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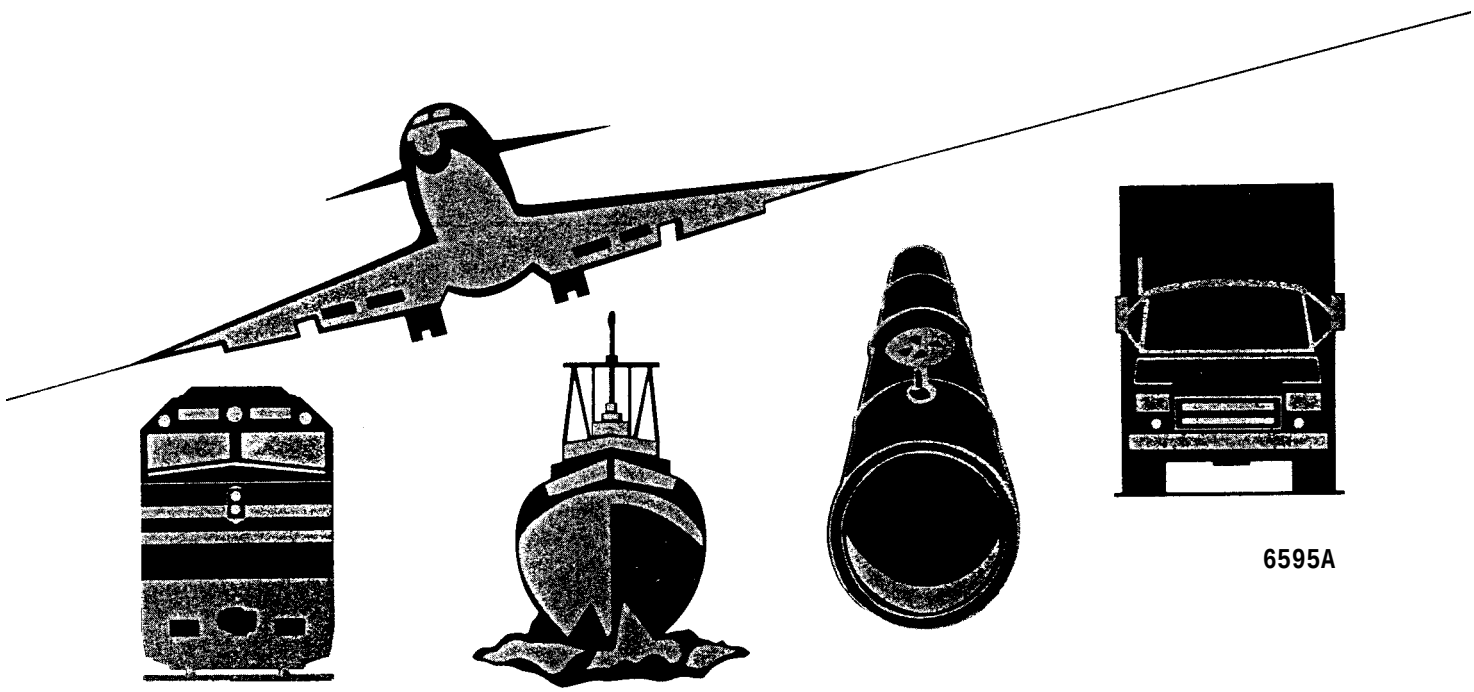
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

GROUNDING OF THE LIBERIAN PASSENGER SHIP *STAR PRINCESS* ON POUNDSTONE ROCK, LYNN CANAL, ALASKA, JUNE 23, 1995



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Abstract: On June 23, 1995, the passenger vessel *Star Princess*, traveling from Skagway to Juneau, Alaska, grounded on Poundstone Rock in Lynn Canal, about 21 miles northwest of Juneau. The vessel's bottom sustained significant damage. No injuries or deaths resulted from this accident. The total cost resulting from required repairs and the delay before the vessel could return to service was estimated at $27.16 million.

The major safety issues discussed in this report are the adequacy of the pilot's physical fitness for duty, the importance of bridge resource management, the pilotage practices in the Alaskan cruise industry, and the need for search and rescue planning.

As a result of its investigation, the National Transportation Safety Board issued safety recommendations to the U.S. Coast Guard, the State pilot commissions, the Alaska Board of Marine Pilots, the Southeastern Alaska Pilots Association, the Alaska Coastwise Pilot Association, the San Diego Bay Pilots Association, Inc., Princess Cruise Lines, the American Pilots' Association, and the International Council of Cruise Lines.

GROUNDING OF THE LIBERIAN PASSENGER SHIP *STAR PRINCESS* ON POUNDSTONE ROCK, LYNN CANAL, ALASKA, JUNE 23, 1995

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Adopted: June 20, 1997
Notation 6595A

National
Transportation
Safety Board

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CONTENTS

EXECUTIVE SUMMARY

On the evening of June 22, 1995, the Liberian-registered passenger vessel *Star Princess*, carrying 1,568 passengers and 639 crewmembers, was en route from Skagway to Juneau, Alaska, via the Lynn Canal under the direction of a southeast Alaska pilot. At 0142 on June 23, the *Star Princess* grounded on the submerged Poundstone Rock in Lynn Canal, about 21 miles northwest of Juneau. The vessel's bottom sustained significant damage on the starboard side, including the rupture of oil tanks, which resulted in the loss of at least 5 gallons of oil. The vessel was piloted to safe anchorage at Auke Bay, Alaska, (about 10 miles north of Juneau) to assess damage and debark passengers. No injuries or deaths resulted from this accident. The total cost resulting from required repairs and the delay before the vessel could return to service was estimated at $27.16 million.

The National Transportation Safety Board determines that the probable cause of the grounding of the *Star Princess* was the pilot's poor performance, which may have been exacerbated by chronic fatigue caused by sleep apnea. Contributing to the accident was the fact that the pilot and the watch officers did not practice bridge resource management.

The major safety issues discussed in this report are:

- The adequacy of the pilot's physical fitness for duty,
- The importance of bridge resource management,
- The pilotage practices in the Alaskan cruise industry, and
- The need for search and rescue planning.

As a result of this accident, the National Transportation Safety Board makes recommendations to the U.S. Coast Guard, the State pilot commissions, the Alaska Board of Marine Pilots, the Southeastern Alaska Pilots Association, the Alaska Coastwise Pilot Association, the San Diego Bay Pilots Association, Inc., Princess Cruise Lines, the American Pilots' Association, and the International Council of Cruise Lines.

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INVESTIGATION

Accident

Preaccident events. -- The 805-foot-long Liberian-registered passenger vessel *Star Princess* (see figure 1), part of Princess Cruise Lines (PCL),[1] began its first trip for the 1995 Alaska cruise season in Vancouver, British Columbia, on May 15, 1995. Its regular cruise itinerary called for a week-long cruise north from Vancouver to Seward, Alaska, with port calls to Ketchikan, Juneau, and Skagway, as well as excursions into Glacier Bay and Prince William Sound (see figure 2). The week-long return cruise southbound from Seward to Vancouver followed the same itinerary in reverse.

The *Star Princess* departed Vancouver for a northbound week-long cruise on June 12, arriving in Seward on June 19, where the vessel disembarked northbound passengers and embarked 1,568 passengers for the southbound trip. About 2000[2] on June 19, a boat drill was conducted in compliance with the International Convention for the Safety of Life at Sea (SOLAS). Passengers gathered at their muster stations and were instructed on the proper use of their lifejackets and on emergency procedures, including evacuation of the vessel using lifeboats.

Two pilots remained on board the vessel while it was in Alaskan compulsory pilot waters, so designated by the State. With few exceptions,[3] Alaska law requires that two pilots be on board a passenger vessel in compulsory pilotage waters. Only one pilot must be on duty at a time.

On both the north and southbound cruises, two Southeastern Alaska Pilots Association (SEAPA)[4] pilots[5] had stood alternate watches. The duration of each watch varied depending on the length of time between port calls and was subject to agreement by the pilots.

One pilot boarded the vessel at 0458 on June 14 at the Point McCartey Pilot Station, about 15 miles[6] south of Ketchikan, Alaska, to pilot the vessel into Ketchikan. It was the pilot's first trip on the *Star Princess* in about 4 years. After boarding, he held a brief master-pilot conference, reviewing with the master the tracklines and vessel information card. He remained aboard for the remainder of the cruise northbound and the southbound transit.

A second pilot also boarded the *Star Princess* on June 14, at Ketchikan, to share the piloting duties. This second pilot left the *Star Princess* at 1453 on June 17 at the Bartlett Cove Pilot Station, near the southern end of Glacier Bay. At that time, the vessel was northbound, en route to Seward by way of the Gulf of Alaska, and was leaving compulsory pilot waters.

Because the *Star Princess* was southbound and entering compulsory pilot waters on June 21, another pilot boarded the vessel in Glacier Bay about 1045, with the vessel en route to Skagway from Seward. This pilot later testified he did not have a master-pilot conference after coming on board the vessel. The master testified that he and the pilot talked about what would "happen" during the voyage.

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[1] A list of the acronyms and abbreviations used in this report is provided on the last page of the document.

[2] All times are given in Alaska daylight time.

[3] A passenger vessel in transit of compulsory pilotage waters must carry two pilots on board except during initial entry transit between the pilot station and harbor, or during a final exit from compulsory waters that is normally less than 8 hours long.

[4] SEAPA is one of two associations that provide pilot services in southeast Alaska. The other is the Alaska Coastwise Pilot Association.

[5] Pilots are typically considered to be self-employed, and each is an individual contractor for the ship for which he or she is providing pilotage. Nearly all pilots organize themselves into pilot associations or corporations for their area of operation. Pilots are hired because of their knowledge of local navigation hazards, currents, and winds. They either advise on conning matters or conn the vessel.

[6] "Miles" refers in this report to nautical miles. A nautical mile measures 6,076 feet.

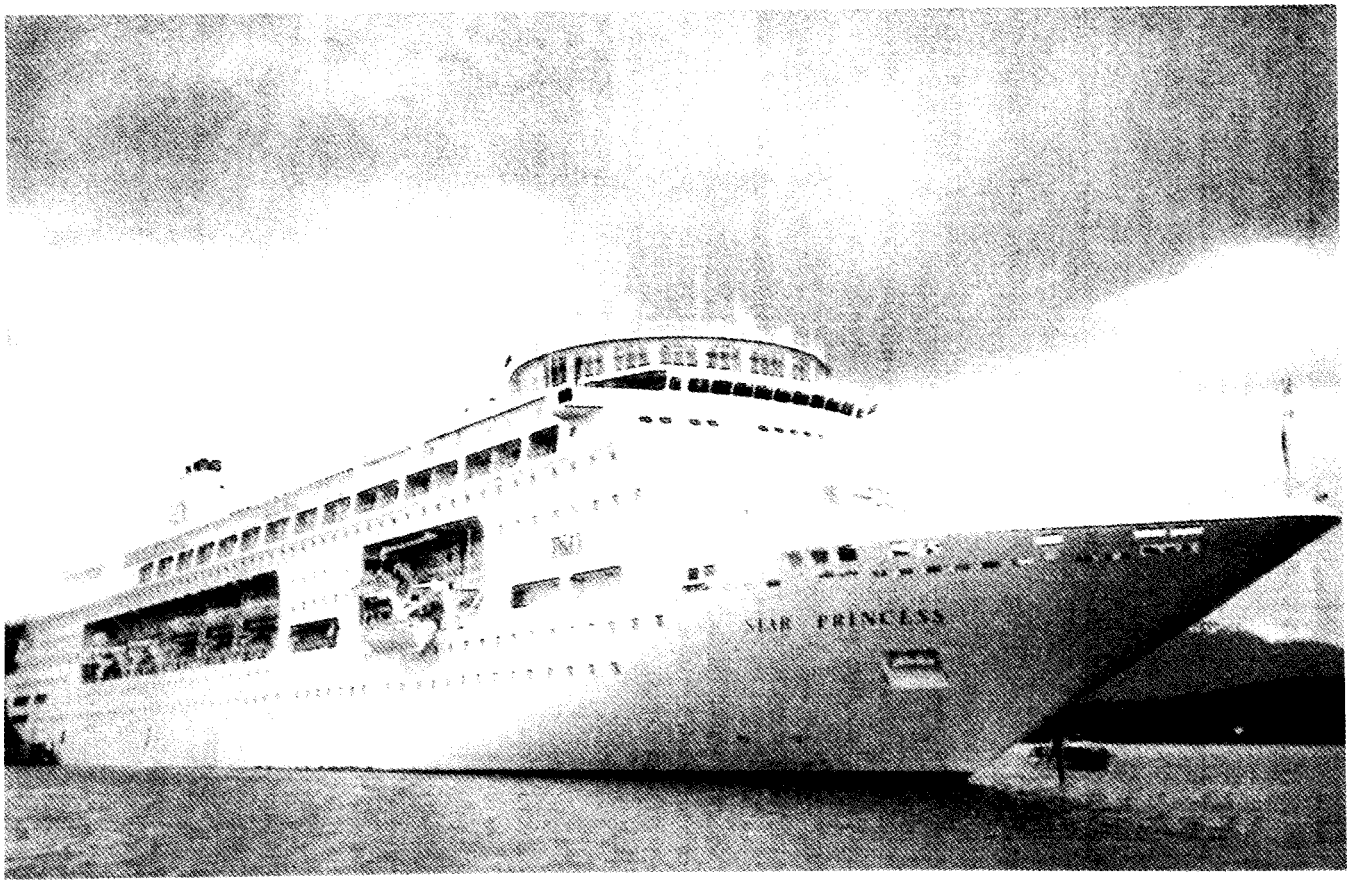
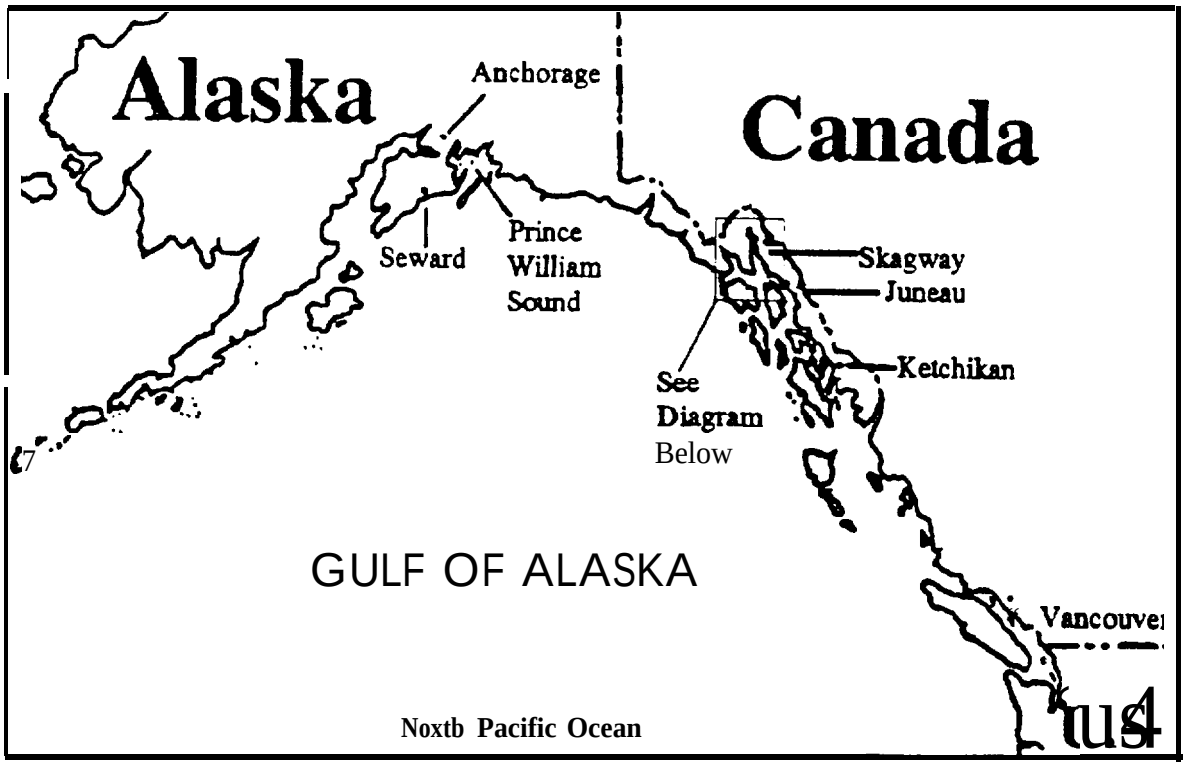


Figure 1.- The *Star Princess* anchored in Auke Bay, Alaska, June 24, 1995



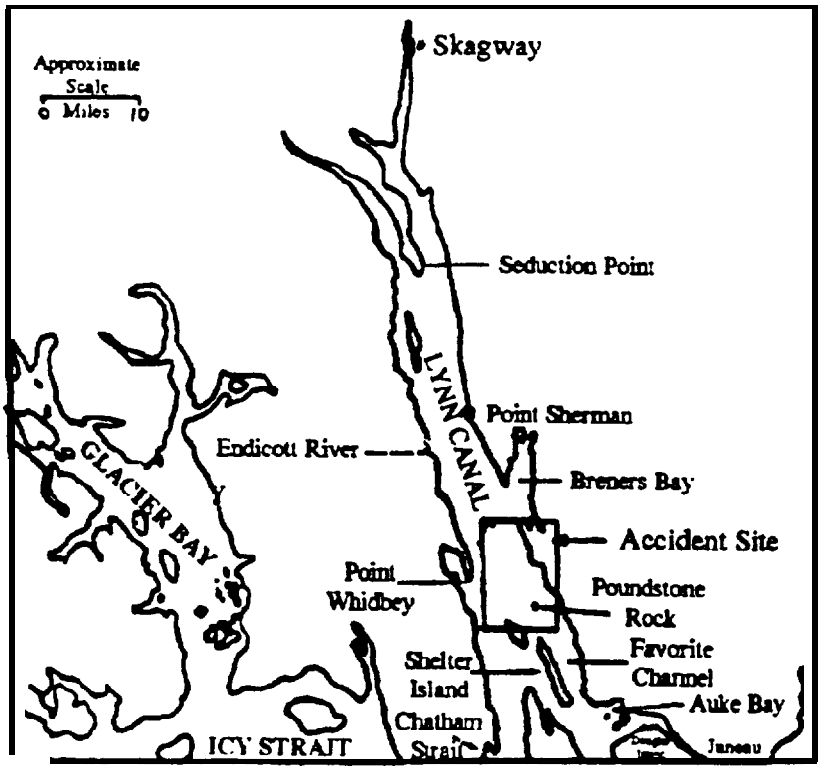


Figure 2. – Accident site

For this part of the cruise, the two pilots agreed to share piloting duties on a 6-hour watch cycle. The pilot on watch during the June 23 grounding had stood watch from 1230 to 1830 on June 21 and from 0030 to about 0600 on June 22 (when the vessel docked in Skagway).

About 1930 on June 22, the *Star Princess* departed from Skagway, bound for Juneau (see figure 2). For the voyage from Skagway to Juneau, the two pilots agreed to share the piloting duties evenly for a 5-hour and 15-minute watch each.

As was his normal practice, the master maneuvered the vessel away from the Skagway dock and headed it outbound. There were 2,207 people on board the vessel — 1,568 passengers and 639 crewmembers. After the vessel was outbound, one of the pilots took over the conning of the vessel.

About 2345 on June 22, the 0000 to 0400 bridge watch, consisting of a second officer, a third officer, a lookout, and a helmsman, relieved the deck watch. The watch officers did not involve the pilot in the change of the watch. The master's orders to the watch were for them to observe the standing orders per fleet regulations while carrying out duties and to call him if they were in any doubt about maneuvers or the safety of the vessel. The lookout stationed himself on the port bridge wing. The lookout's standing orders were to report all lights, sound signals, dangers, and hazards seen or heard to the bridge watch officers. He was not given any orders for his watch by either the second officer or the pilot.

The second officer was the senior deck officer on watch at this time. While on watch, this officer was responsible for the safety of the ship. He was expected to monitor the pilot's passage, cooperate with the pilot, ensure that the helmsman responded properly to steering orders, and verify that the third officer plotted fixes on the ship's navigation chart. The third officer was to plot fixes on the chart and carry out any orders given by the second officer. The helmsman was to follow the steering orders issued by the pilot.

About 0010, on a true course (T) of 156°T and at a speed of about 10 knots, the *Star Princess* passed Point Sherman, which is about 36 miles south of Skagway in the Lynn Canal (see figure 2) and about 65 miles from Juneau. The second officer determined that the vessel was about 1 to 1 1/2 hours ahead of its scheduled 0515 to 0530 arrival time at the entrance to Juneau harbor.

To avoid arriving at Juneau before the vessel's scheduled arrival time, the second officer asked the pilot to turn the vessel around in Lynn Canal. Not wishing to take this action, the pilot proposed, as an alternative, slowing the vessel to less than 8 knots. The second officer did not approve of this proposal, as he was concerned that the vessel did not steer well at speeds below 8 knots. He suggested that the pilot turn the vessel around and circle back at the present speed. The pilot later stated he would have preferred to slow the vessel but had no problem with making the turn because no traffic was evident at the time and Lynn Canal was about 7 miles wide in that area.[7] (See figure 3, which was developed with the information provided by the vessel's voyage event recorder [VER] for 0014 to 0142 on June 23, 1995.) After some discussion with the second officer, who insisted on his making the turn, the pilot turned the *Star Princess* to the right. He made what he called "a slow starboard swing," using a maximum of about 5° right rudder at a speed of about 10 to 11 knots. It took about 33 minutes for the vessel to complete the circle (360° round turn).

About 0030 on June 23, while the *Star Princess* was in the turn, the pilot on watch requested that the second pilot be awakened to relieve the pilot watch. About 0040, with the turn almost completed, the pilot ordered the vessel onto a course of 143°T, heading toward Sentinel Island Light.

[7] In their testimony, the two *Star Princess* pilots stated it is safe, in their opinions, for cruise vessels to make slow turns in the canal when they are ahead of schedule. Other vessel operators and pilots for the area, as well as Coast Guard representatives, told investigators that they considered such a maneuver safe.

