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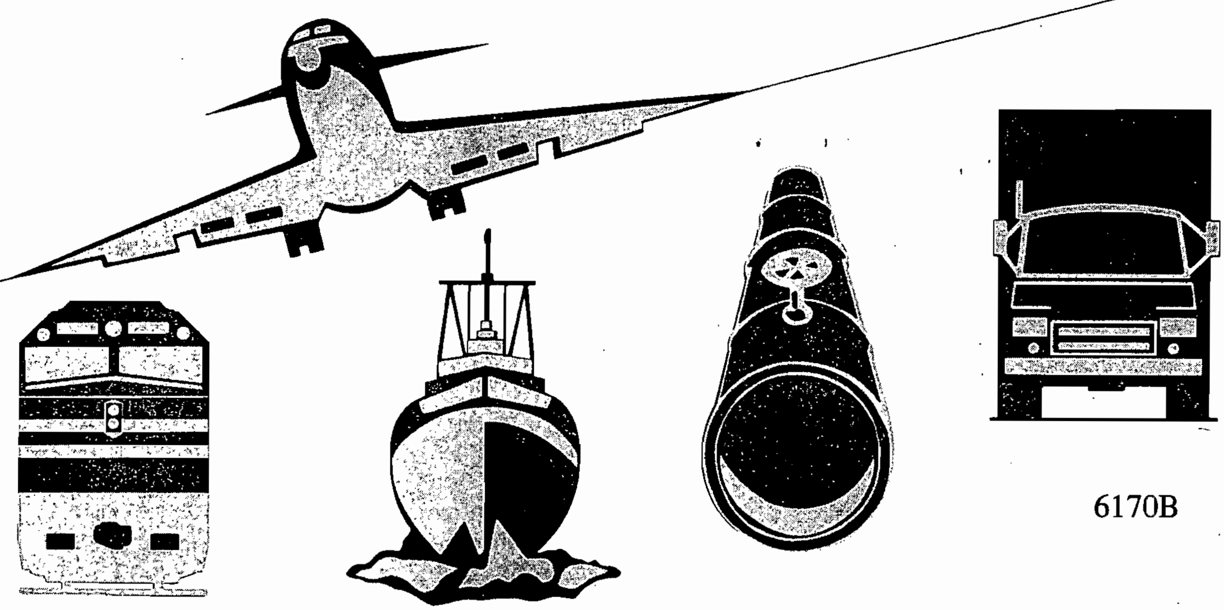
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

GROUNDING OF U.S. PASSENGER VESSEL M/V YORKTOWN CLIPPER IN GLACIER BAY, ALASKA AUGUST 18, 1993



6170B

Abstract: On August 18, 1993, the YORKTOWN CLIPPER, a 224-foot-long passenger vessel with 134 passengers and 42 crewmembers, struck an underwater rock in Glacier Bay, Alaska. The hull was pierced in several locations, and the vessel began to flood. The passengers and most of the crew were transferred to assisting vessels, and the YORKTOWN CLIPPER was moved to a shallow sheltered cove. After temporary repairs, the vessel sailed to a shipyard for permanent repairs.

The major safety issues discussed in this report are the navigational practices used aboard the YORKTOWN CLIPPER, the related training of its watch officer, and the adequacy of the manhole covers installed in the double bottoms.

As a result of its investigation, the Safety Board issued safety recommendations to the U.S. Coast Guard and to the Clipper Cruise Line, Inc.

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GROUNDING OF U.S. PASSENGER VESSEL M/V YORKTOWN CLIPPER IN GLACIER BAY, ALASKA AUGUST 18, 1993

MARINE ACCIDENT REPORT

Adopted: July 19, 1994
Notation 6170B

NATIONAL
TRANSPORTATION
SAFETY BOARD

WASHINGTON, D.C. 20594

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EXECUTIVE SUMMARY

About 1532 on August 18, 1993, the 224-foot-long passenger vessel YORKTOWN CLIPPER, with 134 passengers and 42 crewmembers, was southbound in Glacier Bay, Alaska, when it struck an underwater rock. The hull was pierced in several locations, and the vessel began to flood. The passengers and most of the crew were transferred to assisting vessels, and the YORKTOWN CLIPPER was moved to a shallow sheltered cove where it could be beached if necessary. After temporary repairs, the vessel sailed to a shipyard for permanent repairs.

