other equivalent material, and shall be within enclosures form of "A" class divisions, with positive means of closure at all openings, except that:

.1 a stairway connecting only two deck need not be enclosed, providing the

[**] Refer to the Code on alarms and Indicators adopted by the Organization by resolution A.686(17).

integrity of the deck is maintained by proper bulkheads or doors in one 'tween-deck space. When a stairway is closed in one tween-deck space, the stairway enclosure shall be protected in accordance with the tables for decks in regulation 26;

.2 stairways may be fitted in the open in a public space, provided they lie wholly with such public space.

6.2 Machinery spaces of category A shall be fitted with a fixed fire-extinguishing system complying with the requirements of regulation 7.

6.3 Ventilation ducts passing through divisions between main vertical zones shall be equipped with a fair-safe automatic closing fire damper which shall also be capable of being manually closed from each side of the division. In addition, fair-safe automatic closing fire dampers with manual operation from within the enclosure shall be fitted to all ventilation ducts serving both accommodation and service spaces and stairway enclosures where they pierce such enclosures. Ventilation ducts passing through a main fire zone division without serving that enclosure need not be fitted with dampers provided that the ducts are constructed and insulated to A-60 standard and have no openings within the stairway enclosure or in the trunk on the side which is not directly served.

6.4 Special category spaces and ro-ro cargo spaces shall comply with the requirements of regulations 37 and 38, respectively.

6.5 All fire doors in stairway enclosures, main vertical zone bulkheads and galley boundaries which are normally kept open shall be capable of release from a central control station and from a position at the door."

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ACRONYMS AND ABBREVIATIONS IN THIS REPORT

ABS	American Bureau of Shipping
ACP	Alternate Compliance Program
CCF/R	Capital City Fire and Rescue
CFR	*Code of Federal Regulations*
CVE	Control Verification Examination
EMT	emergency medical technician
EPIRB	emergency positioning indicating radio beacon
FSD	fire screen door
ICCL	International Council of Cruise Lines
IMO	International Maritime Organization
ISM Code	International Safety Management Code
LR	Lloyd's Registry of Shipping
MVZ	main vertical zone
MarAd	U.S. Maritime Administration
NVIC	*Navigation and Vessel Inspection Circular*
RFSA	Retroactive Fire Safety Amendment
SAR	Search and Rescue
SCBA	self-contained breathing apparatus
SCTW	Standards for Training Certification and Watchkeeping
SOLAS	*Safety of Life at Sea*
WTD	watertight door