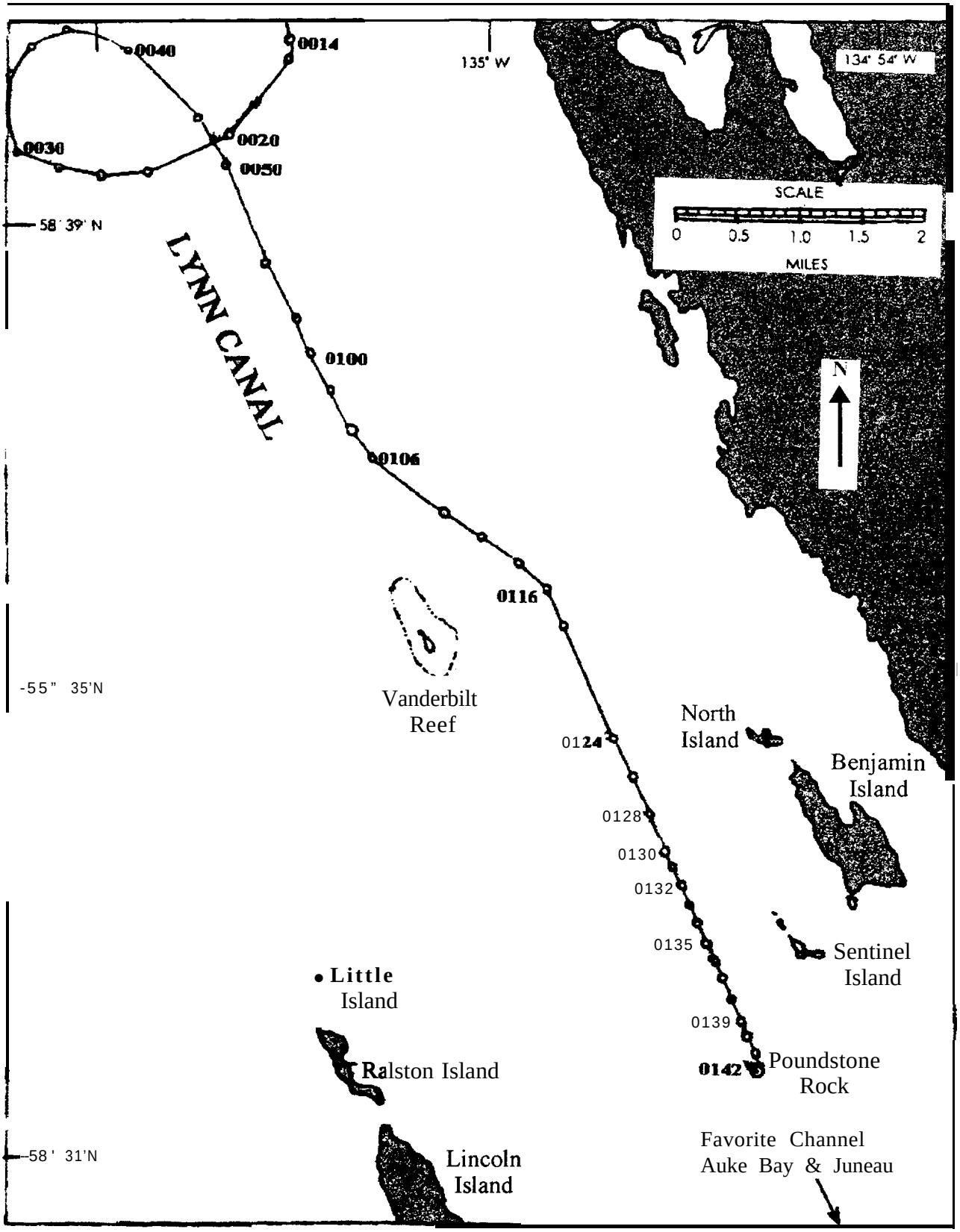


Figure 3. – Trackline of the *Star Princess*

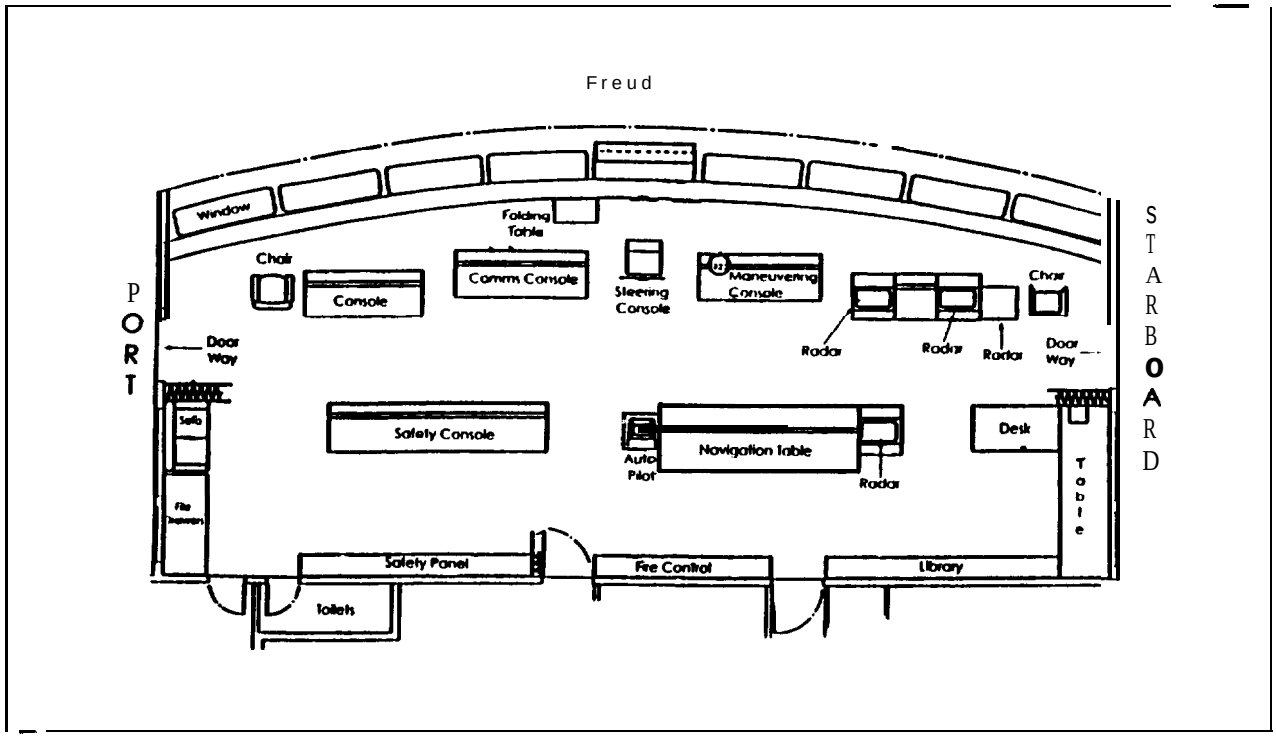


Figure 4. – *Star Princess* wheelhouse layout

The pilot later testified that the vessel was at this time about 1 mile to the west of his intended trackline. He estimated that Sentinel Island Light was about 8 miles to the south-southeast and bearing about 2° to 30 on the *Star Princess's* starboard bow.

Grounding. -- About 0040 the other pilot arrived in the wheelhouse. He and the pilot leaving the watch discussed the vessel's status and other related navigation information. The pilot being relieved oriented the other pilot with the vessel's position visually and by radar without involving the watch officers. The first pilot was relieved about 0045, and he departed the wheelhouse about 0055.

The other pilot (hereafter referred to as "the pilot") later testified that he did not have any discussion with the bridge watch officers and that he did not announce his assumption of the watch or give the bridge watch officers any instructions. He also said he did not address the lookout. The watch officers later testified that neither of the two pilots on the *Star Princess* ever looked at the ship's chart for this part of the voyage that showed the tracklines as plotted by the navigator. The second officer also testified that Alaska pilots typically did not share navigation information with watch officers.

The pilot testified that when he conned the vessel he usually referred to the automatic radar plotting aid (ARPA)[8] radar next to the chair on the starboard side of the wheelhouse (figure 4). He said he usually kept the radar (which had a 12-inch screen) on the 6-mile scale, with the center offset to provide a longer view forward. He said he used the radar to check his vessel's position, vessel traffic, and his own vessel's set and drift." He further testified that the navigation crew used the ARPA radar next to the navigation table aft of the far starboard chair. He stated that he and the bridge crew used two different radars so each would not interfere with the settings used by the other while navigating, taking fixes, or watching traffic.

[8]ARPAs are computer-based devices that process radar signals and display selected navigation information.

[9]Set is the direction toward which the water current and/or wind is moving the vessel from its intended course or trackline, and drift is the speed of these effects on the vessel.

The pilot testified that about 0100 he did not like his vessel's "lineup" with Sentinel Island, so he altered course left from 143°T to 126°T. When the *Star Princess* was about 4 1/2 miles from the Poundstone Rock buoy, he put the electronic bearing line (EBL)[10] on his radar screen on 156°T. The pilot testified that about 0115, without fixing his vessel's actual position and expecting that the vessel's path from the 30° course change would "move me over east of Poundstone Rock," he altered course to 156°T when the EBL crossed over the location of Poundstone Rock buoy. The pilot later testified that he believed the course change had moved the vessel's track to approximately 1 cable (600 feet) east of Poundstone Rock.

At 0116 the pilot ordered the course changed to 155°T. The pilot later told investigators he had intended that the vessel would pass at least 2 cables (1,200 feet) east of Poundstone Rock buoy as a minimum safe margin. The pilot further testified that, "Once you pass Vanderbilt [on the east side], I don't feel that the option to go to west [of Poundstone Rock] is open any longer."

About 0125 the pilot visually detected a northbound vessel (later identified as the passenger vessel *Fair Princess*) about 9 1/2 miles ahead, located "someplace around Aaron Island," which is about 6 miles south of Poundstone Rock. He later testified, "And now the question in my mind is, 'Well, what's the *Fair Princess* going to do?'" The pilot further stated that at the time he was not sure whether the other vessel would go to the east or west of Poundstone Rock. He said that he paid careful attention to the vessel's movements. He did not call the oncoming vessel on the bridge-to-bridge VHF radiotelephone[11] to clarify the situation. When questioned about this later, the pilot said he felt that, "We were both taking actions that would allow a safe passage."

Shortly after 0125, the pilot observed the other vessel's masthead and range navigation lights change ("opened")[12] and saw its red port side light. He later testified that the presentation of these lights indicated to him that the vessel had altered course to the right, which he considered implied a port-to-port passage.

The third officer had been taking radar ranges and bearings to plot the vessel's transit of the Lynn Canal. He plotted the position on the chart and noted in the vessel's rough log that the *Star Princess* was abeam Vanderbilt Reef by 0.9 mile (about 4 miles north-northwest of Poundstone Rock) at 0114. About 0130 the third officer's charted position showed the *Star Princess* about abeam Benjamin Island (an island north and east of Poundstone Rock) at a distance of 1.24 miles. The bridge watch officers did not project a course line from their 0114 and 0130 fixes to the Poundstone Rock passage.

The third officer's plotted 0130 position was west of the *Star Princess*'s established trackline, as drawn by the navigator and approved by the master at the start of the cruise season, by about 0.3 mile. (See figure 5.) The second officer later testified that he was aware the vessel was not following the track plotted on the vessel's chart. Both officers had previously been through this passage with the same pilot on this and other vessels. Both later stated that they fully expected the pilot would clear east of Poundstone Rock buoy. Neither of the two officers asked the pilot his intentions, nor did they offer any information. In their testimony, the bridge watch officers made the following statements about the pilot: "…he was piloting the vessel, ...he is a professional, ...he knows where we should be, ...he has been here before, ...he is making the necessary course changes."

[10] An EBL is a luminous electronic radar cursor that appears on the radar screen and can be used to measure the distance and direction between any two points.

[11] The Bridge-to-Bridge Radiotelephone Act (33 United States Code 1201-1208, 33 *Code of Federal Regulations* 26) applies to vessels operating on the navigable waters of the United States and requires that vessels transmit any information necessary for safe navigation. The Lynn Canal is a navigable waterway of the United States (46 *Code of Federal Regulations* 7.150).

[12] "Opened" means that the relative distance between the range and masthead lights appeared to increase, giving the vessel the appearance that it was turning.

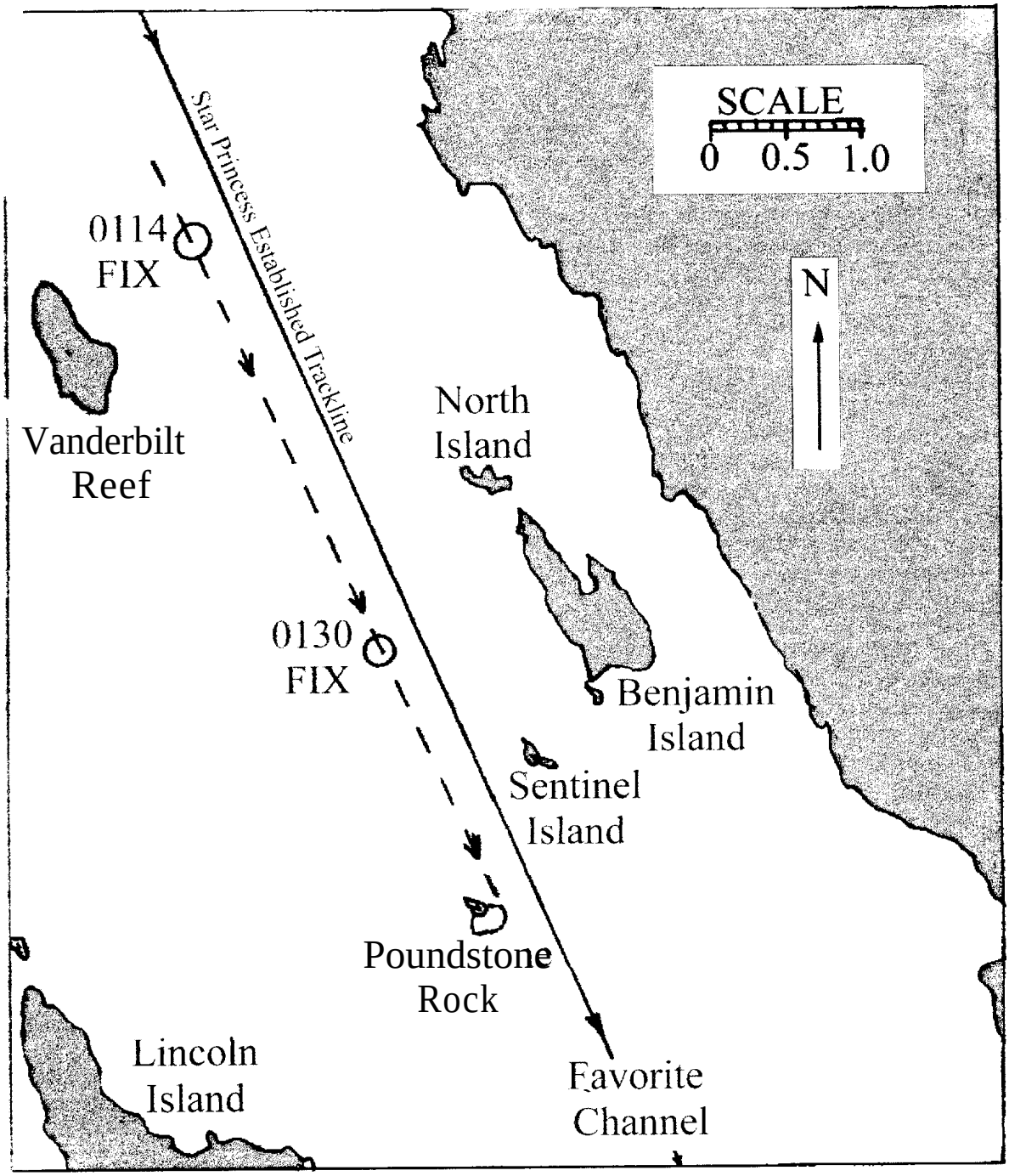


Figure 5. – Established trackline of the *Star Princess* compared with the actual trackline of the *Star Princess* (scale in miles)

The pilot testified that about 0135 he ordered the course altered from 155°T to 153°T, because he "didn't like the lineup on Poundstone Rock" and he expected that the course change to 153°T would bring his vessel's margin with the buoy to 2 cables (1,200 feet). VER data indicates that the vessel's course changed to 153°T about this time.

The pilot testified that after changing the course to 153°T, he visually estimated the vessel was going to clear Poundstone Rock buoy, probably by less than 2 cables (1,200 feet). He testified that by making the course change he thought he had increased the vessel's clearance distance with the buoy. He also testified that although he thought the 153°T course was acceptable in the circumstances he faced, "If the *Fair Princess* isn't over there, I would be more comfortable with 150°T or 145°T."

Throughout the transit, the *Star Princess*'s third officer was monitoring the helmsman to ensure that he followed the pilot's orders. The pilot made no complaint about the helmsman's steering performance. Following the accident, the vessel's course recorder showed that the pilot's courses were accomplished by the helmsman with minimum rudder swing and 1° to 2° deviations in courses steered.

No radio contact was made by the *Star Princess* pilot or the bridge watch officers with, nor was any received from, the *Fair Princess*. Meanwhile, the *Fair Princess* was northbound, approaching the Poundstone Rock area from the Favorite Channel (between the east side of Shelter Island and the mainland). The pilot on the *Fair Princess* testified that he had been watching the *Star Princess* both visually and by radar (see figure 6).

The *Fair Princess* was steering a course of about 336°T at a speed of 17.5 knots. The *Fair Princess* VER information examined after the accident showed that the vessel stayed about on the 336°T course until it passed the *Star Princess* after the accident.

The pilot on the *Fair Princess* later testified that although vessels usually pass each other above or below the Poundstone Rock area and vessels sometimes leave Poundstone Rock to their port when southbound, he thought it was safe for two vessels to pass between Poundstone Rock and Sentinel Island. Poundstone Rock and Sentinel Island are about 1 mile apart, with about 6 cables (3,600 feet [1/2 mile = 3,038 feet]) available for safe navigation. The *Fair Princess* pilot testified that he had estimated that the *Star Princess* and the *Fair Princess* would pass port to port with about 1/2-mile closest point of approach, just south of Poundstone Rock.

The *Fair Princess* pilot testified that he intended, once past Poundstone Rock, to alter course to the left to allow a greater clearance for himself from Sentinel Island. He testified that he thought the preaccident approaches by each vessel were normal, and he did not make a bridge-to-bridge VHF radiotelephone call to the *Star Princess.* He also testified that, although he felt the *Star Princess* was a bit close to the Poundstone Rock buoy, he did not think the vessel was in danger of grounding. The *Fair Princess* pilot further stated he was sure he had not done anything that would have caused the *Star Princess* pilot to misinterpret his intentions. He stated that he usually would not make any VHF radio communications in a meeting situation because pilots allow each other a wide berth.

About 0139, after the *Star Princess* passed Sentinel Island, the *Star Princess* pilot rose from the chair on the starboard side of the wheelhouse and went to stand at the centerline window forward. He later testified that he saw the *Fair Princess* proceeding in his direction as the *Star Princess* was approaching the Poundstone Rock buoy. (According to the VER plotting data, the *Fair Princess* was at this time about 15° off the port bow of the *Star Princess* at a distance of about 2 miles.) The second officer was standing to starboard of the maneuvering console. The third officer was positioned at the radar to starboard of the navigation table. The pilot and the second officer both later testified that they lost sight of the Poundstone Rock buoy as it came close along the vessel's starboard side.

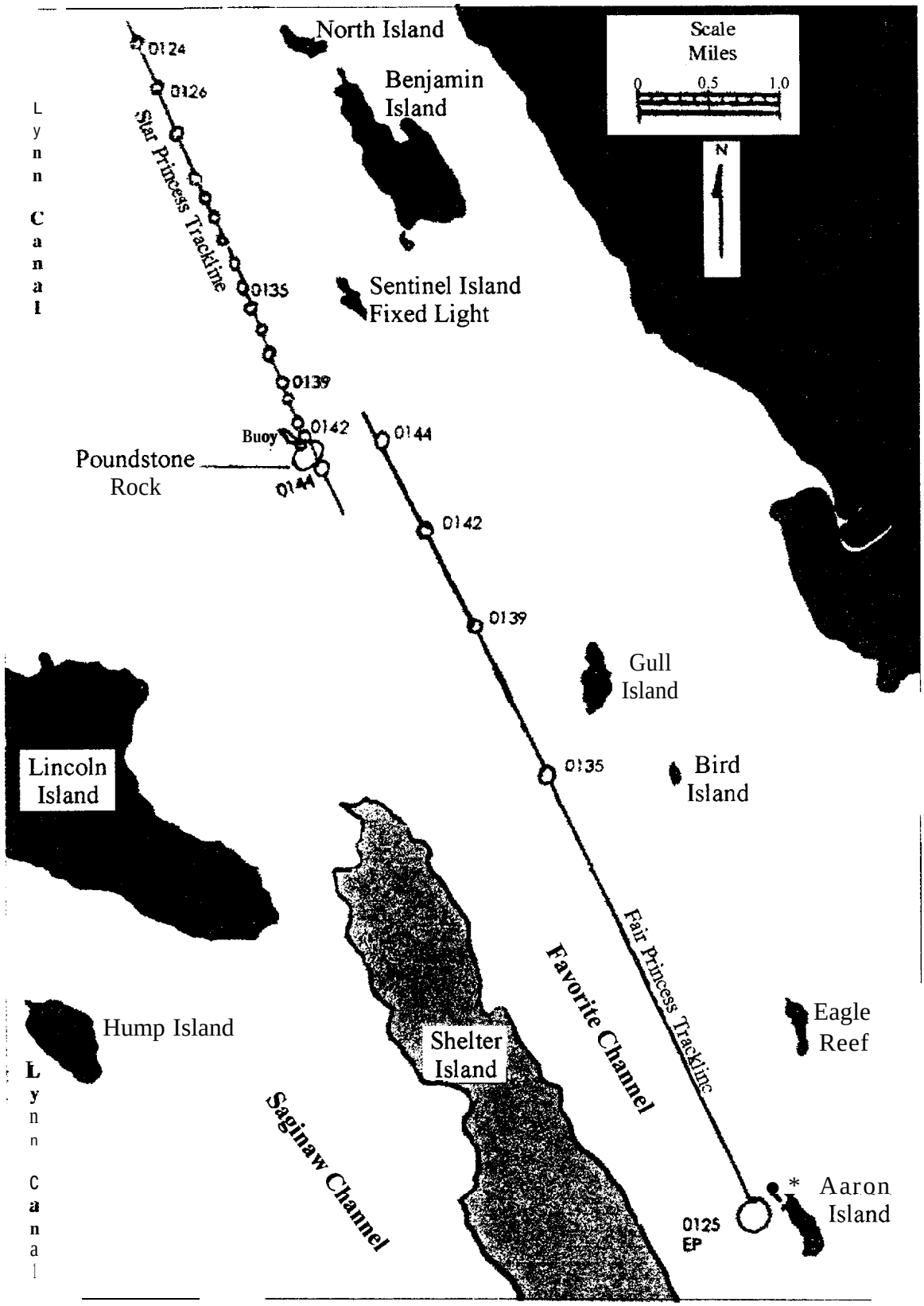


Figure 6. – Tracklines of the *Star Princess* and the *Fair Princess*

At 0142 the *Star Princess* grounded on the east side of Poundstone Rock. Poundstone Rock was at a minimum depth of 24.3 feet below the water (the rock was charted at 16.5 feet below the water surface at mean lower low water [MLLW],[13] and the tide was about 7.8 feet).[14] VER data showed that at 0142, the *Star Princess* was on a heading of 153°T, and the *Fair Princess* was about 1 mile southeast of Poundstone Rock buoy and about 30° off the port bow of the *Star Princess*.