The National Transportation Safety Board determines that the probable cause of the grounding of the YORKTOWN CLIPPER was the failure of the second officer to plot his courses and positions, due to the Clipper Cruise Line's and master's inadequate oversight of the watch officers' navigational planning and procedures. Contributing to the accident was the Coast Guard's lack of a requirement that watch officers on small passenger vessels equipped with radar be qualified in radar navigation.

The major safety issues discussed in this report are the navigational practices used aboard the YORKTOWN CLIPPER, the related training of its watch officer, and the adequacy of the manhole covers installed in the double bottoms.

As a result of this investigation, the Safety Board makes recommendations to the U.S. Coast Guard and to Clipper Cruise Line, Inc.

GROUNDING OF U.S. PASSENGER VESSEL
M/V YORKTOWN CLIPPER
IN GLACIER BAY, ALASKA
AUGUST 18, 1993

INVESTIGATION

The Accident

On Sunday, August 15, 1993, the 224-foot-long passenger vessel YORKTOWN CLIPPER[1] (see figure 1), operated by Clipper Cruise Line, Inc., departed Juneau, Alaska, on its weekly Alaskan cruise (see figure 2). It had 134 passengers and 42 crewmembers. On the first day, the vessel sailed south, visited Sawyer Glacier, and then continued to Baranof Island, where it anchored for the night at Warm Spring Bay. About 1300 on Monday, the vessel sailed for Sitka and arrived that evening. At 1450 on Tuesday, the vessel departed Sitka. Using the inland passages, the vessel arrived at the entrance to Glacier Bay about 0500, Wednesday, August 18, where a National Park Service (NPS) Ranger boarded the vessel for its transit of Glacier Bay.[2]

After entering the bay, at 0800 the master took over his regularly scheduled bridge watch. As normal, the bridge watch consisted of a single person. The vessel was in the vicinity of Marble Islands, and he navigated it to the northwest terminus of the bay. At 1155, the vessel arrived at the foot of Margerie Glacier, where the vessel steamed slowly through the area while the ranger, who was also a naturalist, explained the history of the glacier and passengers were afforded the opportunity to watch portions of the glacier calve. About 1230, the second officer relieved the master of the bridge watch, and he maneuvered the vessel slowly in the same area until other sightseeing vessels moved out of the way. About 1245, he began the departure from Glacier Bay.

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[1]Categorized as a small passenger vessel in accordance with the Federal regulations at *46 Code of Federal Regulations* (CFR), Subchapter T.

[2]The number of vessels permitted to enter Glacier Bay National Park during the whale season, June 1 through August 31, is controlled by the NPS. A vessel must have advance permission to enter Glacier Bay, and some large vessels embark a National Park Ranger when entering the bay.

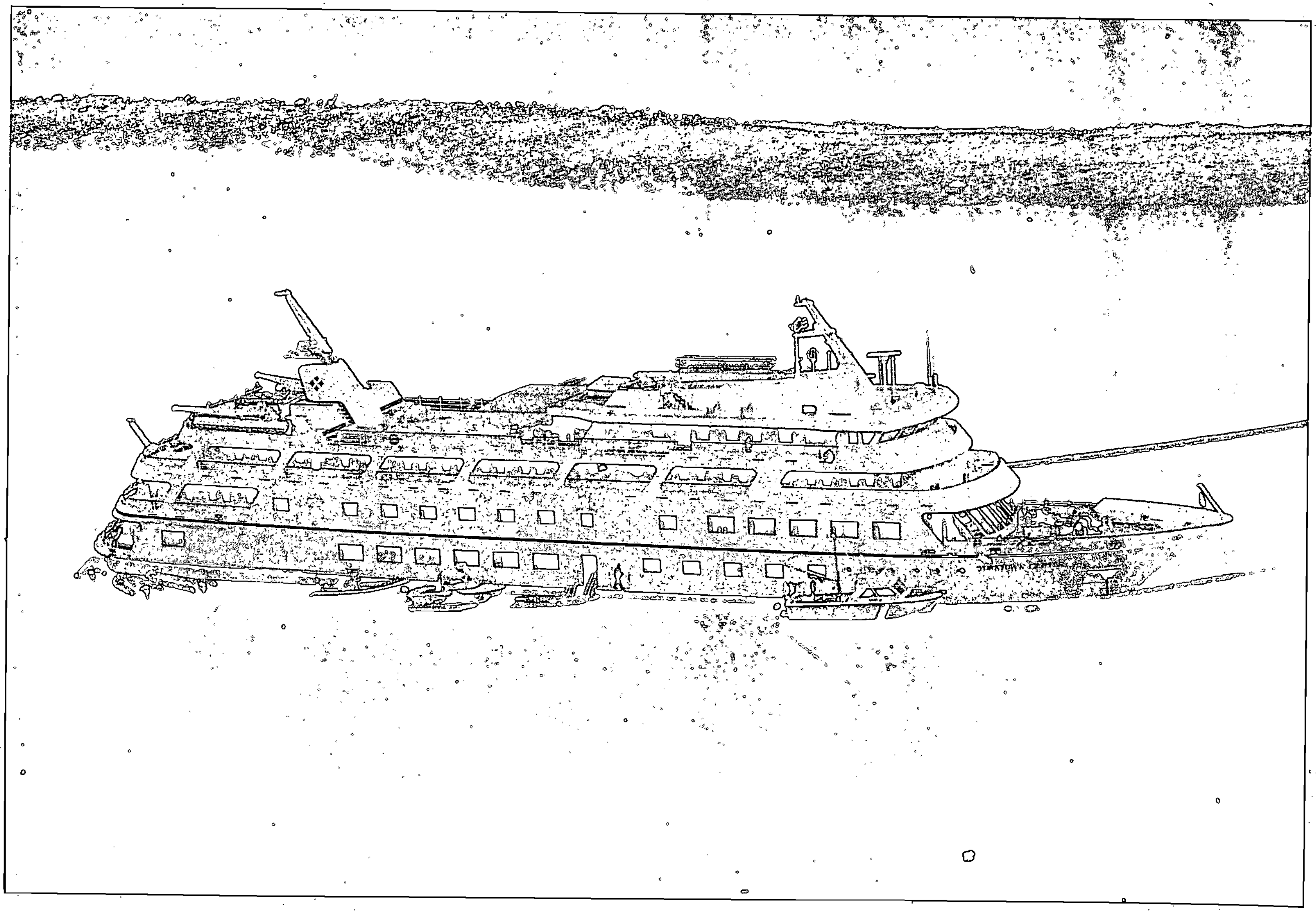

Figure 1.--YORKTOWN CLIPPER in Shag Cove.