The *Star Princess* pilot later testified that when he first felt the ship shudder, he was not immediately sure about the nature of the problem. Both the second officer and the pilot went to the starboard wing of the wheelhouse, where they observed the buoy pass clear of the starboard side. The pilot testified that it was at this time that he realized the vessel had struck Poundstone Rock.

Postaccident events. -- Within about 1 minute after the grounding, the vessel had slowed to 3.5 knots and sheered to port to a heading of about 150°T. The helmsman brought the vessel to course 155°T, and the vessel's speed increased to 7.6 knots.

The grounding awakened the *Star Princess* master, the off-watch pilot, and the other deck officers, all of whom went immediately to the wheelhouse. When the master arrived in the wheelhouse, the pilot told him that the vessel had grounded. The chief engineer and assistant engineers were awakened by the grounding and quickly reported to the engineroom.

Also about 1 minute after the grounding, the pilot on watch radioed the U.S. Coast Guard in Juneau to notify it of the accident. About 0144, the *Star Princess* and the *Fair Princess* passed abeam about 1/2 mile from each other and about 1/4 mile south of Poundstone Rock. The *Star Princess* master asked the off-watch pilot where the vessel could be beached.[15] The off-watch pilot explained that the water was too deep to do so. After some discussion, he suggested that if the vessel was stable, they should proceed to Auke Bay, about 14 miles southeast of Poundstone Rock.

The following vessels were in the Lynn Canal or within about 15 miles of the accident site: the *Golden Princess*, the *Fair Princess*, the *Universe Explorer*, the *Windward*, and the *Glacier Bay Explorer*. The master of the *Star Princess* asked the *Golden Princess*, which was south of the *Star Princess* and moving northward, to follow his vessel in case assistance was needed, which the *Golden Princess* did.

The *Star Princess* master at once had the staff captain (the officer next in command to the master) check all the *Star Princess*'s internal bottom tanks for seawater. The first check showed no water ingress. Almost immediately after hearing this report from the staff captain, the master sent him back to recheck the tanks. The second check revealed that water was entering the ship's double bottom tanks on the starboard side. Flooding in four tanks was reported, and some hydraulic oil was reported lost from the starboard shaft lubrication system. In all, about 1,800 tons of water entered the ship's double bottom tanks and increased the vessel's draft by about 5 inches. The tank tops were not damaged. The chief engineer reported nothing wrong with the propulsion, steering, and other mechanical equipment.

The first officer, who was also the deputy stability officer, reported to the wheelhouse immediately after the grounding and determined the *Star Princess*'s stability using the vessel's on-board stability computer with the information provided by the staff captain and chief engineer. He determined that the vessel was stable and not in danger of sinking. He so advised the master.

About 0150 the vessel was headed toward Coghlan Island at the entrance to Auke Bay. About 0155 the master addressed the crew on the crew's public address system. He advised them that the vessel had struck a submerged object, that the situation was not serious, that they should remain calm and ready, and that they should listen for further announcements.

[13] MLLW is the average height of the lower of two low waters each lunar day.

[14] *1995 West Coast of North and South America Tide Tables*, National Oceanic and Atmospheric Administration.

[15] If a vessel is in danger of sinking in deep water and a suitable shallow area can be located quickly, it may be purposely grounded or beached to prevent its sinking.

He instructed them to advise passengers found awake or up and about in public spaces of the situation. He also had lifeboats readied (swung out and lowered to the embarkation deck) in case the vessel's stability status should change. The master later testified that because the vessel was stable, he decided not to wake the sleeping passengers either to inform them of the situation or have them muster at "abandon ship" stations. He testified he thought such action would have unnecessarily alarmed the passengers.

The master requested and received permission from the Coast Guard office in Juneau to proceed into Auke Bay to anchor. As he had piloted in Auke Bay before, the off-watch pilot relieved the pilot on watch about 0230 and piloted the vessel to anchorage in Auke Bay. When the *Star Princess* was nearing the entrance to Auke Bay, the master advised the *Golden Princess* that its assistance was no longer needed.

About 0330 the *Star Princess* anchored in Auke Bay. Between 0437 and 0655, commercial divers made an initial damage assessment of the hull. When he was assured that temporary repairs could be made and that the oil had stopped leaking, the Coast Guard Captain of the Port granted permission for the *Star Princess* to make temporary repairs.

At 0918, while the vessel was at anchor in Auke Bay, the master gave a complete briefing on the situation to the passengers. Over the next 2 days, the 1,568 passengers were transferred ashore by ship launches and arrangements were made to transport them home. On the evening of June 27, 1995, the *Star Princess* departed Auke Bay for a shipyard in Portland, Oregon, where permanent repairs were made.

Injuries

No fatalities or injuries occurred during the grounding, the response effort, or the transfer of passengers ashore.

Vessel Damage

The PCL, the operator of the *Star Princess,* estimated the total accident cost at $27.16 million, of which about $7.16 million was in damage and about $20 million **was in lost** revenue. The repaired *Star Princess* resumed its cruise schedule on August 7, 1995.

The vessel sustained damage to the keel and the starboard hull bottom. The hull had two 8-inch-wide tears — one 40 feet long and the other 100 feet long — amidships on the starboard side. Altogether, 22 fuel tanks, ballast (water) tanks, and cofferdams[16] were damaged. The starboard propeller blades sustained damage and required repair. (See figure 7, showing damaged hull plate areas.)

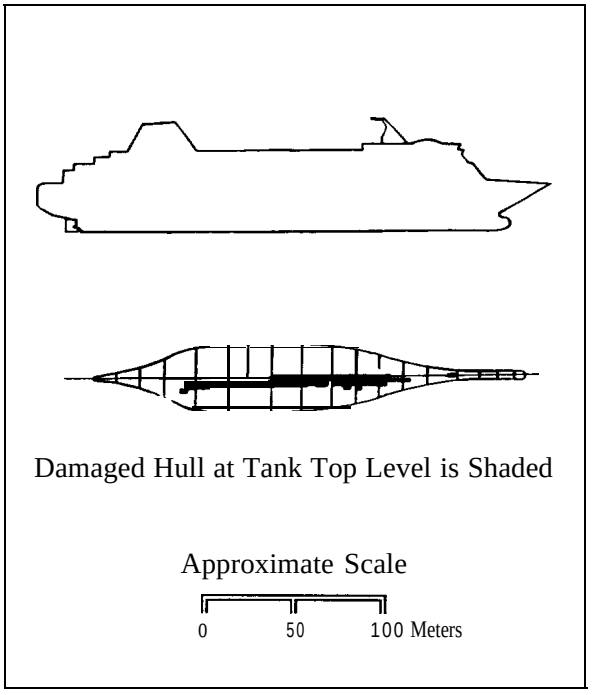


Figure 7. – Approximate areas of damaged hull plate replaced or repaired

It was estimated that as a result of the grounding at least 20 liters (about 5 gallons) of oil spilled into the water at Poundstone Rock. By the time the vessel reached Auke Bay, no further fuel or fluids were leaking from it. Nevertheless, the *Star Princess* was encircled with an oil containment boom in Auke Bay to collect any oil that might leak from damaged tanks while the vessel was at anchor. The PCL reported that oil from damaged tanks was

[16]A cofferdam is the empty or void space between two bulkheads separating the adjacent compartments to prevent the liquid in one compartment from entering the other should a bulkhead failure occur.

transferred within the vessel. Skimming or other cleanup efforts were not considered necessary.

Crew Information

The *Star Princess* was staffed by Italian deck and engineering officers with license certificates from Italy and Liberia, while the unlicensed crewmembers came from various countries. (See appendix B for more detailed information on the crewmembers.)

Pilot on watch. – The pilot on watch, age 57 at the time of the accident, had enlisted in the U.S. Navy in April 1956, graduated from the U.S. Naval Academy in 1962, and served in the Navy for a total of 24 years. He had served about 15 years at sea and upon retirement from the Navy (in 1980) became a marine pilot for the State of Alaska.

At the time of the grounding, he held a Coast Guard 1,600-ton master's license for inland waters with unlimited tonnage first class pilotage endorsements for southeast Alaska, including the Lynn Canal and the area of the grounding. This license had last been renewed on January 9, 1995. As part of his Coast Guard license renewal requirements, the pilot had been tested for controlled substances pursuant to 46 *Code of Federal Regulations* (CFR) 16 and 49 CFR 40. The results were negative for the presence of illegal drugs. He held a State of Alaska marine pilot's license, originally issued on December 9, 1980. It had last been renewed in December 1994.

In 1988, the Division of Occupational Licensing of the Alaska Board of Marine Pilots had placed the pilot's State marine pilot license on probation. The probation resulted from two marine casualties that took place in the State in 1987. (On March 21, 1987, a vessel under his pilotage collided with a log raft in Hobart Bay, Alaska; on April 28, 1987, a vessel under his pilotage grounded in Hobart Bay.) The pilot was prohibited from piloting a vessel in the State for 18 months (from 1987 until 1989) and was required to complete additional training in shiphandling skills. He completed this training. Subsequently, in December 1992, his license was suspended for 6 months and placed on probation for 1 year because of a June 1991 collision that took place between two vessels near Skagway, Alaska, while he was piloting one of them.[17] As a result, he was required to attend remedial training in shiphandling skills, "rules of the road," and radar use. He completed all courses required to reinstate his license and returned to piloting in May/June 1993.

The pilot testified that he was not sure of the number of trips he had made as a pilot in this area, but thought he had transited the Lynn Canal 300 to 400 times during his Alaska piloting career. He said he had completed about six or eight trips up and down the Lynn Canal in the 1995 season. He had previously served as a pilot on the *Star Princess* for about 10 trips. He had last been on the vessel for a 2-week assignment that began on May 17, 1995. He testified that he was familiar with the vessel and its navigation equipment. He said he was somewhat familiar with the navigating crew but was not sure if he had worked before with the second and third officers together.

***Star Princess* Pilot's Activities Before the Accident**

Time	Pilot's Activity
1230-1830 (June 21)	Stood watch
1830-0030 (June 22)	Ate dinner and slept
0030-0600	Stood watch (docked in Skagway at 0600)
0600-1200	Slept
1200-1400	Ate lunch and remained awake
1400-1700	Slept
1700-1900	Awoke and ate dinner
1900-0025 (June 23)	Slept
0025-0040	Awakened, went to the bridge
0040-0142	Stood watch till shortly after the accident

[17] The Safety Board did not investigate any of the three accidents cited in this paragraph.

At the time of the accident, the pilot had been awake and on watch for about 1 hour and 10 minutes. His most recent continuous sleep period had been about 5 1/2 hours long.

Pilot off watch. – The pilot off watch, age 67 at the time of the accident, testified that he began sailing in Alaskan waters in 1963 as a master with the Alaskan Marine Highway System. Since his retirement from that agency, he has served as a marine pilot with SEAPA. At the time of the accident, he held a Coast Guard unlimited inland master's license, issued on November 18, 1993. It included first class pilotage endorsements for southeast Alaska, including the Lynn Canal and the area of the grounding. He also held an Alaska State pilot's license for southeast Alaska, including the Lynn Canal and the area of the grounding. He originally obtained this license in 1970, and it had most recently been renewed in January 1995. He completed bridge resource management and emergency ship handling training for pilots on December 2, 1994, in Seattle, Washington.

Master. -- The master, age 54 at the time of the accident, had served in the Italian navy for 3 years and been employed in the merchant marine industry in various capacities since 1964. He held Italian and Liberian unlimited master's licenses, issued January 11, 1971, and March 7, 1994, respectively.

Second officer. -- This officer, age 52 at the time of the accident, had sailed on various types of vessels in several capacities since approximately 1970. He held an Italian unlimited master's license, originally issued on November 29, 1977, and a Liberian license as second mate, issued on April 17, 1991. He had been employed by the PCL since March 21, 1991, as a second officer aboard the *Star Princess* and the *Dawn Princess*.

Third officer. -- This officer, age 29 at the time of the accident, had served on various vessels in different positions since 1986. He held an Italian second officer's license for all non-passenger vessels and a Liberian third officer's license for passenger ships. The licenses were issued in November 1990 and September 1992, respectively. The third officer had been employed by the PCL since November 29, 1990, and had worked as a cadet aboard the *Regal Princess*, the *Crown Princess*, and the *Star Princess*. He had served about 7 months as third officer on the *Star Princess*.

Vessel Information

General. -- The *Star Princess*, Lloyds Register of Shipping number L8611398, is a conventional steel-hulled, bulbous-bow, passenger liner designed for unrestricted international voyages. It was constructed in 1989 at Chantiers de L'atlantique of the Alsthom Group in St. Nazaire, France. The vessel's home port is Monrovia, Liberia. The owner is Coseida Marine, Inc., a Panamanian corporation. The operator is Princess Cruises Liberia, Inc., Monrovia, Liberia.

The *Star Princess* is certified to carry 1,646 passengers and a crew of 654. It holds the highest vessel classification for construction issued by Lloyds (+100 A1). The vessel has the international certificates required for a vessel of its class. Its principal characteristics are:

Gross Tonnage	63,524
Net Tonnage	32,185
Length Overall	245.60 M (805.8 ft.)
Breadth	32.23 M (105.8 ft.)
Depth (upon departure from Skagway)	7.65 M (25 ft., 11 inches) - Forward 8.00 M (26 ft., 3 inches) - Aft
Service Speed	19.5 knots
Horsepower	32,640[18]
Propellers	2 fixed pitch, 4 blades each

[18]The *Star Princess* is propelled by a diesel electric propulsion system with four main diesel generators and two electric motors using two fixed-pitch propellers. It is also equipped with two bow thrusters of the variable pitch type, combined power 1,780 kW/HP 2,421, and one stern thruster unit, variable pitch type 1,060 kW/HP 1,441. Two folding fin stabilizers limit the vessel's roll and pitch. Steering is provided by one rudder, controlled by an electric hydraulic steering gear.

Following the accident, a Safety Board investigator checked the *Star Princess* navigational equipment and discussed its operation with the vessel's deck officers. They reported that all equipment was functioning properly. The chief engineer of the *Star Princess* reported no problems with the vessel's propulsion, steering, and other mechanical equipment.

The pilot later testified that he felt that the PCL vessels, with their high sides (which is typical of all large cruise ships), had a windage[19] problem. The pilot testified that in the preaccident period he did not feel any wind acting on the vessel, nor did he feel the vessel being offset by the wind or current.

Equipment. -- The *Star Princess* was furnished with navigation and collision avoidance equipment.[20] The vessel was equipped with all survival equipment required by SOLAS rules. The *Star Princess* employed a public address system throughout the vessel and had a closed circuit television system with output in all staterooms and at public locations throughout the vessel. The vessel was equipped with a separate system for providing private announcements to the crew.

The *Star Princess* had four radars (refer to figure 4, the wheelhouse layout). The radar the pilot used was beside the chair on the starboard side of the wheelhouse. The antenna for this radar was mounted on the ship's bow. (The bow-mounted antenna provided a better presentation of small craft vessels, buoys, and other objects that might be shadowed by the ship's bow and go undetected by a mast-mounted antenna.)

[19]Windage is wind impinging on the large area of the vessel's side.

[20]4 Radars - 2 Krupp Atlas, Model No. 8600 3 cm and 10 cm Band with ARPA, 1 Krupp Atlas, Model No. 7600 3 cm Band with ARPA, and 1 RACAL-DECCA (Bow radar) Bridge-Master 3 cm with ARPA; VHF radios - 2 Sailor (with dual monitoring capabilities); a Loran C - Raytheon Raynav 780; a GPS - Magnavox MX200 professional GPS navigator; an RDF - STC International Marine ADF-790; an Automatic Direction Finder; an EchoGraph - Atlas 486 Digigraph; a Speed Log - Atlas Dolog 20; a Gyro Compass - Anschutz Standard 4 (2x); an Autopilot - Sperry SRP 2000; and a Course Recorder - Sperry.

Waterway Information

Lynn Canal. -- The Lynn Canal extends north from the junction of Chatham Strait and Icy Strait at Hanus Reef in a north-northwest direction for about 58 miles to Seduction Point. Here it divides into two arms called the Chilkat and Chilkoot Inlets. The latter inlet extends 25 miles farther north from Seduction Point to Skagway. At Rocky Island, the canal is 5 miles wide; from Point Howard to Ralston Island, it is about 3 miles wide; from Ralston Island, it averages 6 miles wide to Seduction Point. The canal is nearly free of dangers, and the water is generally very deep — over 22 fathoms (132 feet) to over 300 fathoms (1,800 feet), except near islands and a few rocks marked with fixed navigation lights or floating aids.

The last Coast Guard Waterway Analysis and Management System (WAMS) study[21] for the Lynn Canal was completed in 1991.[22] It specifically included Lynn Canal to the north of Poundstone Rock and both Saginaw and Favorite Channels to the south of Poundstone Rock.

Lynn Canal was not deemed "navigational critical"[23] by the WAMS report. The report found that the waterway was adequately marked by the existing aids to navigation, which included the Poundstone Rock buoy. In the report, the Coast Guard stated that responders to a questionnaire — including fishermen, pilots, ship masters, and recreational boaters — were generally pleased with the aids to navigation provided in the Lynn Canal. Responders reported that the aids were adequate to meet the needs of mariners year-round.

The area studied contains no formal traffic separation schemes. One area mariner told Safety Board investigators that tradition, possibly from the established ferry routes, has accustomed local mariners to the routine that northbound vessels transit the area between

[21]WAMS studies are conducted periodically as directed by the Coast Guard District Commander to determine navigation aid adequacy in an area.

[22]The U.S. Coast Guard Cutter *Woodrush* (WLB 407) conducted and completed the study on November 15, 1991.

[23]If an area is found to be navigational critical, additional navigation aids are needed for its safe transit.

Sentinel Island and Poundstone Rock, whether they meet southbound traffic or not. Southbound vessels not encountering northbound traffic are accustomed to pass between Sentinel Island and Poundstone Rock. When meeting northbound traffic, southbound vessels en route to the Favorite Channel are to use that part of the Lynn Canal that lies to the west of Poundstone Rock.

The three SEAPA pilots (the two *Star Princess* pilots and the *Fair Princess* pilot) who testified about this accident stated that it is safe, in their opinions, for two vessels to pass between Poundstone Rock and Sentinel Island. None could recall previously passing a vessel in that exact area. All stated they preferred to use the traditional meeting and passing scenario (outlined in the preceding paragraph). All three pilots testified that they considered 2 cables (1,200 feet) a safe distance by which to pass either Sentinel Island or Poundstone Rock.

Poundstone Rock is about 2.5 miles north of Shelter Island and 1.1 miles south-southwest of Sentinel Island. The rock has 2 3/4 fathoms (16.5 feet) of water over it at MLLW and is marked by a lighted bell buoy. From Poundstone Rock, a relatively shallow area extends about 3 miles northwest toward Vanderbilt Reef. The shallows have depths of 5 1/4 to 7 fathoms (31.5 to 42 feet) and are located about 1.4 miles northwest of the rock.

Accidents. -- The Coast Guard lists one marine accident as having occurred in the Lynn Canal before this accident — a June 1991 collision of the motor vessel (M/V) *Island Princess* with the M/V *Regent Sea* near Skagway. The Coast Guard attributed the accident to pilot error by both pilots. The pilot who had been on watch on the *Island Princess* during the June 1991 collision was the pilot on watch on the *Star Princess* during the accident investigated in this report.

Aids to navigation. -- The Poundstone Rock buoy has the following characteristics: it flashes a red light every 6 seconds, its range visibility is 4 miles, and it is painted with red and green bands. The buoy is anchored in 67.5 feet of water at MLLW. The buoy chain is 180 feet long. Following the *Star Princess* grounding, a Coast Guard buoy tender visited Poundstone Rock on June 24. The tender's commanding officer determined that the buoy at Poundstone Rock was on its charted position, operating properly, and not damaged by the accident. The buoy's anchor (a concrete sinker) was found to be 21 yards from the assigned position, within its 150-yard position tolerance,[24] and in the same position it had occupied when last checked in February 1995.

Currents. -- The velocities of currents in the Lynn Canal vary from 0.3 to 1.0 knot in the southern part, diminishing toward the northern end of the canal. From Point Whidbey to Point Sherman, the currents are regular and tidal. Tides in Lynn Canal vary from approximately 15 feet in the southern part (the area of Funter Bay) to 20 feet near Skagway in the north.

The *Star Princess* pilot and the ship's bridge watch officers testified that they had not expected any significant currents during this passage through the Lynn Canal. The pilot also testified that his only explanation for the grounding was a possible strong current that could have set the vessel toward Poundstone Rock when it emerged from the lee of Sentinel Island about 0135.

According to the *1995 National Oceanic and Atmospheric Administration Pacific Coast of North America and Asia Tidal Current Tables*, the current setting the ship westerly toward Poundstone Rock at 0135 on June 23, 1995, was about 1/2 knot.

Vessel Bridge-to-Bridge Radiotelephone Act. -- This act is applicable on navigable waters of the United States inside the boundary lines established in 46 CFR 7. The area of the Lynn Canal is considered navigable waters of the United States, so vessels[25] operating in the Lynn

[24]Position tolerance is essentially the distance that a buoy anchor may be expected to move from its prescribed location. Each buoy is assigned its own position tolerance by the Coast Guard based on the waterway bottom composition (sandy or rocky, etc.), water depth, waterway users, traffic, positioning references, and other factors. The buoy, once positioned, should never extend outside its assigned position tolerance.

[25]In this instance, "vessel" refers to a power-driven vessel of over 300 gross tons, every vessel of 100 gross tons carrying one or more passengers for hire, every towing vessel of 26 feet or greater in length, and certain dredges and floating plants.

Canal must comply with the Vessel Bridge-to-Bridge Radiotelephone Act.

The regulations require that vessels transmit any information necessary for safe navigation. Each vessel is required to maintain a listening watch and, "when necessary, transmit and confirm, on the designated frequency, the intentions of his vessel and any other information necessary for the safe navigation of vessels." The *Star Princess* and the *Fair Princess* had the required radios on their bridges to comply with the regulation, and the crews were maintaining listening watches.

Because of this accident, on July 13, 1995, the Alaska Marine Pilot Coordinator wrote to all Alaska-licensed pilots reminding them to communicate passing, crossing, or overtaking intentions by use of VHF radiotelephone or sound signals. In his letter, the Alaska Marine Pilot Coordinator wrote, "[I]t is common practice for passing agreements made by radiotelephone to be substituted for required whistle signals in our waters." He further wrote, "Failure to communicate effectively is a contributing factor in most maritime accidents."

Pilot Licensing and Oversight

Federal pilot licensing requires that pilots annually pass a "thorough physical examination"[26] that requires use of a form that addresses the prospective pilot's acuity of vision, color sense, and general physical condition.[27] The *Merchant Marine Personnel Physical Examination Report* (CG-719K, revised in March 1995), used to conduct this examination, contains a block number 15 that directs the examining physician to query the pilot being examined concerning "Medications taken: include dosage, purpose, and side effects."

To obtain an original California pilot's license (or to renew the license), an applicant must disclose whether he or she suffers from depression or is using medications. California law further provides authority for the immediate disqualification of, or an additional evaluation for, any pilot diagnosed with active depression within 1 year of the application.

Washington State pilot regulations require that an applicant disclose whether he or she suffers from depression or is taking antidepressant drugs. The regulations provide that an applicant's existing need to use antidepressants or anti-anxiety drugs can disqualify a pilot for license renewal. They also require that an applicant with depression undergo an in-depth evaluation before his or her license can be renewed.

Alaska statutes and professional regulations set licensing requirements for marine pilots. The Alaska Board of Marine Pilots (ABMP) is responsible for overseeing marine pilotage. The ABMP was given the authority to set standards under which pilots would receive licenses. The authority states:

> The Alaska Administrative Code ('regulations') requires that any applicant for a pilot's license provide evidence of a satisfactory physical examination, whether for renewal or original application. The required physical examination must demonstrate that the applicant is in all respects physically fit to perform the duties of a pilot and [include] an examination of eyesight, hearing, and blood pressure.

Alaska State law and regulations do not go into greater detail about the physical requirements for obtaining a pilot's license. The physical and medical requirements for obtaining a pilot's license vary among pilot licensing organizations in the United States.

The ABMP consists of seven members, each appointed by the Governor: two licensed pilots who have been actively engaged in piloting vessels subject to Alaskan law, two registered agents or managers of vessels subject to Alaskan pilotage laws, two members of the public, and a commissioner. The ABMP is responsible for, among other things:

[26] 46 CFR Part 10.710 (b).

[27] 46 CFR Part 10.10.205 (d) (1).

- Providing for the maintenance of efficient and competent pilotage service on the inland and coastal waters of and adjacent to the State to ensure the protection of shipping, the safety of human life and property, and the protection of the marine environment;
- Establishing the qualification of and required training for pilots and providing for the examination of pilots and the issuance of original or renewal pilot licenses;
- Auditing a pilot organization or an individual pilot as necessary to implement or enforce State pilotage requirements; and,
- Making any other provision for the proper and safe pilotage upon the inland and coastal water of and adjacent to the State, including: a mandatory drug and alcohol testing program, including random tests, postincident tests, and tests based upon reasonable cause for pilots.

The ABMP may discipline a licensed pilot or a marine pilot organization recognized by the board. Sanctions include:

- Permanently revoking a license;
- Suspending a license for a specified period;
- Censuring or reprimanding;
- Limiting the professional practice of a licensee;
- Requiring remedial professional education to correct deficiencies in the education, training, or skill of a licensee;
- Imposing probation requiring a licensee to report regularly to the board on matters related to the grounds for probation; and,
- Imposing civil fines on individual pilots or on pilot organizations.

The board must discipline a pilot if it finds that the pilot:

- Is incompetent in the performance of pilotage duties;
- Is chemically impaired;
- Illegally possesses, uses, or sells narcotic or hallucinogenic drugs;
- Makes a false statement to obtain a license;
- Violates a provision of the pilotage statutes or regulations;
- Is guilty of misconduct during the course of employment; or,
- Has had a Coast Guard pilot license conditioned, suspended, or revoked.

A pilot is required to notify the ABMP marine pilot coordinator whenever a vessel piloted by him or her is involved in a grounding or "collides with another vessel or dock, meets with any casualty, or is damaged in any way." No monetary minimum damage threshold is specified, and the incident must be reported within 72 hours. The marine pilot coordinator may, at his or her discretion, investigate the reported incident. Between January 1990 and January 1997, 58 incidents/accidents were investigated. In 39 cases, no action resulted. In the remaining cases, 2 pilots surrendered their licenses, 1 pilot's license was placed on probation, 1 pilot's license was suspended, 1 pilot's license was suspended (with probation), 1 pilot's license was suspended (ultimately surrendered), 3 warning letters were issued, 1 case was a Federal violation, 1 pilot died before action was completed, 1 pilot retired, and 7 cases were pending.

The pilot in this accident was involved in a license suspension/probation and a license suspension/surrender. On July 5, 1995, the State of Alaska suspended the license of the pilot for his part in the *Star Princess* grounding. On September 29, 1995, the State sought revocation of the pilot's license. On April 1, 1996, the pilot surrendered his license and agreed to "never again apply for a marine pilot license of any sort issued by the State of Alaska." The agreement does not preclude the pilot from applying for a pilot's license in another jurisdiction.

Alaska requires that new pilots and pilots renewing a license take training under which they must meet pilot licensing requirements through classroom training, familiarization trips,

and the satisfactory docking and undocking of vessels at various ports within the State. The ABMP may, for good cause, require a State-licensed pilot to submit to a physical or mental examination to determine fitness to perform pilot duties. (General information on pilots and piloting appears in appendix C.)

Meteorological Information

General. -- The weather and sea conditions recorded in the *Star Princess* logbook between 0200 and 0400 on June 23 were cloudy skies, force 3 winds (approximately 7 to 10 knots) out of the east, and seas of 2 to 4 feet. Visibility was at least 10 miles. The seawater temperature was about 50°F.

High tide in Juneau was at 2252 on June 22, with a height of 15.5 feet. Low tide was expected at 0458 on June 23 and to be 1.3 feet. At the time of the grounding, the tide was approximately 7.8 feet and dropping. An ebb current of about 0.3 to 0.5 knot in an approximate west-southwest direction was anticipated in this part of the Lynn Canal. The tide and current data were available through two computer systems located on the bridge of the *Star Princess*. The pilot on watch testified that he was familiar with these tools.

Visibility and assessment of distance from Poundstone Rock buoy. -- The pilot subsequently testified that he had wanted to pass east of the Poundstone Rock buoy by 2 cables (1,200 feet). About 0115 the pilot turned the vessel to course 156°T using the EBL as a reference. The pilot's stated reason for making the course change to 156°T was to provide the 2-cable (1,200 feet) offset to the east of the buoy. At the time of the course change, Poundstone Rock buoy was about 4 1/2 miles away. After making the EBL course adjustment and during the 27 minutes remaining before the grounding, the pilot relied almost exclusively on visual cues for navigating the vessel as it approached Poundstone Rock buoy.

The pilot characterized visual conditions in the hour before the accident as "a little darker than twilight." He testified that although it was not entirely dark outside, the light was insufficient for him to discern details of the environment, such as the outlines of the *Fair Princess* and the lighthouse on Sentinel Island. He stated that he initially saw the flashing red light of the buoy marking Poundstone Rock, as well as the white light from the lighthouse on Sentinel Island and the deck lights of the *Fair Princess*, when he was several miles from them. The pilot testified that as the vessel continued to approach Poundstone Rock, all three sources of light were distinctly visible. He specifically recalled that, from his perspective, the brightest light was generated by the lighthouse, followed by the lights of the *Fair Princess* and the light from the buoy marking Poundstone Rock.

Investigators contacted a vision researcher[28] in an attempt to determine how well individuals can appraise relative distances in low light conditions. The following information, as provided by the researcher, was compiled by Safety Board investigators.

Vision is normally binocular. Because the eyes are separated, each eye receives a slightly different view of the visual scene. This slight difference in each eye's image, known as "lateral retinal image disparity," is a primary cue to depth. Stereo acuity permits the visual resolution of small differences in depth or distance by means of retinal disparity. Because depth perception is heavily dependent on cues that exist during daylight (such as those that create such phenomena as contrast, texture gradient, and linear perception), individuals have difficulty accurately judging distances of objects under conditions of little or no light. Assessment of a single lighted object under such environmental conditions is particularly difficult because of the absence of these cues. Two or more lighted objects that occur simultaneously in the visual field allow for subjective judgments as to their apparent relative distance from each other and perceived relative intensity (brightness), which are cues that create depth perception.

Medical and Pathological

Tests conducted. -- On June 23, 1995, selected *Star Princess* crewmembers and the

[28]Telephone conversation with Dr. D. Alfred Owens, professor of psychology, Whitely Psychology Laboratory, Franklin and Marshall College, Lancaster, Pennsylvania, on May 3, 1996.

pilot who had been conning the vessel at the time of the accident provided breath and urine specimens pursuant to postaccident alcohol and drug testing requirements.[29] Toxicology testing began at 0540, when the pilot supplied breath and urine specimens that were tested for alcohol and illegal drugs.[30] Eleven crewmembers also provided breath and urine specimens, concluding with the master at 1007. The results from the specimens from all individuals' tests were negative for the presence of alcohol and illegal drugs.

Pilot's condition. -- ABMP records showed that the pilot on watch had last undergone a physical examination, which included a vision and hearing test, on October 31, 1994. The certificate of medical examination completed by the pilot and the examining physician on October 31, 1994, did not specifically address whether the pilot was taking medications. The examining physician found the pilot physically qualified to perform his duties as a marine pilot.

The form used for the exam asked the applicant or licensee whether he or she had a "medical disorder" or "physical impairment," to which the pilot responded that he did not. Likewise, the form contained an entry to be completed by the examining physician that concerned the applicant's "neurological and mental health," which the physician indicated as "normal" for the pilot. The form did not address whether the applicant suffered from specific illness or was taking medication.

Effexor. -- The pilot who was conning the *Star Princess* at the time of the accident later testified that he was taking Effexor, a prescription medication used to treat depression. The pilot stated that he had been on this medication for 3 years before the accident and that he had been treated for depression for about 8 years. Most recently before the grounding, on June 22, 1995, he had taken 75 mg of Effexor at his normal time of about 1800.

The pilot testified that the medication sometimes caused some moderate physical reactions (such as sweating). He stated that he was not taking any other medications, and that he did not have any other illness.

According to the 1995 edition of the *Physician's Desk Reference*, Effexor (venlafaxine hydrochloride) is indicated for the treatment of depression. In controlled clinical trials, the most commonly observed adverse effects associated with Effexor were sweating, nausea, constipation, anorexia, vomiting, somnolence (drowsiness), dry mouth, dizziness, nervousness, anxiety, tremors, and blurred vision. The *Physician's Desk Reference* indicated that the medication is not a controlled substance.

During this investigation, the Safety Board requested the pilot's physician (who initially prescribed the Effexor) and several other physicians to provide professional opinions on how Effexor might have affected the pilot. One physician stated that in controlled clinical studies of Effexor, a low incidence of somnolence had been indicated by some subjects in early stages of use. He indicated that this finding was not applicable to the pilot, who had been taking the medication for more than 1 year. Additionally, the physician stated that the dosage of Effexor being taken by the pilot (75 mg) was "generally the lowest clinical effective dose, so the incidence [of sedation] is even lower statistically."

Another physician stated that the pilot had never been chemically impaired by his use of Effexor, and neither the pilot's depression nor his use of the medication "constituted a physical or mental disability or impairment that would impair or interfere with his ability to practice as a marine pilot." A third medical consultant said that Effexor "has been found to affect information processing less than expected with classical antidepressants."[31] He stated that little evidence indicated Effexor impaired coordination or spatial skills. (Additional information on Effexor appears in appendix D.)

[29] See title 46 CFR 4.06.

[30] Cocaine, amphetamines, cannabinoids, opiates, and phencyclidines.

[31] Classical antidepressants may be considered those used generally before the early 1990s. Newer classes of antidepressants, of which Effexor is one, operate in such a way as to have a less sedative effect on human beings than the earlier medications did.

Fatigue. -- Previous accident investigations[32] have identified three background factors related to fatigue — cumulative sleep loss, continuous hours of wakefulness, and time of day when the incident occurred. Sleep research[33] has established that individuals require a certain number of continuous hours of sleep each day to be fully alert and functioning; the amount is typically about 6 to 10 hours, depending on the individual. Some evidence suggests that only 2 hours less sleep than is normally required can degrade an individual's alertness and performance. During a thorough physical examination conducted in November 1995, the pilot reported he usually obtained 7 to 8 hours of sleep each night when not piloting. He reported that from the time he boarded the vessel on June 21 until the accident, he had obtained an average of just over 5 hours of sleep per sleep period — a total of about 14 1/2 hours of sleep in a 24-hour period. With respect to continuous wakefulness, the pilot had been awake slightly more than 1 hour when the grounding occurred.

Researchers have established[34] that two periods of maximum sleepiness occur during a 24-hour period, determined by physiological fluctuations controlled by the brain. These periods are approximately from 1500 to 1700 and from 0300 to 0500. Research further indicates that performance and alertness can also be affected throughout the period from 0000 to 0800. Regardless of the amount and quality of prior sleep, the body has a natural tendency to sleep during these specified periods.[35] Individuals who are not sleep deprived will, on average, require about 20 minutes to fall asleep when placed in a dark, quiet room.[36] A sleep researcher[37] who tested the *Star Princess* pilot several months after the accident found that he (when tested on several different nights) fell asleep in an average of about 5 minutes when placed in a dark, quiet room.

An attorney representing the pilot informed the Safety Board in a November 2, 1995, letter that the pilot had been diagnosed several weeks earlier with sleep apnea. The letter stated that in late October 1995, a physician specializing in sleep disorders had informed the attorney that an initial evaluation had suggested that the pilot suffered from obstructive sleep apnea (OSA). Additional tests conducted in a laboratory setting had resulted in a diagnosis of OSA. The Safety Board subsequently contacted two independent sleep researchers[38] and requested that they evaluate the data and opinions generated by the physician who made the diagnosis. Both researchers corroborated the validity of the physician's findings and acknowledged the presence of OSA in the pilot.

Sleep apnea is a syndrome in which abnormal respiratory functions during sleep prevent adequate breathing.[39] *Apnea* means

[32]See Safety Study -- *Factors that Affect Fatigue in Heavy Truck Accidents* (NTSB/SS-95/01) and Aircraft Accident Report -- *Uncontrolled Collision with Terrain American International Airways Flight 808 Douglas DC-8-61, N814CK, U.S. Naval Station, Guantanamo Bay, Cuba, August 18, 1993* (NTSB/AAR-94/04).

[33](a) Carskadon, M. and Dement, W., "Normal Human Sleep: An Overview," *Principles and Practice of Sleep Medicine*, pp. 16-26, section 1, chapter 2. W.B. Sanders Company, Philadelphia, Pennsylvania, 1994. (b) Roth, T., Roehrs, T., Carskadon, M., and Dement, W., "Daytime Sleepiness and Alertness," *Principles and Practice of Sleep Medicine*, pp. 40-50, section 1, chapter 4. W.B. Sanders Company, Philadelphia, Pennsylvania, 1994. (c) National Commission on Sleep Disorders Research, *Wake Up America; A National Sleep Alert, Vol. 1*: Executive Summary and Executive Report. Submitted to the U.S. Congress and the Secretary of Health and Human Services, 1993.

[34]Rosekind, M., Gander, P., Connell, L., and Co, E., *Crew Factors in Flight Operations X: Alertness Management in Flight Operations.* NASA/FAA Technical Memorandum DOT/FAA/RD-93/18, 1994.

[35]Dinges, David, "Napping Strategies," *Fatigue Symposium Proceedings, November 1-2, 1995*, p. 48. The National Transportation Safety Board and the NASA Ames Research Center sponsored the symposium.

[36]Association of Sleep Disorders Centers Task Force on Daytime Sleepiness: *Sleep*, 9(4):519-524, Raven Press, 1986.

[37]Dr. Noel Johnson, D.O., of the Seattle, Washington, Sleep Disorder Center.

[38]Mark R. Rosekind, Ph.D., Chief, Aviation Operations Branch, Light Management and Human Factors Division, NASA Ames Research Center, Moffett Field, California, and Allan I. Pack, M.D., Ph.D., Director, Center for Sleep and Respiratory Neurobiology, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania.

[39]Goldberg, P., Kaufman, D., *Everybody's Guide to Natural Sleep*, pp. 60-61, Jeremy P. Tarcher, Inc., Los Angeles, California, 1990.

"without breath," and sleep apnea is a condition in which a sleeping individual ceases to breathe for short periods. Sleep apnea was not identified until the early 1970s. One sleep researcher estimates that 1 to 4 percent of the U.S. population, and 2 to 8 percent of the U.S. male population, suffer from this syndrome.[40]

Researchers have identified three types of sleep apnea — central apnea; obstructive or upper airway apnea; and mixed apnea, which is a combination of the other two conditions. When an individual suffers from central apnea, the respiratory effort discontinues altogether. In cases of OSA, which are more common, the lack of respiration automatically induces the body to try to start breathing again, but a partial or total obstruction of the breathing passage prevents the free flow of air. Obstruction can be caused by tonsils or adenoids, by fatty deposits or excess tissue that reduce the diameter of the airway, or by abnormalities in the throat or jaw structure.[41]

Predisposing factors to sleep apnea include being male, being obese, and having enlarged tonsils, hypothyroidism, or acromegaly.[42] Alcohol and sedative use predispose individuals to snoring and apnea by relaxing the upper airway dilating muscles. Problems caused by apnea worsen with age, particularly after age 40. Consequences of sleep apnea include excessive daytime sleepiness, irritability, depression, and impaired cognitive functioning and work performance.

Research[43] indicates that while individuals may experience the symptoms of sleep apnea, they typically are not aware until they have been medically evaluated that they suffer from this syndrome. The sleep apneic may wake many times during the night so briefly as to have no recollection of having awoken. Sleep apneics awaken poorly rested and, since they were unable to obtain restorative, uninterrupted sleep, go through the day feeling fatigued and disoriented. Additional manifestations of sleep apnea include morning headaches, excessive daytime sleepiness, depression, intellectual impairment, and memory deficit.

Bridge Resource Management

General. -- Bridge resource management (BRM) may be defined as the effective use by bridge watchstanders of all available resources, in the form of information, equipment, and personnel, to achieve safe operation. The concept of BRM was developed to help mariners recognize and correct operational and human errors before they lead to an accident. BRM is a model for effective communications among bridge watchstanders, a means to trap errors, and an aid to decisionmaking in an operational environment.

One of the principles of BRM requires that everyone on the bridge be familiar with the passage plan, know his or her responsibilities in connection with the passage, and be able to communicate observations on the progress of the passage plan to other members of the bridge watch freely and professionally. Sound BRM requires that when a pilot boards a vessel, the pilot's knowledge and expertise concerning local waters be communicated and integrated into the watchstanders' information flow.

The Safety Board has investigated a number of marine accidents that have occurred because members of the bridge watch and the pilot failed to communicate, coordinate their efforts, recognize potential problems, and cooperatively solve imminent problems.[44] In its investigation

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[40]Dement, W., *The Sleepwatchers*, p. 66, Stanford: The Portable Stanford Book Series, 1992.

[41]Dotto, L., *Losing Sleep: How Your Sleeping Habits Affect Your Life*, pp. 108-109, William Morrow and Company, Inc., New York, New York, 1990.

[42]Acromegaly is a disorder marked by progressive enlargement of the head, face, hands, feet, and thorax caused by excessive secretion of a growth hormone by the pituitary gland.

[43]Catalano, E., *Getting to Sleep: Simple, Effective Methods for Falling and Staying Asleep, Getting the Rest You Need, and Awakening Refreshed and Renewed*, pp. 32-33, New Harbinger Publications, Inc., Oakland, California, 1990.

[44]Marine Accident Reports -- *Grounding of the United Kingdom Passenger Vessel* RMS Queen Elizabeth 2 *near Cuttyhunk Island, Vineyard Sound, Massachusetts, August 7, 1992* (NTSB/MAR-93/01*); Grounding of the U.S. Tankship* Star Connecticut, *Pacific Ocean, near Barbers Point, Hawaii, November 6, 1990* (NTSB/MAR-92/01); *Collision between the Greek Tankship* Shinoussa *and the U.S. Towboat* Chandy N *and Tow near Red Fish Island, Galveston Bay, Texas, July 28, 1990* (NTSB/MAR-91/03);

of these accidents, the Safety Board found that they occurred largely because BRM techniques were not being used and the bridge watches and pilots failed to function as teams.

In the case of the *Star Princess* grounding, the pilot on watch at the time of the accident initially stated he considered himself and the two bridge watch officers a team. He subsequently stated that the team atmosphere on the *Star Princess* bridge before the accident was minimal. He further stated that he expected the watch officers to keep tabs on his performance and inform him of errors.

PCL company policies. -- The PCL advocates the use of BRM for its cruise vessels. The PCL has instituted BRM training for its watch officers, and some PCL officers had received BRM training before the accident date. The *Star Princess* master had not been to BRM training before the accident. The two bridge watch officers on duty when the *Star Princess* grounded had also not received such training. The master managed his vessel by following PCL fleet regulations. Relevant PCL policies and regulations regarding acceptable performance of bridge watch duties are reviewed in the following sections.

Watchstander duties. -- PCL company policy concerning the activities of watchstanders is reflected in the *Princess Cruise Lines Fleet Operations Manual* under "Fleet Regulations, Deck Standing Orders - Navigation." (See appendix E for additional information.) The manual addresses requirements for plotting navigation fixes, checking for gyro errors, and summoning the master to the bridge. It states that a lookout should be posted to observe lights, sounds, vessels, or any obstruction to navigation, and that the lookout should report observations to the watch officer. It also states that the individual should have no other duties while acting as lookout.

Plotting and recording of navigation fixes. -- Under the section "Handing over the Watch," the PCL fleet regulations state:

> When temporarily relieved in this manner (master or pilot has the conn), the officer-in-charge of the watch is to continue to fix the ship's position at suitable and frequent intervals and to report the results (recorded on charts or in the telegraph and stations book or recorded on the bridge tape recorder) of such fixes.

The PCL fleet regulation for "Navigation under Pilotage" states:

> The fact that the captain, staff captain, or pilot may have the conn does not relieve the officer of the watch from continuing to fix the ship at frequent intervals, right up to or from the berth to anchorage.

On the *Star Princess*, according to testimony from the second officer on watch, plotting fixes at suitable and frequent intervals meant taking fixes approximately every 15 minutes during transit of the Lynn Canal. Examination of the *National Oceanic and Atmospheric Administration Chart No. 17316 (Lynn Canal: Icy Strait to Point Sherman),* which was in use during the hours preceding the accident, showed that fixes were being plotted on the *Star Princess* at about 15-minute intervals.

The PCL further requires that ship's positions be fixed at frequent intervals using all possible aids, which are listed as "cross bearings of land, leading lights or marks, soundings, radar, and any electronic navigation aids." The PCL requires that positions be checked by independent means whenever possible. The PCL requires that careful attention be paid to the steering, compass error, tides, and currents, and that the ship's position be fixed both before and after every significant course alteration. The PCL fleet regulations state that whenever a vessel passes abeam of a major or significant landmark, a fix should be taken and recorded in the log book.

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and *Ramming of the Spanish Bulk Carrier* Urduliz *by the* USS Dwight D. Eisenhower (CVN 69), *Hampton Roads, Virginia, August 19, 1988* (NTSB/MAR-90/01). Also, Marine Accident Brief DCA-94-MM-035, *Grounding of the Netherlands Antilles Passenger Ship* Nieuw Amsterdam *in Nichols Passage, near Ketchikan, Alaska, on August 8, 1994*.

Oversight. -- The PCL acknowledges that it has the responsibility and authority to monitor the safety and pollution prevention aspects of its vessels and to ensure that adequate resources and shore-based support are provided to them. To fulfill this responsibility, the PCL schedules regular boarding of the vessels by company officials to ensure that proper procedures are in place and being carried out in conformity with company policy.

VERs

The *Star Princess* and *Fair Princess* are equipped with VERs (also known as VDRs, for voyage data recorders). These devices were operating during the accident and they recorded time, global positioning system (GPS) position (latitude and longitude), course, heading, speed made good over the ground, and radar data from various sensors. Audio data were also recorded from several microphones located on the ship's bridge. The navigation information was later used to reconstruct the actual tracklines of both vessels. In addition, the audio portion of the *Star Princess* VER provided investigators with information concerning navigation orders and discussions between individuals on the bridge. This is the first time Safety Board investigators have used event recorder data (other than from a course recorder) on a marine accident investigation.

In accordance with PCL requirements, after the accident the VER recording tapes were removed by the masters of both involved vessels and sent to London, England, for review.[45] Two Safety Board investigators went to England in December 1995 to observe the VER playbacks. The recorded radar, GPS, and gyro data for the June 23, 1995, periods from 0000 to 0145 (for the *Star Princess*) and from 0135 to 0145 (for the *Fair Princess*) as provided by the VERs were used to reconstruct the vessels' tracklines, as displayed in figures 3 and 6.

The PCL provided investigators with a transcript of conversations that took place in the *Star Princess* wheelhouse from 0102 until 0159 on June 23. The bridge voice recording quality was poor, and intelligible conversations were broken and disjointed. The matters discussed by the watch officers and pilot were not of a navigational nature and were not related to shipboard duties. For the 20 minutes preceding the accident (from 0122), the conversations on the bridge of the *Star Princess* as recorded by the bridge voice recorder primarily concerned personal grooming and family relationships.

Since 1976, the Safety Board has recommended in various accident reports that VERs be used to preserve vital navigation information. (See appendix F for Safety Board history on marine VERs.) In 1993, the International Maritime Organization (IMO) considered whether VERs were too complex to justify a requirement for their use. Since then, technology has expanded the capability of VERs and reduced their cost. More marine companies are installing these systems as means of monitoring bridge watchstanding performance, as well as for conducting accident reconstruction. The PCL has installed VERs on at least seven passenger ships, including the *Star Princess* and the *Fair Princess*. P&O Lines, Ltd., the parent company of the PCL, has equipped most of its cargo vessels with VERs.

Since early 1996, the Coast Guard has been working on VER policy with the IMO. Safety Board staff have been monitoring the status of this initiative. In an August 9, 1996, letter to the Commandant of the Coast Guard, the Safety Board wrote:

> the U.S. Coast Guard has just returned from the Subcommittee on Navigation meeting in London where the IMO is considering requirements for VDRs…. Now that the international community is engaged in discussion on this important matter, steps should be taken to avoid any further delay in the international adoption of at least a baseline standard for VDRs. We understand that a performance standard has been submitted to the upcoming meeting of the Maritime Safety Committee in December [1996]. We further understand that a carriage requirement for VDRs has been included in the draft text of a comprehensive revision to SOLAS Chapter V. Unfortunately, if the Maritime Safety Committee does not

[45]The VER readout equipment is in London.

> find itself in a position to approve the entire text of SOLAS Chapter V, the requirement for VDRs may be delayed until the next cycle of SOLAS requirements, possibly for another 4 years. The Safety Board believes VDR requirements may be one of the most urgent and significant amendments which are being considered for SOLAS, and we urge the Coast Guard to continue to play a leading role on this issue at IMO, even to the point of pressing to have the VDR provisions considered separately from other proposals amending Chapter V.

In August 1996, a Coast Guard initiative to recommend VER use for all vessels operating on international voyages was presented to the Maritime Safety Committee (MSC) Subcommittee on Navigation. The subcommittee met at the IMO's headquarters in London, England, to draft requirements for VERs. The United States was one of three countries that presented the requirements for consideration to the MSC in December 1996. The VER requirements were referred to the Design and Engineering Subcommittee, which is scheduled to present its findings to the MSC in mid-1997.

Survival Factors

Star Princess passengers were requested to provide information about their observations by filling out a questionnaire. Summary of their observations revealed that most responding:

- Had received a safety briefing instructing them how to don life preservers, locate their muster/lifeboat stations, and identify the different alarm signals.
- Recalled seeing emergency placards posted throughout the ship and in their cabins.
- Had been asleep before the incident.
- Were alerted to the incident when they felt a jolt or bump (the grounding), but did not feel that they were in any danger and so went back to sleep.
- Recalled hearing an announcement from the captain the next morning informing them of the situation and stating that they were not in any danger.
- Were provided with a memo that explained the procedures to be followed to prepare to leave the *Star Princess*.
- Found the demeanors of fellow passengers "calm," "reassured," "quiet," "surprised," and "disappointed" (that the cruise was concluded).
- Thought there had been no panic and that the crew had lowered lifeboats and was prepared if they had to evacuate.
- Found the crew well-organized and responsive to passengers' questions. (Some further stated that the crew provided "first-class" treatment, doing an "excellent" or "tremendous" job.)
- Did not feel that they had been in any danger.

A few passengers told the Safety Board they thought they should have been informed of the grounding shortly after it occurred. Several stated they believed that if passengers had been informed earlier, they could have sooner gathered their belongings and prepared to disembark.

Other Information

Alaskan cruise industry. *Traffic.* -- According to the Alaska Bureau of Tourism, passenger ship cruising is a growing industry in Alaska and this trend seems likely to continue. Large numbers of ships operate in the region and tourists visit relatively few areas. Passenger ship traffic can be heavy near visited ports. The Coast Guard has stated[46] that in the area of cruise activity:

> Alaska continues to experience soaring growth. In the last 4 years alone, capacity in the inside passage has increased by 39 percent, from 114,000 passengers in 1992 to 158,000 passengers in 1995…. Some ports are reaching capacity; Juneau, Ketchikan, and Sitka, for example, may host from three to five ships on many days….

The Coast Guard further reported that in the 1995 season (between May and September), 7

[46] *Report of the Cruise Ship Safety Review Task Force*, p. 7, October 31, 1995.

cruise ship companies were operating 29 vessels in the Alaska cruise market. The Coast Guard expected that more companies and ships were planning to enter this market.

The traffic separation scheme (TSS) in Prince William Sound for vessels traveling to or from the oil terminal at Valdez, Alaska, has been successful in preventing collisions between vessels in this region. Other areas in the United States with high traffic density or other risk factors (such as the approaches to New York Harbor, New Orleans, and Rhode Island Sound) have TSSs designed to prevent accidents.

On June 8, 1996, the Marine Safety Task Force published its *Southeast Voluntary Waterway Guide*. This reference was cooperatively developed by the Coast Guard, the State of Alaska, and industry and pilot associations in Alaska. It provides recommended guidelines intended to assist pilots, bridge teams, and the cruise industry and (ship) agents in improving safety in southeast Alaskan waters. The guidelines provide navigating watches with a standard on which to base their navigating practices. The guidelines, which are similar to a TSS, clarify the routing or vessel separation in the areas listed, including the Lynn Canal.

The area from Vanderbilt Reef to Poundstone Rock in Lynn Canal is cited in the guide. The guide states that northbound vessels should pass east of these obstructions and southbound vessels should pass west of them. The guidelines particularly encourage southbound pilots to navigate to the west of Poundstone Rock whenever they expect to encounter a northbound vessel between Poundstone Rock and Sentinel Island.

Also listed in the guide are radio security call points[47] for the Poundstone Rock area. For southbound vessels, the call point is Vanderbilt Reef (about 5 miles north of Poundstone Rock); for northbound vessels, the call point is Outer Point (about 15 miles south of Poundstone Rock) on the west side of Douglas Island. Besides the *Southeast Voluntary Waterway Guide*, mariners passing between Poundstone Rock and Sentinel Island have no other commonly accepted written guidance to which they can refer.

Use of pilots. -- The use of pilots in southeast Alaska is different from that typically encountered, where a pilot is responsible primarily for conning the vessel into and out of port. The southeast Alaska tourist trade is conducted mainly in inland waterways or "pilot waters." In pilot waters, continuous use of pilots is compulsory. A pilot, as designated by State or Federal law, must be on board to assist the master or navigation watch officer whenever the vessel is in pilot waters. Consequently, in the southeast Alaska cruise industry, pilots serve aboard cruise vessels for extended periods, often 3 to 12 days.

Safety Board investigators requested information from the American Pilots' Association[48] regarding the responsibilities of a compulsory pilot. In a December 13, 1996, letter, an association representative stated:

> You have asked about the respective roles and responsibilities of the compulsory pilot and a ship's crew and about the master-pilot relationship. Both, of course, are the subject of considerable discussion and debate. They are difficult to define in brief statements. In addition, pilotage statutes and regulations may affect in some degree the status, role, and responsibilities of a state pilot. For that reason, those aspects of compulsory pilotage may differ slightly from State to State. With that caveat, however, the following general principles of American maritime law would be useful for your purposes.
>
> The compulsory pilot has direct control of the navigation of the ship, subject to the master's overall command of the ship and the ultimate responsibility for its safety. 'It is always to be presumed, in the absence of positive evidence to

[47]Radio security call points are locations from which vessels should broadcast radio security calls that provide information that could be useful to other vessels in the area.

[48]The American Pilots' Association represents approximately 60 pilot associations, which is nearly all such associations in the United States. About 1,100 pilots are members of these groups.

> the contrary, that a local pilot employed for the occasion and actually on the bridge is in charge of the navigation of the ship, subject to the authority of the master.' *United States v. Jacksonville Forwarding Co.* ISF-2nd 39, 40 (5th Cir. 1929)….

Territory. -- The area in which Alaska passenger cruising takes places is vast. The distance from the southern border with Canada to Skagway, Alaska, is about 400 miles; from Skagway to the Gulf of Alaska is about another 200 miles; and from the Gulf of Alaska to Seward is another 400 miles. The distance that the Coast Guard must watch over for the cited area is roughly equivalent to the distance from New York City to Miami, Florida.

Navigation*. Fixed navigation aids and floating markers.* -- The aids to navigation depicted on marine charts comprise a system of fixed and floating markers having varying degrees of reliability. The Coast Guard Light List[49] states:

> Buoy positions represented on nautical charts are approximate positions only, due to the practical limitations of positioning and maintaining buoys and their sinkers in precise geographical locations. Buoy positions are normally verified during periodic maintenance visits. Between visits, atmospheric and sea conditions, seabed slope and composition, [and] collisions or other accidents may cause buoys to shift from their charted locations, or cause buoys to be sunk or capsized.
>
> Buoy moorings vary in length. The mooring lengths define a "watch circle," and buoys can be expected to move within this circle. Actual watch circles do not coincide with the symbols representing them on charts.
>
> CAUTION: Mariners attempting to pass close aboard risk collision with a yawing buoy or with the obstruction which the buoy marks. Mariners must not rely on buoys alone for determining their positions due to factors limiting buoy reliability. Prudent mariners will use bearings or angles from fixed aids to navigation and shore objects, soundings, and various methods of electronic navigation to positively fix their position.

Contingency planning and exercises. *Report of the Cruise Ship Safety Review Task Force.*[50] -- In response to four cruise ship accidents that took place in summer 1995,[51] the Coast Guard established a task force to conduct a safety review of the seagoing cruise ship industry (both U.S. and foreign flag) "to determine if adequate mechanisms are in place to ensure a continued high level of safety for all passengers who embark on cruise ship voyages from U.S. ports."

While the task force considered cruise shipping a "safe industry" overall, it found that some areas could be improved. Among other issues, the task force recommended that improvements be made in crew training and communications. The task force further found that "greater emphasis should be placed on contingency planning and exercises and [such exercises] should be done in partnership with the industry, emergency responders, and other associated port entities."

The Coast Guard task force found that the approach of the International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM) was supportive of this more participatory industry role in safety responses. (See appendix G for a description of the ISM Code requirements.) The task force said that the ISM Code is:

> Intended to refocus the past approach to regulatory compliance from the industry's passive defect notification and cor-

[49]This is a complete Coast Guard list of lights, sound signals, buoys, daybeacons, and radiobeacons. The list is published in seven volumes that cover the U.S. coasts and include the U.S. island possessions, the Great Lakes, and the Mississippi River System.

[50]Issued on October 31, 1995, by the Coast Guard.

[51]The four cruise vessel accidents cited by the Coast Guard that occurred in summer 1995 were the grounding of the *Royal Majesty* on Nantucket Island, off Massachusetts; the electrical fire on the *Celebration*, off the Bahamas; the engineroom fire on the *Regent Star*, 65 miles southeast of Valdez, Alaska; and the *Star Princess* grounding.

> rection response mode to an aggressive approach to safety. Under this proactive approach, potential discrepancies are resolved by the companies themselves before they can become significant safety or environmental problems.

High Capacity Passenger Vessel (HCPV) Incident Response, Planning, and Risk Management Workshop.[52] -- Also in response to the cruise ship accidents of summer 1995, the Coast Guard and the cruise ship industry held an HCPV[53] incident response, planning, and risk management workshop, September 20-21, 1995, at the Massachusetts Maritime Academy in Buzzards Bay, Massachusetts. The workshop included representatives of the Coast Guard, the Massachusetts Maritime Academy, other government agencies, the cruise industry, and passenger vessel associations. Workshop participants expressed awareness of the potential for disaster should a cruise vessel accident occur. In particular, the working group developed to consider "Operational Procedures" involved in cruise response efforts found:

> Passenger vessels should not depend solely on the availability of Coast Guard assets for search and rescue, as [Coast Guard] resources are limited by location, time of day, maintenance schedules, and capabilities of vessels/aircraft.

The working group developed to address "Available Resources" recommended that, as "Coast Guard response resources may be limited due to distance, weather, repair and downtime, capacity of the vessel/aircraft and competing operations," the industry should, "Conduct exercises around contingency plans to test availability of and limits to resources." The group further recommended that such plans be implemented and reinforced by crew training.

The third HCPV working group focused on "Communication." The working group stated that "Coast Guard/industry training programs are an excellent medium to exchange ideas, theories, and goals; continued participation [in them] is to be recommended." Many members of this group agreed that a tabletop exercise should be held in spring 1996.

Such a drill was held in Juneau, Alaska, in March 1996 (as summarized below). Two more exercises were held in spring 1997 – one in Ketchikan, Alaska, and one in Key West, Florida.

Cruise Ship Exercise 96-2, Juneau, Alaska. -- On March 19-21, 1996, a command post exercise designed to evaluate existing plans, procedures, systems, and interactions that occur when a major marine disaster takes place was conducted in Juneau, Alaska, by Federal, State, local, and cruise industry officials. The Coast Guard's exercise evaluation team published a report on the exercise.[54] Most of the comments in the report relate to response structure and the problems involving passenger accountability, medical issues, and communication. The team found that the exercise had been extremely beneficial and recommended holding a cruise ship exercise annually, before the start of each Alaska cruise season, which begins in mid-May.

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[52] *Summary of High Capacity Passenger Vessel Incident Response, Planning, and Risk Management Workshop*, Buzzard's Bay, Massachusetts, 1995.

[53] The Coast Guard informally considers an HCPV to be any ship that carries more than 600 passengers.

[54] *Evaluation Report for Cruise Ship Exercise 96-2 in Juneau, Alaska, on 19-20 March 1996.* Prepared by staff from the U.S. Coast Guard 17th District, Juneau, Alaska, and the State of Alaska.

ANALYSIS

The analysis has three main parts. First, the Safety Board identifies factors that can be excluded as causal or contributory to the accident as a result of the investigation. The second section focuses on the accident sequence, outlining the actions and events that led to problem conditions. In the final section, the report discusses those findings that concern the safety factors identified in the investigation.

Exclusions

Visibility in the vicinity of the grounding was clear to a distance of 10 miles, the sea was calm, and the wind was light. The steering gear and propulsion engines of the *Star Princess* functioned satisfactorily before and after the grounding. All electronic equipment used for locating the vessel's position, including the GPS, was functioning satisfactorily.

Beginning approximately 4 hours after the accident, breath and urine specimens were obtained from 11 crewmembers of the *Star Princess* and the pilot who had been conning the vessel when the grounding took place. All specimens were collected in a timely fashion and all tested negative for the presence of alcohol and illegal drugs.

No evidence was found to indicate that the *Star Princess* helmsman did not steer courses as ordered by the pilot.

The Accident

About 0040 on June 23, 1995, a pilot arrived in the *Star Princess* wheelhouse to relieve the pilot on duty. The pilot being relieved acquainted this pilot with the vessel's position. The new pilot did not address the navigating crew, nor did he announce his assumption of the watch. The pilot did not communicate with the lookout. The pilot left his radar on a 6-mile scale.

About 0100 the pilot altered course left (east) to 126°T from 143°T. About 0115, without fixing his vessel's actual position or using the watch officer's 0114 fix, and intending to set a course that would be sufficiently far off Poundstone Rock to allow for safe passage, he used the EBL on the radar to alter the course to 156°T. Almost immediately thereafter (about 0116), he further altered course, based on a visual estimate, to 155°T. About 0125 the pilot visually detected a northbound vessel (the *Fair Princess*) about 9 1/2 miles ahead. While he later claimed he was concerned about the oncoming vessel's intentions, the pilot did not call it on the bridge-to-bridge radiotelephone.

The third officer was taking radar ranges and bearings to plot the vessel's transit. The third officer's plotted 0114 and 0130 positions were both west of the established trackline of the *Star Princess* by about 0.3 mile. The second officer was aware from review of the third officer's plotting that the vessel was not following its established trackline. Neither officer informed the pilot of the vessel's off-track position.

At 0135 the pilot ordered a 2° course alteration to 153°T based on his visual assessment of the navigation situation, in an attempt to improve his vessel's position for passing Poundstone Rock safely. In the minutes before the accident, the pilot visually estimated that the vessel was going to clear Poundstone Rock, but by only about 1 cable (600 feet) rather than the 2 cables (1,200 feet) he would have preferred. At 0142 the *Star Princess* grounded on the northeast side of Poundstone Rock.

The Safety Board identified five main safety factors affecting the accident; they are pilot performance, medical issues, pilot oversight, bridge resource management, and survival factors.

Pilot Performance

General. -- The passage of Lynn Canal was a standard and easy maneuver that the pilot had successfully performed hundreds of times. Familiarity could have induced him to consider navigating the route a predictable and routine

procedure. The weather was clear, seas were calm, and winds were light. He had served as a pilot on the *Star Princess* some 10 times in the past, he was accustomed to the vessel and its navigation equipment, and he was familiar with the two bridge watch officers.

While the transit was an accustomed procedure to the pilot, he realized that he faced an unusual situation in that another vessel would be passing the *Star Princess* somewhere near Poundstone Rock. All the SEAPA pilots who testified regarding this accident stated that they could not recall ever passing a vessel in the specific vicinity of Poundstone Rock.

Safety Board investigators considered that when he sighted the *Fair Princess* proceeding northward in the Favorite Channel at about 0125, the *Star Princess* pilot had three general options. He could have: (1) stayed essentially on his current course, making minor navigational adjustments to avoid Poundstone Rock when he reached it; (2) made a course alteration to the right (west) to allow the *Star Princess* to pass Poundstone Rock on the port side; or (3) called the *Fair Princess* on the bridge-to-bridge radiotelephone, either to communicate his intention of making a significant course alteration to the left (east) or to request that the *Fair Princess* reduce its speed so the two vessels would not pass each other in the Poundstone Rock area.

The pilot chose the first option, the response requiring the least action on his part. He made no course change at all for 10 minutes, until about 0135, when he ordered the course altered by 2°, from 155°T to 153°T. He made no further course adjustments until the grounding. He later acknowledged in his testimony that, under less confined circumstances (without the *Fair Princess* in the waterway), he would have preferred a course of 150°T or 145°T to pass this area. The pilot also admitted that he estimated after changing to 153°T that the *Star Princess* would clear Poundstone Rock buoy by a distance less than 2 cables (1,200 feet), which he had considered the minimum safe margin between the vessel and the rock.

The pilot suggested in his testimony that he did not take the second option – altering course to the right (west) — because he had already passed Vanderbilt Reef by the time he saw the *Fair Princess*, and he thought that it was then too late to make such a course adjustment. Based on examination of the vessel's recorded trackline and the navigation chart of the area, the Safety Board considers that the pilot had sufficient time and depth of water to make a course alteration to the right (west) at this time.

The third option open to the pilot was to call the *Fair Princess* on the bridge-to-bridge radiotelephone either to communicate a course change intention or to request the *Fair Princess* to slow down. To move the *Star Princess* significantly to the left (east) could have required the vessel to turn so that the bow of the *Star Princess* would cross the track being followed by the *Fair Princess*. While the *Star Princess* would only have been taking this course temporarily to reset its track further off Poundstone Rock, the pilot of the *Fair Princess* might interpret the action as threatening a collision situation. This danger of misinterpretation could have been addressed by ship-to-ship communication. Alternatively, the *Star Princess* pilot could have used the radio telephone to request the *Fair Princess* to slow down, so the two vessels would not have to pass in the limited area for navigation immediately around Poundstone Rock.

The *Star Princess* pilot said that he did not call the *Fair Princess* on the radiotelephone because he felt that both he and the *Fair Princess* pilot were "taking actions that would allow a safe passage." He did not specify the actions to which he referred, but whatever they may have been, they did not succeed in ensuring safe passage for the *Star Princess*.

The Safety Board has not identified any valid reason why the pilot did not call the *Fair Princess*. Instead, the pilot chose to remain essentially on a course that he acknowledged took the *Star Princess* close to the underwater hazard. The Safety Board concludes that the pilot's decision to stay essentially on his existing course ultimately resulted in the grounding of the vessel.

Evidence indicates that in these circumstances, if he had intended to clear Poundstone Rock buoy by moving to the left (east), the *Star Princess* pilot should have made a significant

course change of at least 5° or even 10° to the left (east) to warn the oncoming *Fair Princess* of his vessel's movement and possible intentions in the meeting situation. The 2° change he elected to make would not have been easily discernible visually or by radar, whereas a 5° or larger change could have been detected by the other vessel (even had the pilot not communicated with it by radiotelephone), so the other could react as necessary. Investigators estimate that a 5° course change to the left (to course 150°T) would not have caused the *Star Princess* to cross the bow of the *Fair Princess*. Because the *Star Princess* sustained damage from the centerline (keel) to about a 50-foot width of the hull on the starboard side, it appears that any course change greater than 2° taken at 0135 probably would have avoided the grounding. The Safety Board therefore concludes that the 2° course change ordered by the pilot 7 minutes before the accident was not sufficient to allow the *Star Princess* to clear Poundstone Rock or to indicate his intentions to the pilot of the *Fair Princess*.

Other facts suggest that the pilot was not adequately responsive to the threat of grounding on Poundstone Rock. The last navigation orders recorded on the *Star Princess* bridge voice recorder for the period before the accident occurred about 0116, when the pilot issued the course change to 155°T. The transcript of the bridge conversations for the approximately 26 minutes remaining before the accident established that these discussions were not about navigation. Had the pilot been in doubt about navigation developments or considering more definite actions in response to them, some recorded conversation likely would reflect orders or discussion concerning the possibly hazardous situation.

Current. -- The pilot testified that his only explanation for the grounding was the possible existence of a strong current at 0135 – a current that could have set the vessel westerly toward Poundstone Rock when the *Star Princess* emerged from the lee side of Sentinel Island. The pilot ordered the course changed to the left (east) from 155°T to 153°T about this time. (The order was not recorded on the bridge voice recorder.) No cross current had been expected by the pilot and the *Star Princess* watch officers and, except for the minor 2° course change ordered by the pilot, no course adjustment was made between 0116 to 0135.

A cross current (a combination of water current from the tide ebbing and the light winds) probably did move the vessel to the west during the 26 minutes before the accident, as indicated by the comparison of the course steered and the course made good. The plot of the track shows that the *Star Princess* remained on a steady heading toward Poundstone Rock, rather than being offset from the buoy as the pilot had intended when he turned to course 155°T at 0116. Although the vessel was steering a course of 155°T, the effects of the current caused the vessel to actually make a course of about 158°T. Consequently, the 3° difference between the course steered and the trackline indicates that the vessel did encounter a cross current along its track. The current setting the ship westerly toward the rock, however, calculates only to about 1/2 knot, not the strong current that the pilot later speculated might have occurred. Such a weak current acting on the vessel before the grounding might have set the ship somewhat toward the rock, which an effective pilot would have taken steps to counteract.

If the cross current had not existed, the 2° course change to the left (east) ordered by the pilot at 0135 might have enabled the vessel to miss the rock, although by less than 0.1 mile clearance. But such a miss would have been happenstance, so the pilot's failure to maintain the navigation limit clearance must be regarded as dangerous in this case. It therefore appears that no significant cross currents affected the *Star Princess* as the vessel began to approach the buoy, but when the vessel emerged from the lee of Sentinel Island, a weak cross current occurred. The Safety Board concludes that the pilot should have been alert to the current and taken appropriate actions in response to it.

Radar. -- The *Star Princess* pilot did not use the full range of radar options available to him. Instead of employing the radar proactively and effectively, he took minimal advantage of the radar's capabilities and relied primarily on visual distance estimates. The 2-cable (1,200 feet) safety margin that the pilot had mentally established between the vessel and the Poundstone Rock buoy was a visual estimate. The pilot acknowledged that throughout his

piloting of the Lynn Canal, he based his decisions primarily on his visual assessments, rather than on radar presentations.

When the pilot did refer to the radar, the fact that he left it on a 6-mile scale decreased the accuracy achievable. At this scale, the pilot's radar scope would represent a distance of 0.1 mile by a length of 0.1 inch on the screen. Theoretically, a reduction in distance between the ship's radar heading marker and the buoy from 0.2 inch to 0.1 inch would have revealed a danger that the ship would strike the rock. But on the 6-mile scale that the pilot let stand, it would have been difficult to discern such a small radar change as 0.1 inch over a period of minutes, particularly as the heading marker oscillated in response to the helmsman's minor rudder adjustments. If the pilot had placed the radar on the 3-mile scale when the buoy reached that range, and later on the 1.5-mile scale, the screen distances would have doubled and quadrupled (respectively) and so have become increasingly discernible. (See figure 8.) Had he selected a more suitable radar screen scale, the pilot might have been alerted to danger by the more obvious radar presentation.

After the pilot set his 156°T course with the EBL and then changed course to 155°T about 1 minute later (0116), he did not attempt to verify his subsequent position estimates by any means, including comparing them to the radar fixes the bridge watch officers were plotting on the ship's chart. Review of the vessel's trackline shows that while the pilot thought he was on a course of 155°T, he was actually making good a course of 158°T. He had relied on his own mental conjecture of the path of the vessel's turn when making the course change to move it 2 cables (1,200 feet) to the east of Poundstone Rock. But the maneuver, which he made based on his visual estimates, did not move the vessel sufficiently to the east of Poundstone Rock. Comparison with the watch officers' radar fixes might have alerted him to the fact that the actual course the vessel was on would take the *Star Princess* very close to Poundstone Rock.

The pilot did not make full and active use of the radar, such as by changing scales, plotting targets, setting up danger bearings, or using parallel indexing.[55] Therefore, the Safety Board concludes that the pilot's limited use of the radar hampered his ability to evaluate the navigation situation accurately.

Visual navigation during low light conditions. -- The pilot had navigated vessels through this area several hundred times. He appears to have been combining this experience with the available visual cues to direct the vessel past the underwater obstruction of Poundstone Rock. To make appropriate course adjustments, the pilot had to be able to accurately choose a correct course.

Even under good light conditions, visual navigation can produce only rough distance estimates. The estimation process involves evaluating the distance to the reference buoy and the angle it subtends with the imagined extension of the ship's centerline, and then estimating the distance to the buoy that will exist when the ship arrives abeam the buoy. In any of these mental evaluations, knowledge of the distance to the buoy is vital. The pilot must combine this knowledge with his prior experiences and recall the passing distances associated with such angles. In darkness, however, humans cannot accurately determine the distance to a single point of light, or to a blinking light, such as the one on the Poundstone Rock buoy. The Safety Board concludes that although it was not totally dark in the period before the accident, the pilot's sense of distance to the Poundstone Rock buoy would have been inaccurate due to the level of illumination.

[55] A radar method used in conning or navigating a vessel. First, a conspicuous navigation object is chosen. Then, a line is drawn on the radar screen parallel to the vessel's course line heading flasher and the desired abeam distance off the object. The object should appear to track along the line drawn on the radar screen for as long as the vessel remains on course. If the object drifts to either side of the line, the conning officer will know that the vessel is off course. The pilot should then make course corrections as necessary.

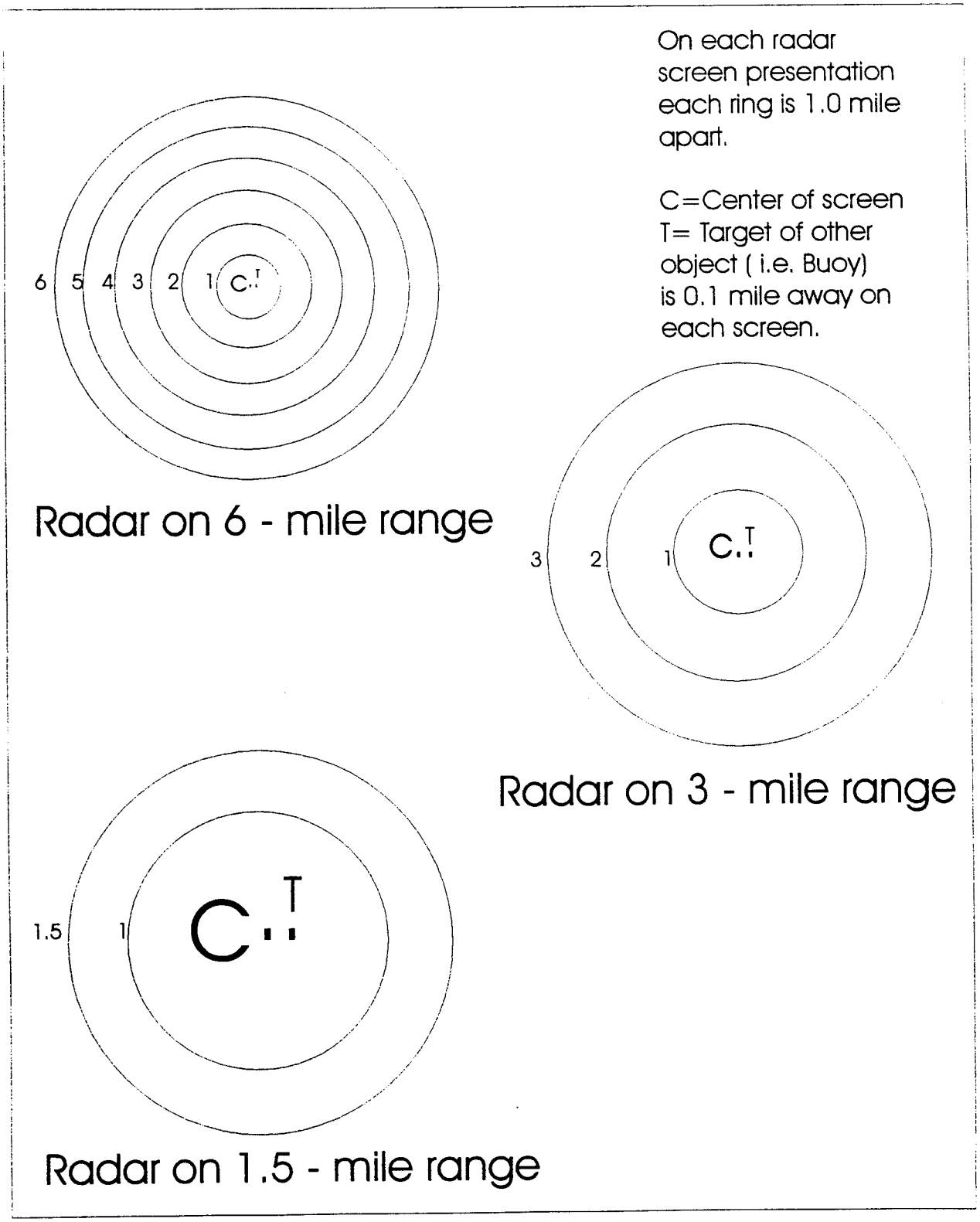

Figure 8. – Radar screen comparison

Navigation on a floating marker. -- Using a floating marker as the principal navigation indicator is not a recommended piloting practice. The anchors of floating aids may shift from their charted positions if they are rammed by a vessel, displaced by drifting ice, or acted upon by various weather and sea conditions. Also, buoys regularly move within the ranges of their anchor chains, as they are subject to wind, waterway currents, and tides. Mariners generally do not attempt to pass too close to buoys because they move. To positively affirm a vessel's position, the mariner should use bearings on fixed aids to navigation, as well as shore references, water depths, and various electronic aids.

The pilot's only EBL course was set on the buoy marking Poundstone Rock. The buoy was affected by the light wind and weak current, which probably caused it to drift west on its anchor chain, toward the rock and away from the safe water to the east. By using this mobile buoy as his primary navigation reference, the pilot was basing his piloting on a floating aid that was moving to the west and so reducing the margin of safety between the *Star Princess* and the rock. The Safety Board concludes that by relying on visual reference to a floating aid, the pilot did not follow sound navigation practices.

Communication. -- As has been noted, one means of dealing with the navigation situation that the *Star Princess* pilot faced would have been to communicate with the *Fair Princess* to establish an agreement that the *Star Princess* would make a temporary maneuver to move further off Poundstone Rock or to agree upon other steps to deal with the situation. As soon as the *Star Princess* pilot had any doubt whether the *Fair Princess* might crowd his vessel in the channel, good marine practice required that he communicate with the *Fair Princess*.

The pilot testified that he was concerned about the *Fair Princess*'s intentions as early as 0125, when he was not sure whether the other vessel would go to the east or west of Poundstone Rock. A radio call would have told him exactly what the *Fair Princess* pilot intended. Instead he assumed, based solely on the changing aspects of the *Fair Princess*'s lights, that the vessel was moving to the right. The aspects of the vessel's lights, however, would have changed as the distance between the two vessels decreased, as well as if the other vessel had altered course to the right. In fact, according to its VER information, the *Fair Princess*'s course made good did not change.

At 0135, when the *Star Princess* pilot made his course adjustment to 153°T, he moderated the course change he would have preferred to take to avoid Poundstone Rock because the *Fair Princess* was in the channel. In essence, he decided to pilot closer than he would have liked to Poundstone Rock because the *Fair Princess* was nearby. Had he discussed these circumstances by radio with the *Fair Princess*, he could have piloted a course further off Poundstone Rock without alarming the *Fair Princess*.

The *Star Princess* pilot had less room north of Poundstone Rock than the *Fair Princess* pilot had between Aaron Island and Poundstone Rock, so the *Star Princess* pilot should have initiated radio communication. Had he done so, he could have requested that the *Fair Princess* reduce speed or change course to allow the *Star Princess* to make adjustments to provide for greater clearance when passing Poundstone Rock.

The *Star Princess* pilot made navigation decisions on the basis of unconfirmed assumptions about the *Fair Princess*'s intentions and modified his preferred course because the *Fair Princess* was in the Favorite Channel. The Safety Board concludes that before the pilot tried to pass Poundstone Rock buoy, he should have established communication with the pilot of the *Fair Princess*.

Medical Factors

Fatigue. -- The Safety Board examined the possibility that fatigue, associated with previously undiagnosed OSA, might have impaired the pilot's ability to safely navigate the *Star Princess* on the morning of the grounding. It was medically determined after the accident that the pilot suffered from OSA, a sleeping disorder. OSA can cause an individual to awaken repeatedly throughout a sleep period, often without being aware of having done so. This situation may have prevented the pilot's

obtaining restful sleep, creating circumstances that may have caused fatigue.

The fact that the pilot suffered from a sleep disorder would likely affect any fatigue-based performance criteria. One sleep researcher found that the pilot fell asleep in an average of about 5 minutes when placed in a dark, quiet room. An individual who is not sleep deprived will, on average, require about 20 minutes to fall asleep under similar circumstances. Thus the less time a person needs to fall asleep from the 20-minute average, the more the individual is sleep deprived and in need of rest. In the case of the pilot, during postaccident testing sessions he fell asleep in about one-quarter the time required for rested individuals. OSA is a chronic disorder that is often present for years or decades prior to diagnosis. Since daytime sleepiness is almost uniformly present in patients who suffer from OSA, chronic fatigue is one of the hallmarks of the disorder. Therefore, the Safety Board concludes that the pilot was chronically fatigued as a result of OSA.

The pilot claimed that because he was unsure of what course the *Fair Princess* would take, he paid careful attention to the vessel. If such was the case, the pilot could have concentrated on the *Fair Princess* to the exclusion of maintaining a safe distance from Poundstone Rock. Focus on a particular stimulus to the exclusion of other critical data can be one effect of fatigue on performance.

The pilot also stated that when he first felt the ship shudder upon grounding, he was not immediately sure as to the nature of the problem. Only when he moved to the starboard bridge wing and observed the buoy traveling down that side of the vessel did the pilot realize that he had struck Poundstone Rock. Not only should the pilot have been aware of the location of the buoy from transiting the area on previous occasions, he had for several miles been observing the buoy marking the rock. Under normal conditions, such an experienced pilot should have immediately deduced that he had not safely passed Poundstone Rock when he felt the vessel shudder. A fatigued pilot, however, might not be sufficiently alert to realize that he had grounded.

Because the available data suggest that the pilot's performance was degraded consistent with the effects of fatigue, the Safety Board concludes that fatigue may have reduced the pilot's ability to appropriately assess and respond to the developing situation. Given the detrimental effect that fatigue may have had on the pilot's performance in this accident, the Safety Board believes that the Coast Guard, State pilot commissions, and pilot associations should advise pilots about the effect of fatigue on performance and about sleeping disorders such as sleep apnea.

Effexor. -- The Safety Board also evaluated the pilot's use of Effexor in the context of his performance on the accident morning. Besides the postaccident statements made by the pilot about his Effexor use, the Safety Board obtained and reviewed medical opinions concerning the pilot's use of this medication and what effect, if any, it may have had on his performance.

The pilot himself stated that while the medication tended to cause some minor physical side effects, these did not affect his ability to pilot the vessel. The physicians consulted by the Safety Board were in agreement that Effexor would have had no effect on the pilot's behavior. Their consensus was that the pilot was not impaired by his medication at the time of the accident, particularly given the low dosage of Effexor he was taking. Based on the unanimity of the professional opinions of all physicians consulted, the Safety Board concludes that the pilot's use of an antidepressant (Effexor) probably did not affect his performance.

While concluding that the pilot's use of medication was not causal or contributory to this accident, the Safety Board remains concerned about the possible effects of medication on pilot performance. The ABMP was not aware that the pilot had been regularly taking the prescription medication Effexor, nor was the pilot required to provide this information to the agency. The pilot first provided the information during testimony following this accident.

Use of medication by operators in the transportation industry has been an issue in previous accidents the Safety Board has investigated. For instance, after its investigation into the collision of the towboat *Mauvilla* and

its tow with a railroad bridge,[56] the Safety Board recommended to the U.S. Department of Transportation (DOT) that it should:

> I-94-5
>
> Require the modal operating administrations to develop and disseminate bulletins, notices, circulars, and other documents that call attention to the need for an employee reporting procedure concerning use of medication (over-the-counter and prescription) while on duty and that urge the transportation industry to develop and implement informational and educational programs related to this subject.

The DOT developed a statement for use by all operating administrations concerning the potential threat to public safety posed by the on-duty use of some over-the-counter and prescription medications by persons performing safety-sensitive duties, strongly urged employers to include appropriate information to address this issue in their employee training materials, and encouraged employers to reiterate to their employees the need to report use of such medications when required by applicable DOT rules or company policies. The DOT circulated this statement to all departmental drug and alcohol program managers, asking that it be made available throughout the regulated industries. Because these efforts satisfied the intent of the recommendation, on October 26, 1995, the Safety Board classified Safety Recommendation I-94-5 "Closed--Acceptable Action."

During the *Star Princess* accident investigation, Safety Board representatives found that, in the marine transportation mode, the issue of medication reporting may not be as familiar with industry members as it could be. For instance, the pilot in this accident did not consider it necessary to inform his professional association or the cruise line that hired him of his use of the antidepressant Effexor. In particular, as marine pilots are individual contractors rather than employees of firms that may have medication reporting requirements, it would be helpful for them to be made aware of the possible effects that medications could have on their work performance and of the safety benefits provided by medication reporting policies.

Federal pilot licensing procedures require that pilots annually pass a physical examination that addresses vision, color sense, and general physical condition. The *Merchant Marine Personnel Physical Examination Report* (as revised in March 1995), used to conduct the examination, directs the examining physician to report what medications the pilot is taking. (The pilot who was on duty during the *Star Princess* grounding had last renewed his Federal license on January 9, 1995.)

At the State level, the medication reporting situation is less clear. The Alaska State medical certification procedure for pilot licensing does not specifically require a pilot to declare whether he or she is taking medications. Other States' pilot licensing organizations also do not appear to require pilots to make full disclosure regarding medications they may be taking. Many medications have effects that could negatively affect the performance of persons with safety-sensitive responsibilities. The Safety Board has previously discussed the need for transportation employers to be aware that employees are taking medication so that employers can determine the potential effects of the medication on the employee's fitness for duty.[57] While pilots are not "employees" but self-employed individual contractors, they nevertheless have safety responsibilities in marine transportation of valid concern to licensing authorities.

The Safety Board believes that the State pilot commissions and the Coast Guard,[58]

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[56]See Railroad/Marine Accident Report -- *Derailment of Amtrak Train No. 2 on the CSXT Big Bayou Canot Bridge near Mobile, Alabama, September 22, 1993* (NTSB/RAR-94/01).

[57]See, for example, Marine Accident Report--*Grounding of the Panamanian Flag Passenger Carferry* M/V A. Regina, *Mona Island, Puerto Rico, February 15, 1985* (NTSB/MAR-86/02) and Railroad Accident Report -- *Derailment of Amtrak Train 87, Silver Meteor, Palatka, Florida, December 17, 1991* (NTSB/RAR-93/02/SUM).

[58]The Coast Guard issues Federal pilot licenses. U.S. vessels over 1,600 gross tons engaged in domestic trade must be under the direction of a Federally licensed pilot in certain domestic waters. Individual States require State-licensed pilots for vessels in transit from foreign ports.

in consultation with experts in occupational health, should review their medical standards, guidelines, and examination forms to ensure that they require the disclosure and appropriate evaluation of the history or presence of any medical conditions, symptoms, or medication use that would affect an individual's fitness to pilot a vessel.

Pilot Oversight

The ABMP exercises remedial pilot oversight. The oversight focuses on retraining those pilots who cause serious accidents, thus showing themselves to be negligent or incompetent. Focusing on pilots after they cause accidents is the traditional approach, which many States take, to maintaining high-quality pilotage services. The approach can be very effective in weeding out pilots who perform poorly, but it has a major shortcoming — the oversight authority must wait until a pilot has had one or more serious accidents before it takes action.

The Safety Board considers that oversight would be more effective before an accident takes place. If pilots are under such observation, deficiencies in their performance can be corrected before they cause a serious accident. Oversight is particularly necessary for pilots operating passenger cruises in Alaska. In the past 10 years, passenger carriage in Alaskan waters has expanded rapidly. Considering the unforgiving nature of the Alaskan marine environment, with its deep, cold waters and rocky shores, and the remoteness of the areas of operation, an accident caused by the poor performance of a pilot cannot be tolerated. Too many lives are at risk.

The Safety Board concludes that pilot performance would be improved if the ABMP had a mechanism for obtaining feedback on pilot performance. The Safety Board further concludes that, considering the accident history and medical condition of the *Star Princess* pilot, the ABMP did not oversee his performance adequately. Therefore, the Safety Board believes that the ABMP should develop and implement a mechanism for monitoring the performance of pilots on a routine basis.

BRM

Investigators found that the *Star Princess* pilot typically navigated the vessel without involving the ship's watch officers in navigation tasks or informing them of his piloting intentions. Watch officers stated that the pilot did not look at the ship's established trackline as drawn on their chart, and that he did not inform the watch officers of his own intended tracklines. The pilot transferred the conn without involving the navigational watch, thereby not communicating to the watch officers the information he considered important for the ship's safe navigation. For their part, neither of the watch officers took the initiative to seek such information or to communicate with the pilot regarding navigation issues.

Although the second officer was responsible for the ship's safety during this watch, he did not effectively monitor the pilot's passage. He did not question the pilot's decisions, even when he knew the pilot was not following the vessel's established trackline. Had he discussed the tracklines with the pilot, the pilot might have been more alert to the grounding danger.

The available information indicates that the second officer and third officer left all navigational decisions to the pilot, as they considered him to be responsible for navigation. While they plotted position fixes according to standing policy, the watch officers did not use the fixes to project the *Star Princess*'s course based on time or distance. In the half hour before the grounding, the watch officers took two fixes (at 0114 and 0130) but did not make any effort to project the ship's future track from these fixes. Had they done so, they should have perceived that the pilot's course would bring them precariously close to Poundstone Rock. The Safety Board concludes that had the watch officers monitored the pilot's navigation, projected the course ahead from their fixes, and communicated this information to the pilot, he would have had time to take action to avoid grounding.

The pilot and the watchstanders conducted their parts of the watch almost independently of each other. Moreover, neither the pilot nor the watchstanders used the equipment available to them to properly monitor the progress of the

Star Princess. The Safety Board concludes that effective management of resources and coordination of duties were not practiced on the *Star Princess* at the time of, or immediately before, the accident.

The *Star Princess* master and bridge watch officers had not received BRM training before the accident. The Safety Board has advocated BRM training for all bridge watch officers as well as pilots. The Safety Board notes that the PCL is working to provide BRM training for all its bridge watch officers. The American Pilots' Association has supported the Safety Board position on BRM training and has advocated BRM training to its members. The Safety Board is encouraged by the emphasis that both the PCL and the American Pilots' Association are placing on BRM training for bridge watch officers and pilots.

On June 25, 1993, as a result of the investigation of the grounding of the United Kingdom passenger vessel RMS *Queen Elizabeth 2* near Cuttyhunk Island, Vineyard Sound, Massachusetts, on August 7, 1992,[59] the Safety Board issued Safety Recommendation M-93-34 to the State pilot commissions, including the ABMP. Safety Recommendation M-93-34 asked that each pilot commission:

> Require pilots, upon boarding a vessel, to conduct a conference with the master and other relevant deck officers that includes a discussion of the pilot's proposed route, including courses, speeds, squat, and unique maneuvers that may be encountered.

By a letter dated July 15, 1993, the ABMP informed the Safety Board that Safety Recommendation M-93-34 had been forwarded to each of Alaska's six pilot associations. In part, the letter stated that:

> The problem of pilot/master communications has been addressed informally during several conversations to which I've [Alaska Marine Pilot Coordinator] been party, and I appreciate the problems which are inherent to faulty or incomplete communications. A recommendation has been included in the report on page 2 for State Pilot Commissions (Boards) to act upon.
>
> I will include this item in the September Board meeting agenda, however, I solicit your inputs in advance before public discussion to include in the package for the Board members. I believe there is validity in the recommendation and look forward to receiving your comments....

On August 16, 1993, the Safety Board wrote that:

> The Safety Board is pleased that this recommendation will be addressed at the September pilot board meeting and that copies of the recommendation have been forwarded to the Alaska pilot associations soliciting their comments for this meeting. Safety Recommendation M-93-34 will be classified "Open--Acceptable Response" pending notification on the action taken to implement this recommendation. We have also enclosed a draft copy of a paper developed by the Society of Naval Architects and Marine Engineers, Marine Safety Panel, that addresses the intent of M-93-34 and recommend that you pass it along to your constituency.

The State of Alaska has since amended its State regulations to require all new applicants for State pilot licenses to complete BRM training and all renewal applicants for State pilot licenses to have taken refresher BRM training within the previous 6 years. According to the Alaska Marine Pilot Coordinator, Alaska pilot licenses are valid for 2 years, expiring at the end of each even-numbered year. Therefore, as of January 1, 1997, all original and renewal applicants for Alaska pilot licenses are required to have taken BRM training. Accordingly, the Safety Board is classifying Safety Recommendation M-93-34 "Closed--Acceptable Action" for the State of Alaska. (The new Alaskan pilot regulations were not in effect at

[59] Marine Accident Report – *Grounding of the United Kingdom Passenger Vessel* RMS Queen Elizabeth 2 *near Cuttyhunk Island, Vineyard Sound, Massachusetts, August 7, 1992* (NTSB/MAR-93/01).

the time the pilots on the *Star Princess* last renewed their State pilot licenses.)

The Safety Board considers that in Alaska, given the relatively long periods pilots spend on cruise vessels, pilots and bridge watch officers would particularly benefit from attending BRM training together. In the southeast Alaska cruise industry, pilots typically serve aboard cruise vessels for 3 to 12 days. Under such circumstances, watch officers can become used to, and rely too strongly on, the presence of a pilot on the vessel. The watch officers on duty during the *Star Princess* grounding were convinced that the pilot had the situation under control in part because they were used to relying on this pilot and his expertise. They chose not to interfere with his decisions or actions — even though they knew the vessel was approaching dangerously near to Poundstone Rock — because they had full confidence in the pilot's abilities.

Providing BRM training would give pilots and bridge watch personnel the opportunity to interact with each other in a nonconfrontational and safe environment. Joint training could also provide pilots and bridge watch members with greater understanding concerning the problems faced in carrying out their respective responsibilities. According to the director[60] of a major BRM training center:

- Training attended jointly by pilots and deck officers is more realistic in that the roles during simulations are played by the actual parties.
- Training attended jointly by pilots and deck officers has the advantage of improving communication between the two professions, as they can sharpen communication skills with coaching in an instructional setting rather than within the pressures of the work setting. It should be noted that communication skills tend to be at their optimum at the end of the training period and are expected to decline to some extent when the parties return to their normal work routines. Hence, recurrent training is expected and needed.
- Joint training provides an opportunity for deck officers and pilots to become personally acquainted and to learn how the other reacts during simulated portrayals of critical incidents. In addition, they can learn about the other's corporate cultures and company or organizational procedures.

The mutual understanding developed through joint BRM training would contribute to more efficient use of equipment and better coordination of activities, which would result in enhanced safety. The Safety Board concludes that to learn how to work effectively as teams, pilots and watch officers in Alaska should take BRM training together.

The Safety Board understands that the scheduling of such joint training is difficult. The results, however, would be well worth the time and effort. Training that provides opportunity for interaction between pilots and watch officers could make both pilots and watch officers comfortable with a more supportive model of bridge watch operations. Pilots would learn to view monitoring by watch officers as a useful tool rather than a challenge, and watch officers would learn to contribute to the pilot's effectiveness. The Safety Board believes that the PCL should coordinate with the Alaska pilot associations to arrange BRM training between its bridge watch officers and Alaska pilots.

The Safety Board further believes that the International Council of Cruise Lines, the American Pilots' Association, the Southeastern Alaska Pilots Association, and the Alaska Coastwise Pilot Association should advise their members about the *Star Princess* accident and encourage those members that operate vessels or navigate on vessels in the Alaska cruise trade to participate in BRM training, including such training that involves both bridge watch officers and pilots.

Further, given the special nature of Alaskan cruise operations and the fact that pilots in southeast Alaska tend to spend more time on cruise vessels than is common in many other regions, the Safety Board believes that the

[60]Information obtained during a March 19, 1997, telephone conversation with Harry J. Crooks, Director, RTM STAR Center, Toledo, Ohio.

ABMP should encourage or require pilots of passenger vessels operating in southeast Alaska to take BRM training with bridge watch officers.

Survival Factors

About 1 minute after the *Star Princess* grounded, the pilot radioed the Coast Guard to advise it of the accident. The master and crew immediately began to check the vessel for damage and flooding and, although four tanks were flooding and hydraulic oil had leaked from the starboard shaft lubrication system, the ship was determined to be stable. As a precaution, lifeboats were readied to be lowered. The master also questioned the off-watch pilot about where the vessel might be beached, if necessary.

At 0155 the master notified the crew of the grounding and told crewmembers to advise those passengers who were awake of the accident. He did not wake the sleeping passengers to tell them that there had been a grounding, that the situation was under control, or that they would be kept informed. He did not direct any passengers to go to their muster stations. The master said that he thought waking the passengers would have upset them unnecessarily.

On the other hand, the master also clearly considered the situation serious enough to call for the readying of lifeboats, and he explored the possibility of beaching the damaged vessel. The Coast Guard, too, had been alerted. The alternative not taken by the master — notifying all passengers shortly after the grounding — would have allowed them time to prepare for a possible evacuation, rather than being awakened suddenly when and if the vessel became endangered.

The damage assessment by divers was not made until between 0437 and 0655. An announcement to all passengers informing them of the situation was not made until 0918. Had the initial damage assessment in this instance been incorrect and the vessel been more seriously damaged, the passengers and crew could have been exposed to undue risk. Given that 2,207 passengers and crewmembers were on the ship, the delay before a thorough damage assessment was made consumed valuable time that might have been needed to muster everyone at lifeboat stations had the ship been in danger and a rapid evacuation necessary. The Safety Board concludes that the master did not give the passengers timely notification about the situation; had the passengers needed to evacuate, they would not have been prepared.

The Safety Board considers that passengers and crew should receive timely public announcements concerning emergency situations that may require evacuation of the vessel. Timely notification allows passengers and crew to effectively manage an evacuation, if necessary, and avoids confusion and panic. Therefore, the Safety Board believes that the PCL should require its masters to notify both passengers and crew immediately of emergency situations that have been assessed as having the potential to require evacuation of the vessel. The Safety Board further believes that the International Council of Cruise Lines should encourage its members to ensure that masters provide immediate notification to passengers and crew of emergency situations that have been assessed as having the potential to require evacuation of the vessel. Likewise, the Safety Board believes that the Coast Guard should advise passenger vessel operators of the need for masters to provide immediate notification to passengers and crew of emergency situations that have been assessed as having the potential to require evacuation of the vessel.

CONCLUSIONS

Findings

1. Neither weather nor equipment failure caused the grounding of the *Star Princess*, neither the pilot nor the navigating crewmembers were impaired by alcohol or illegal drugs, and the helmsman steered courses as ordered by the pilot.
2. The pilot's decision to stay essentially on his existing course ultimately resulted in the grounding of the vessel.
3. The 2° course change ordered by the pilot 7 minutes before the accident was not sufficient to allow the *Star Princess* to clear Poundstone Rock or to indicate his intentions to the pilot of the *Fair Princess*.
4. The pilot should have been alert to the current and taken appropriate actions in response to it.
5. The pilot's limited use of the radar hampered his ability to evaluate the navigation situation accurately.
6. Although it was not totally dark in the period before the accident, the pilot's sense of distance to the Poundstone Rock buoy would have been inaccurate due to the level of illumination.
7. By relying on visual reference to a floating aid, the pilot did not follow sound navigation practices.
8. Before the pilot of the *Star Princess* tried to pass Poundstone Rock buoy, he should have established communication with the pilot of the *Fair Princess*.
9. The pilot was chronically fatigued as a result of obstructive sleep apnea.
10. Fatigue may have reduced the pilot's ability to appropriately assess and respond to the developing situation.
11. The pilot's use of an antidepressant (Effexor) probably did not affect his performance.
12. Pilot performance would be improved if the Alaska Board of Marine Pilots had a mechanism for obtaining feedback on pilot performance.
13. Considering the accident history and medical condition of the *Star Princess* pilot, the Alaska Board of Marine Pilots did not oversee his performance adequately.
14. Had the watch officers monitored the pilot's navigation, projected the course ahead from their fixes, and communicated this information to the pilot, he would have had time to take action to avoid grounding.
15. Effective management of resources and coordination of duties were not practiced on the *Star Princess* at the time of, or immediately before, the accident.
16. To learn how to work effectively as teams, pilots and watch officers in Alaska should take bridge resource management training together.
17. The master did not give the passengers timely notification about the situation; had the passengers needed to evacuate, they would not have been prepared to do so.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the grounding of the *Star Princess* was the pilot's poor performance, which may have been exacerbated by chronic fatigue caused by sleep apnea. Contributing to the accident was the fact that the pilot and the watch officers did not practice bridge resource management.

RECOMMENDATIONS

-- to the U.S. Coast Guard:

Advise pilots about the effect of fatigue on performance and about sleeping disorders such as sleep apnea. (M-97-41)

Review, in consultation with experts in occupational health, your medical standards, guidelines, and examination forms to ensure that they require the disclosure and appropriate evaluation of the history or presence of any medical conditions, symptoms, or medication use that would affect an individual's fitness to pilot a vessel. (M-97-42)

Advise passenger vessel operators of the need for masters to provide immediate notification to passengers and crew of emergency situations that have been assessed as having the potential to require evacuation of the vessel. (M-97-43)

-- to the State pilot commissions:

Advise pilots about the effect of fatigue on performance and about sleeping disorders such as sleep apnea. (M-97-44)

Review, in consultation with experts in occupational health, your medical standards, guidelines, and examination forms to ensure that they require the disclosure and appropriate evaluation of the history or presence of any medical conditions, symptoms, or medication use that would affect an individual's fitness to pilot a vessel. (M-97-45)

-- to the Alaska Board of Marine Pilots:

Develop and implement a mechanism for monitoring the performance of pilots on a routine basis. (M-97-46)

Encourage or require pilots of passenger vessels operating in southeast Alaska to take bridge resource management training with bridge watch officers. (M-97-47)

-- to the Southeastern Alaska Pilots Association:

Advise your members about the *Star Princess* accident and encourage those members that navigate on vessels in the Alaska cruise trade to participate in bridge resource management training, including such training with bridge watch officers. (M-97-48)

-- to the Alaska Coastwise Pilot Association:

Advise pilots about the effect of fatigue on performance and about sleeping disorders such as sleep apnea. (M-97-49)

Advise your members about the *Star Princess* accident and encourage those members that navigate on vessels in the Alaska cruise trade to participate in bridge resource management training, including such training with bridge watch officers. (M-97-50)

-- to the San Diego Bay Pilots Association, Inc.:

Advise pilots about the effect of fatigue on performance and about sleeping disorders such as sleep apnea. (M-97-51)

-- to Princess Cruise Lines:

Coordinate with the Alaska pilot associations to arrange bridge resource management training between your bridge watch officers and Alaska pilots. (M-97-52)

Require your masters to notify passengers and crew immediately of

emergency situations that have been assessed as having the potential to require evacuation of the vessel. (M-97-53)

-- to the American Pilots' Association:

Advise your members about the effect of fatigue on performance and about sleeping disorders such as sleep apnea. (M-97-54)

Advise your members about the *Star Princess* accident and encourage those members that navigate on vessels in the Alaska cruise trade to participate in bridge resource management training, including such training with bridge watch officers. (M-97-55)

-- to the International Council of Cruise Lines:

Advise your members about the *Star Princess* accident and encourage those members that operate vessels in the Alaska cruise trade to participate in bridge resource management training, including such training that involves both bridge watch officers and pilots. (M-97-56)

Encourage your members to ensure that masters provide immediate notification to passengers and crew of emergency situations that have been assessed as having the potential to require evacuation of the vessel. (M-97-57)

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, JR.
Member

June 20, 1997

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APPENDIX A

Safety Board Investigation

Investigation

The U.S. Coast Guard notified the National Transportation Safety Board of this accident on June 23, 1995. Three investigators from the Safety Board's Washington, D.C., headquarters were dispatched to Juneau, Alaska, and began their investigation on June 24, 1995. The Safety Board invited the American Pilots' Association, Princess Cruise Lines, the U.S. Coast Guard, and the Liberian Office of the Deputy Commissioner of Maritime Affairs to assist in the investigation. All these organizations sent representatives to Juneau, and all were parties to the investigation.

The Safety Board investigated this accident independently, under authority of Section 304(a)(1)(F) 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 made by the Safety Board. The Safety Board 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.

Testimony

Sworn testimony regarding this accident was taken on June 26 and 27, 1995, in Juneau, Alaska, on June 29, 1995, in Seattle, Washington, and on July 2, 1995, in Portland, Oregon.

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APPENDIX B

Pilot and Crew Information

Pilot Nerup

Captain Robert K. Nerup, age 57, began his maritime career in 1956 as an enlistedman in the U.S. Navy. He was accepted to the U.S. Naval Academy, from which he graduated in 1962. He served 20 years of active duty and spent approximately 15 years of his active service at sea. Before his 1980 retirement, he had been the commanding officer aboard a U.S. Navy fleet tugboat. Upon retirement from the Navy, he became a marine pilot in Alaska.

At the time of the grounding, Pilot Nerup held a U.S. Coast Guard (USCG) 1,600 ton master's license for inland waters endorsed with Federal first class pilotage for southeast Alaska, including Lynn Canal and the grounding area. Pilot Nerup's USCG license had last been renewed on January 9, 1995. He also held a State of Alaska marine pilot's license applicable to Lynn Canal and the area of the grounding. Pilot Nerup was originally issued a State pilot's license on December 9, 1980. It had most recently been renewed in December 1994. (State law requires that licenses expire in even-numbered years and be valid for 2 years.)

Pilot Nerup was a member of the Southeast Alaska Pilots Association (SEAPA) and was not operating under authority of his Federal license at the time of the accident. Pilot Nerup did not serve as an Alaska marine pilot year-round; he worked only during the summer cruise season.

Since 1987, Pilot Nerup had been piloting vessels on four occasions (including this accident) when marine casualties occurred. In 1987, Pilot Nerup was involved in two casualties (a collision with a log raft and a vessel grounding) in Hobart Bay, Alaska. Because of these accidents, he was not allowed to pilot vessels in Alaska for a total of 18 months; placed on probation for 2 years; and required to meet proficiency requirements before piloting any vessel in Hobart Bay. In 1991, Pilot Nerup was piloting the cruise vessel *Island Princess* when it collided with the *Regent Sea* while maneuvering into the dock in Skagway Harbor. Because of this accident, the State suspended Pilot Nerup's license for 6 months. He was also required to complete a 1-day radar course and a 2-week course on advanced shiphandling and navigation (including navigation management), pass a Coast Guard examination on "rules of the road," and remain on probation for 1 year. Pilot Nerup fulfilled the terms of the settlement and returned to piloting in southeast Alaska in late spring 1993.

During his testimony, Pilot Nerup estimated that he had made 300 to 400 trips through the Lynn Canal. He had served as pilot aboard the *Star Princess* on approximately 10 previous trips. At the time of the grounding, Pilot Nerup had been aboard the *Star Princess* for 2 days and had been the pilot in command on 2 prior shifts, alternating with Pilot Kutz. Of the two, Pilot Nerup was the senior pilot aboard the *Star Princess*.

Pilot Nerup had been suffering from depression for the last 8 years. His treatment had included the prescription of antidepressant drugs; for the last 3 years, he has been taking the antidepressant Effexor, as prescribed. Before the accident, Pilot Nerup last took Effexor at approximately 1800 on June 22, 1995.

Pilot Kutz

Captain Ronald J. Kutz, age 67, began his maritime career in the 1940s on tugboats and then served for 11 years on Washington State ferries, ultimately achieving the position of relief master. In 1963, he became a master on an Alaska Marine Highway vessel. He retired from the Alaska Marine Highway System in 1987. During his employment with the State of Alaska, he also worked as a marine pilot. Following his retirement from State service in 1987, he served as a pilot on an as-needed basis with SEAPA.

Pilot Kutz held a USCG unlimited inland master's license, which had last been renewed on November 18, 1993, for 5 years. This license

was endorsed with Federal first class pilotage for southeast Alaska, including Lynn Canal and the grounding area.

Pilot Kutz also held an Alaska State pilot's license for southeast Alaska, including Lynn Canal and the area of the grounding. He was issued his initial Alaska State marine pilot's license in January 1970. His State license was last renewed in January 1995. Pilot Kutz completed a training course in Bridge Resource Management and Emergency Shiphandling for Pilots on December 2, 1994, in Seattle, Washington.

Before the accident voyage, Pilot Kutz had been aboard the *Star Princess* once before, about 4 years earlier. He joined the vessel on June 14, 1995, at the Point McCartey Pilot Station, about 15 miles south of Ketchikan, Alaska, while the vessel was northbound from Vancouver. He began splitting shifts with Pilot Nerup, who joined the vessel on June 21, 1995, near the southern end of Glacier Bay.

At the time of the grounding, Pilot Kutz was not on duty and was in his cabin resting. He returned to the bridge to assist immediately after the grounding.

Master

Captain Emanuele Chiesa, age 54, is a graduate of the Nautical Institute of La Spezia, Italy. He served in the Italian Navy for 3 years and then went into the merchant marine. He has served aboard vessels in various capacities since approximately 1964. Captain Chiesa possessed an Italian unlimited master's license issued January 11, 1971, and a Liberian unlimited master's license issued March 7, 1994. (It expires March 7, 1999.) At the time of the grounding, Captain Chiesa was asleep in his cabin. He went to the bridge immediately after the grounding.

Second Officer

Second Officer Gampiero Landi, age 52, had sailed on various types of vessels and in several capacities since approximately 1970. He held an Italian unlimited master's license first issued November 29, 1977, and a Liberian second mate's license issued April 17, 1991.

Second Officer Landi had been employed by Princess Cruise Lines since March 21, 1991, as a second officer aboard the *Star Princess* and the *Dawn Princess*. In all, he had worked aboard the *Star Princess* for approximately 14 months and made trips in Alaska for 3 summer seasons. Second Officer Landi had made several previous trips with Pilot Nerup and was familiar with him. The accident voyage was the first time that Second Officer Landi had worked with Pilot Kutz. Second Officer Landi had transited Lynn Canal more than 50 times before the accident voyage.

Second Officer Landi was the senior bridge officer on watch at the time of the grounding. Before the grounding, he had been working with the Third Officer to assist with Pilot Nerup's navigation of the vessel and to plot the ship's position.

Third Officer

Third Officer Vincenzo Alcaras, age 29, had served aboard several ships in various capacities since 1986. Third Officer Alcaras held an Italian license issued in November 1990 and a Liberian third mate's license issued September 17, 1992. Third Officer Alcaras had been employed by Princess Cruise Lines since November 29, 1990, and had worked aboard the *Regal Princess*, the *Crown Princess*, and the *Star Princess*, first as a cadet and later as third officer. He had worked aboard the *Star Princess* for approximately 7 months in total and had previously cruised Alaska for 1 summer season (2 years past). Third Officer Alcaras had met Pilot Nerup once before, approximately 2 years earlier. He had never met Pilot Kutz before the accident trip.

Third Officer Alcaras was on watch at the time of the grounding and had been working with Second Officer Landi to monitor Pilot Nerup's navigation and to plot the ship's position on the chart.

Helmsman

Quartermaster Basri Hasan, age 47, had been sailing aboard vessels as an able seaman since 1964. He had been employed by Princess Cruise Lines since December 1991. He had worked aboard both the *Fair Princess* and the *Star Princess*. He was the helmsman on watch

at the time of the grounding and alternated each hour between helmsman and lookout duties.

Lookout

Quartermaster Hilmi Masdar, age 31, had been an able-bodied seaman for 17 years and employed by Princess Cruise Lines since May 1991. He had worked aboard both the *Fair Princess* and the *Star Princess*. He was the lookout on watch at the time of the grounding and was carrying out his duties standing on the port bridge wing.

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APPENDIX C

Pilot and Piloting Information

A pilot is a person qualified, by local, State, and/or Federal jurisdictions, by reason of familiarity with certain navigational routes, channels, and local dangers of the region concerned, to conduct or guide vessels into or out of port, along a coast or through restricted or narrow waters. A pilot is hired for his or her extensive local knowledge of the waters being navigated.

Pilots are typically considered to be self-employed, and each is an individual contractor for the ship for which he or she is providing pilotage. Nearly all pilots organize themselves into pilot associations or corporations for their area of operation. Each pilot owns a share of the association's property, which may include pilot vessels and boats, automobiles, and real estate (pilot offices and quarters). The association normally performs the following functions: dispatching pilots according to a rotation system; collecting pilotage fees earned by the pilots from the vessel owner, operator, or agent; paying association expenses; and disbursing pilot pay.

The term "piloting" refers to actions taken to determine the position and direct the movements of a vessel by reference to land and sea marks, by measurements of depth, or by radar. When piloting, the pilot should use every method available to: obtain warnings of approaching dangers; assess the ship's position accurately and frequently (by eye, by radar, and with the assistance of the deck watch); and determine the proper course of action to navigate the vessel safely.

While the pilot is piloting, the senior watch officer has the duty to intercede if the vessel is moving into danger. He should call the pilot's attention to hazards and, if the pilot takes no action, notify the master. Watch officers should constantly check on the vessel's position and ensure that the pilot's navigation orders are carried out promptly.

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APPENDIX D

Effexor

According to the 1995 edition of the *Physician's Desk Reference*, Effexor (venlafaxine hydrochloride) is a medication indicated for the treatment of depression. Clinical studies conducted on healthy individuals to examine the effects of venlafaxine on behavioral performance revealed no clinically significant impairment of psychomotor, cognitive, or complex behavior performance. The *Physician's Desk Reference* also states that since any pyschoactive drug may impair judgment, thinking, or motor skills, patients should be cautioned against operating machinery until they are reasonably certain the medication will not adversely affect their ability to engage in such activities.

The 1996 edition of the *Complete Guide to Prescription and Nonprescription Drugs* states that venlafaxine (brand name Effexor) is an antidepressant drug used to treat mental depression. It states that Effexor increases the amount of certain chemicals in the brain necessary for the transmission of messages between nerve cells. The text reports that common adverse reactions or side effects of the drug include fast heartbeat, blurred vision, increased blood pressure, stomach pain, gas, insomnia or drowsiness, dizziness, decreased sexual drive, impotence, nausea or vomiting, headache, diarrhea or constipation, dryness of mouth, skin flushing, rash, loss of appetite, unusual tiredness, weakness, strange dreams, sweating, tremors, and nervousness.

Less frequent possible adverse effects caused by Effexor include lightheadedness or faintness, mood or behavior changes, mental changes, difficulty in urinating, weight loss or gain, changes in taste, and ringing in the ears. Rare possible side effects include seizures. In the event of overdose, no symptoms may be apparent, or extreme drowsiness, convulsions, or rapid heartbeat may occur. The *Complete Guide to Prescription and Nonprescription Drugs* further states that individuals using the drug should be warned not to drive or pilot an aircraft until it is known how Effexor affects them.

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APPENDIX E

PCL Fleet Regulations, NAV. 7.2 -- Pilotage

FLEET REGULATIONS

DECK STANDING ORDERS	NAVIGATION

NAV.7.2 PILOTAGE AND THE PILOT INFORMATION CARD

1. **THE PILOT**

1.1 Pilots make a vital contribution to the safety of navigation in confined waters and port approaches, of which they have up-to-date knowledge; but it must be stressed that when the ship is in pilotage charge, the Captain or Officer of the Watch is not to consider himself relieved from responsibility for the safety of the ship; he must continue to pay full attention to the navigation and safe handling of the ship. Responsibility for the ship's navigation is not transfered to the pilot and the officer of the watch retains all his duties.

1.2 After his arrival on board, the pilot will be advised by the Captain of the manoeuvring characteristics and basic details of the vessel for its present condition of loading using a pilot card. This card will be completed as directed by the Captain. The pilot must be advised of the status of all bridge navigational equipment and of any restrictions or limitations on the ship's ability to manoeuvre. The pilot will advise the Captain regarding the local conditions and his navigational intentions. This information is to be in a form to enable the Captain and officer of the watch to monitor the planned passage. The Captain must ensure that the plan is safe and the expertise of the pilot is fully supported by the ship's bridge personnel.

1.3 The officer of the watch must co-operate closely with the pilot, assist him where possible and maintain an accurate check on the ship's position and movements. If the officer of the watch becomes unsure of the pilot's actions or intentions, he must immediately seek clarification and, if still in doubt, inform the Captain immediately in situations of sudden and immediate danger.

1.4 When a ship is being swung in pilotage waters the position must be monitored throughout the swing by radar ranges and/or clearing bearings or angles.

1.5 Except whilst the ship is in transit of the Panama Canal, the Captain or Officer of the Watch is to intervene, or even take over from the Pilot, if he considers this to be necessary, in order to avoid or extricate the ship from danger.

1.6 In the event of an accident occurring to a vessel whilst the Pilot is on board, no certificate of exoneration referring to such mishap is to be given to him by the Captain under any circumstances. Pilots are not to assist in the navigation of the ship in a district for which they are not licensed.

1.7 See Deck Standing Order LEG.7.1 with regard to the Panama Canal.

2. **PILOT INFORMATION CARD**

2.1 A standard Pilot Information Card is to be used on all the ships. A copy is appended to this standing order. The content is developed from the information required in the International Chamber of shipping "Bridge Procedure Guide" and the relevant "M" notice.

2.2 The manoeuvring information recorded on board is to be made available by means of a notice in the wheelhouse.

2.3 Where equipment is not aboard the ship indicate N/A.

2.4 The dimensional diagram is to be completed aboard the ship.

2.5 **The Pilot Information Card is to be given to the pilot on his arrival on the bridge and prior to him commencing pilotage.**

FLEET REGULATIONS

DECK STANDING ORDERS	NAVIGATION

PRINCESS CRUISES PILOT INFORMATION CARD P&O CRUISES (UK)

Date		Ship's Name	
Ship's Callsign		Displacement	
N.R.T.		G.R.T.	
Draught f'rd		Draught aft	
Length overall		Breadth	

Bulbous bow	Yes/No		
Type of engines:		KW (max)	
Power of: bow thruster(s)		KW (max)	
stern thruster(s)		KW (max)	
		rpm/pitch	knots
Manoeuvring speeds	Full Ahead		
TIME FROM SEA SPEED TO MANOEUVRING SPEED: .....SECONDS	Half Ahead		
	Slow Ahead		
	Dead Slow Ahead		
TIME FROM MANOEUVRING SPEED TO STOPPING THE FR'D PROPULSION & REVERSING THE PITCH /ENGINES: .....SECONDS	Dead Slow Astern		
	Slow Astern		
	Half Astern		
	Full Astern		

Full ahead to full astern			Seconds
Maximum No. of consec starts			
Astern power as % of ahead			
Minimum rpm			knots
Rudder angle for neutral effect			
Number of rudders		Type	
Maximum rudder angle			Degrees
Hard over to hard over			Seconds
Number of propellers		Type	

This ship is fitted with voyage event recording equipment.

FLEET REGULATIONS

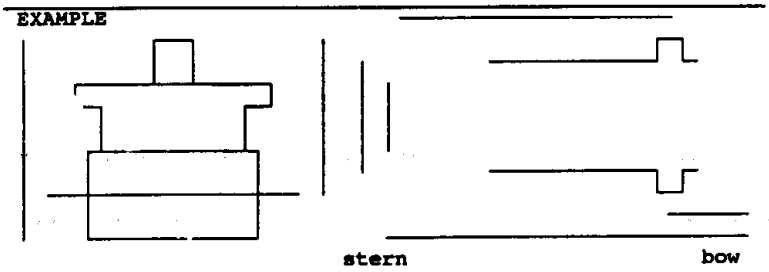
DECK STANDING ORDERS — NAVIGATION

The following have been checked and are ready:

Anchors	Bow				Stern							
Anchor chain lengths	port				stbd				stern			
Whistles												
Radars	1		2		3		4					
A.R.P.A.												
Speed log	Doppler		Water Track				Ground track					
Engine telegraphs												
Steering gear			units operating									
Indicators:	Rpm/Pitch				Rudder							
	Rate of Turn											
Gyro system and rptrs			Gyro error									
V.H.F.	1.				2.							
All electronic fixing aids:	Satellite Navigator											
	G.P.S.											
	Decca											
	Loran											
	Omega											

Turning circle and manoeuvring characteristic diagrams are displayed in the following locations:

EXAMPLE



APPENDIX F

Voyage Event Recorder Information

For more than 20 years, the Safety Board has recommended the use of voyage event recorders (VERs) for accident reconstruction. As a result of the investigation of the SS C.V. *Sea Witch* - SS *Esso Brussels* collision and fire in New York Harbor on June 2, 1973,[1] the Safety Board recommended that the Coast Guard:

M-76-008

Require the installation of an automatic recording device to preserve vital navigational information aboard oceangoing tankships and containerships.

Following the investigation of the U.S. tankship SS *Marine Floridian* collision with the Benjamin Harrison Memorial Bridge in 1977,[2] the Safety Board recommended that the Coast Guard:

M-78-002

Conduct a formal study in coordination with the Federal Maritime Administration and the shipping industry to determine a standard array of operational and audio data that should be recorded automatically with a view to establishing a requirement for the installation and operation of suitable equipment in U.S. vessels over 1,600 gross tons built after 1965, and to submitting an initiative to the Intergovernmental Maritime Consultative Organization (IMCO)[3] for the adoption of a similar international requirement.

As a result of a Safety Board special study (*Major Marine Collisions and Effects of Preventive Recommendations*, MSS-81-1), the Board recommended that the Coast Guard:

M-81-084

Expedite the study to require the installation of automatic recording devices to preserve vital navigational information aboard applicable ships.

The status of all three recommendations cited above is "Closed—Unacceptable Action." The most recent response (May 21, 1982) from the Coast Guard concerning these safety recommendations stated:

> The Coast Guard generally supports the concept of shipboard voyage recorders as an aid in casualty analysis. Recently, the U.S. Maritime Administration canceled their voyage recorder project and IMCO removed voyage recorders from their work schedule. In view of this and the severe funding limitations within the Department of Transportation, the Coast Guard does not plan to actively pursue a voyage recorder project at this time.

As a result of its investigation of the collision between the Netherlands Antilles passenger ship *Noordam* and the Maltese bulk carrier *Mount Ymitos* in 1993,[4] the Safety Board made the following safety recommendations to the Coast Guard:

M-95-5

Require all vessels over 1,600 gross tons operating in U.S. waters to be equipped with voyage event recorders.

[1] Marine Accident Report – SS C.V. Sea Witch - SS Esso Brussels *Collision and Fire, New York Harbor, June 2, 1973* (NTSB/MAR-75/06).

[2] Marine Accident Report – *U.S. Tankship* SS Marine Floridian *Collision with Benjamin Harrison Memorial Bridge, Hopewell, Virginia, February 24, 1977* (NTSB/MAR-78/01).

[3] Now known as the International Maritime Organization (IMO).

[4] Marine Accident Report – *Collision of the Netherlands Antilles Passenger Ship* Noordam *and the Maltese Bulk Carrier* Mount Ymitos *in the Gulf of Mexico, November 6, 1993* (NTSB/MAR-95/01)

M-95-6

Propose to the IMO that it require all vessels over 500 gross tons to be equipped with voyage event recorders.

In responding to a December 1, 1995, Coast Guard letter concerning voyage event recorders, the Safety Board wrote on February 6, 1996, that because the Coast Guard was not taking unilateral action as requested, Safety Recommendation M-95-5 had been classified "Closed—Unacceptable Action." Regarding Safety Recommendation M-95-6, the Safety Board wrote that it:

> is aware of the IMO 'panel of experts' assembled to review the stability and other related design matters of 'RoRo'[5] vessels after the sinking of the *Estonia*. Because the Coast Guard's letter does not address the recommended action that voyage event recorders be installed on all vessels over 500 gross tons, Safety Recommendation M-95-6 has been classified 'Open—Await Response.' We request that the Coast Guard inform the Safety Board of its strategic action plan for implementing this recommendation.

The Safety Board also made the following recommendation to the International Council of Cruise Lines: [6]

M-95-8

Propose to members that all passenger vessels over 1,600 gross tons operating from U.S. ports be equipped with voyage event recorders.

On December 12, 1995, responding to an International Council of Cruise Lines letter of October 18, 1995, the Safety Board wrote that it "…was pleased that the International Council of Cruise Lines generally supports the Safety Board's position on this issue and has distributed copies of the recommendations to its constituency for their information and consideration." Accordingly, Safety Recommendation M-95-8 was classified "Closed—Acceptable Action."

The Safety Board made the following recommendation to Holland America Line Westours, Inc.:

M-95-10

Review the management oversight program and implement measures to ensure that company watchstanding policies are followed on all ships.

In an August 8, 1995, letter responding to Safety Recommendation M-95-10, Holland America advised the Safety Board that, along with other management and oversight measures, it was evaluating a VER that had been installed on its passenger vessel *Statendam*. It stated that if the VER package was satisfactory, Holland America would install the system on other Holland America vessels. Because of Holland America's prompt action on this recommendation, including testing VERs for possible installation on all its vessels, Safety Recommendation M-95-10 was classified "Closed—Acceptable Action" on October 17, 1995.

[5] Roll-on roll-off vessels that are designed with large bow or stern ramps (or both) to allow trailers or cars to be driven rather than lifted on and off the vessel.

[6] The International Council of Cruise Lines is a major association of cruise ship operators that represents some 19 cruise lines. Each year, its overnight cruise vessel operators carry more than 4 million U.S. passengers on 87 ships.

APPENDIX G

International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention

The International Maritime Organization (IMO), in November 1993, adopted the *International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention* (ISM Code). The ISM Code recognizes and codifies the responsibilities of shipping company management in ensuring adherence to marine safety guidelines and environmental protection standards. The objectives of the ISM Code (Article 1.2.1) are to:

> Ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment, and to property.

A dominant theme of the ISM Code is accountability, which, according to the IMO, can no longer be limited to shipmasters and crews, but now must extend to the upper levels of company management. Compliance with the ISM Code will require that companies[1] develop and maintain a safety management system (SMS) that will:

- Provide for safe practices in ship operation and a safe working environment;
- Establish safeguards against all identified risks; and,
- Improve the safety management skills of personnel both ashore and on ships.

The SMS must include the following functional requirements:

- A safety and environmental protection policy;
- Instructions and procedures to ensure safe vessel operation and environmental protection in compliance with relevant international and domestic laws;
- Defined levels of authority and lines of communication between and among shipboard and shoreside personnel;
- Procedures for reporting accidents and nonconformities;
- Emergency preparedness and response procedures; and,
- Internal audit and management review procedures.

The ISM Code also requires that companies appoint a "designated person" (or persons) ashore with direct access to the highest level of management. The designee must have the responsibility and authority to monitor the safety and pollution aspects of each of the company's ships and to ensure that adequate resources and shore-based support are available to maintain the SMS. The ISM Code states that the company should clearly define and document the master's responsibility regarding:

- Implementing the safety and environmental protection policy of the company;
- Motivating the crew in the observation of that policy;
- Issuing appropriate orders and instructions in a clear and simple manner;
- Verifying that specified requirements (such as marine regulations, operational directives, etc.) are observed; and,
- Reviewing the SMS and reporting its deficiencies to shore-based management.

Under procedures established by the IMO, companies that demonstrate compliance with the ISM Code will be issued a Document of Compliance. Vessels owned and/or operated by these companies will be issued a Safety Management Certificate to be displayed on board the vessel. While the ISM Code was developed primarily for deep-draft ships engaged in international commerce, its provisions might be applied to all sectors of the maritime industry,

[1] "Companies" includes ship owners as well as other persons or entities that have assumed responsibility for operating a ship or ships and, by so doing, have also assumed responsibility for adhering to the ISM Code.

including inland and coastal barge and towing operations.

Compliance with the ISM Code is mandatory for companies operating large vessels in international trade. Deadlines for compliance are (1) July 1, 1998, for all passenger ships and for oil tankers, chemical tankers, gas carriers, bulk carriers, and cargo high-speed craft of more than 500 gross tons, and (2) July 1, 2002, for all other cargo ships and mobile offshore drilling units of 500 gross tons or more. Companies that fail to comply will be considered in violation of the International Convention for the Safety of Life at Sea and may be prevented from trading.

ACRONYMS AND ABBREVIATIONS USED IN THE REPORT

ABMP	Alaska Board of Marine Pilots
ARPA	automatic radar plotting aid
BRM	bridge resource management
CFR	*Code of Federal Regulations*
DOT	U.S. Department of Transportation
EBL	electronic bearing line
GPS	global positioning system
HCPV	high capacity passenger vessel
IMO	International Maritime Organization
ISM Code	International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention
MLLW	mean lower low water
MSC	Maritime Safety Committee
M/V	motor vessel
OSA	obstructive sleep apnea
PCL	Princess Cruise Lines
SEAPA	Southeastern Alaska Pilots Association
SMS	safety management system
SOLAS	International Convention for the Safety of Life at Sea
T	true course
TSS	traffic separation scheme
USCG	U.S. Coast Guard
VDR	voyage data recorder
VER	voyage event recorder
WAMS	Waterway Analysis and Management System