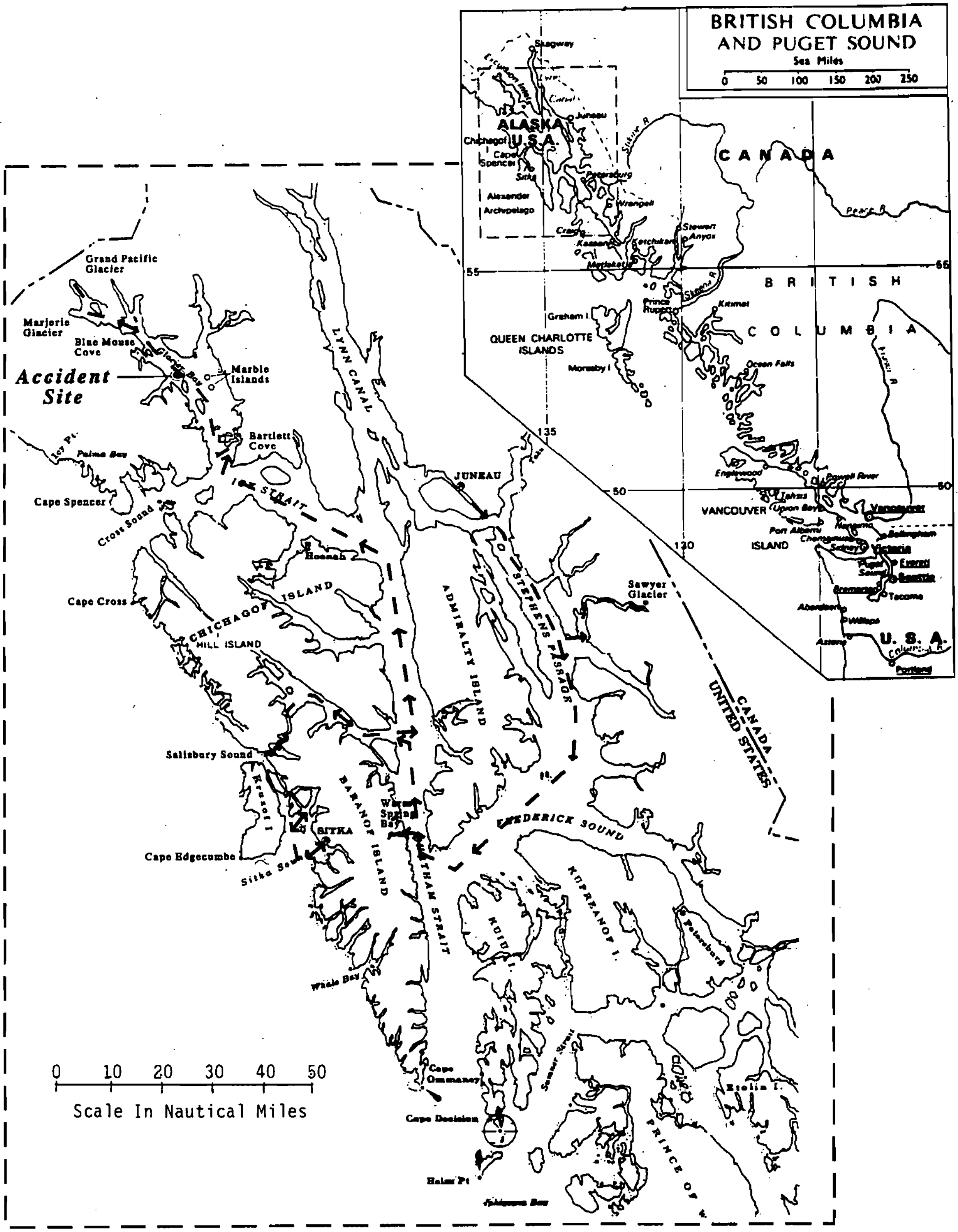

Figure 2.--YORKTOWN CLIPPER's route.

About every hour as the vessel progressed, the second officer entered the vessel's position and heading in the vessel's log. He did not plot the position information on the chart. He navigated by visually observing the vessel's position with respect to its surroundings and by using radar, which was not stabilized by input from the ship's gyrocompass. As the vessel neared the southern end of the bay, the second officer decided to navigate between Lone Island and Geikie Rock (see figure 3), as he had done on two prior voyages. The gyrocompass heading was 135°. The starboard radar was operating on the 6-mile scale. With the port radar operating on the 3-mile scale, he set one variable range marker at 3/4 mile to indicate that he should begin a turn to the left when that range marker advanced to Geikie Rock. He also set a second variable range marker on the port radar at 1 1/2 miles to indicate that he should begin turning back to the right for Whidbey Passage when that range marker reached Drake Island.

Both Geikie Rock and Lone Island were visible. They are separated by about 1.8 miles, but each is surrounded by shallow water that covers rocks extending outward about 1/2 mile. The tidal range in this area on August 18 was about 20 feet. A large rock about 900 yards to the northeast of Geikie Rock is uncovered at low tide, but it was submerged and not visible as the YORKTOWN CLIPPER approached.

The second officer stated the vessel was being steered by autopilot at full speed of about 11.3 knots and he was at the vessel's control console as he began maneuvering the vessel to go between Geikie Rock and Lone Island. The vessel's draft was about 8 feet 4 inches. Suddenly, about 1532, the vessel struck bottom, the bow jolted upward, and the vessel lurched to the right and continued traveling forward.

The master and first officer, whose cabins were just aft of the bridge, immediately rushed to the bridge. The master stopped the engines, took the steering out of autopilot, and asked the second officer to take fixes to determine their location. The master could not see what the vessel had hit, and he was uncertain of the vessel's location. The second officer took several fixes using the satellite global positioning system (GPS) and plotted them on the chart. The park ranger and the vessel's cruise director came to the bridge to assist.

Rescue and Salvage Operations

As the YORKTOWN CLIPPER drifted and listed to port, the master radioed the NPS Station at Bartlett Cove, the U.S. Coast Guard, and nearby vessels for assistance. The NPS Station received the YORKTOWN CLIPPER's radio notification of the grounding at 1541. The station personnel dispatched their own boats with portable pumps, notified the Coast Guard communications center in Juneau, and coordinated the response of various vessels in the vicinity. At 1545, the 797-foot-long Bahamian cruise vessel WESTERDAM reversed course to go to the assistance of the YORKTOWN CLIPPER. At 1551, the master of the YORKTOWN CLIPPER broadcast a Mayday.

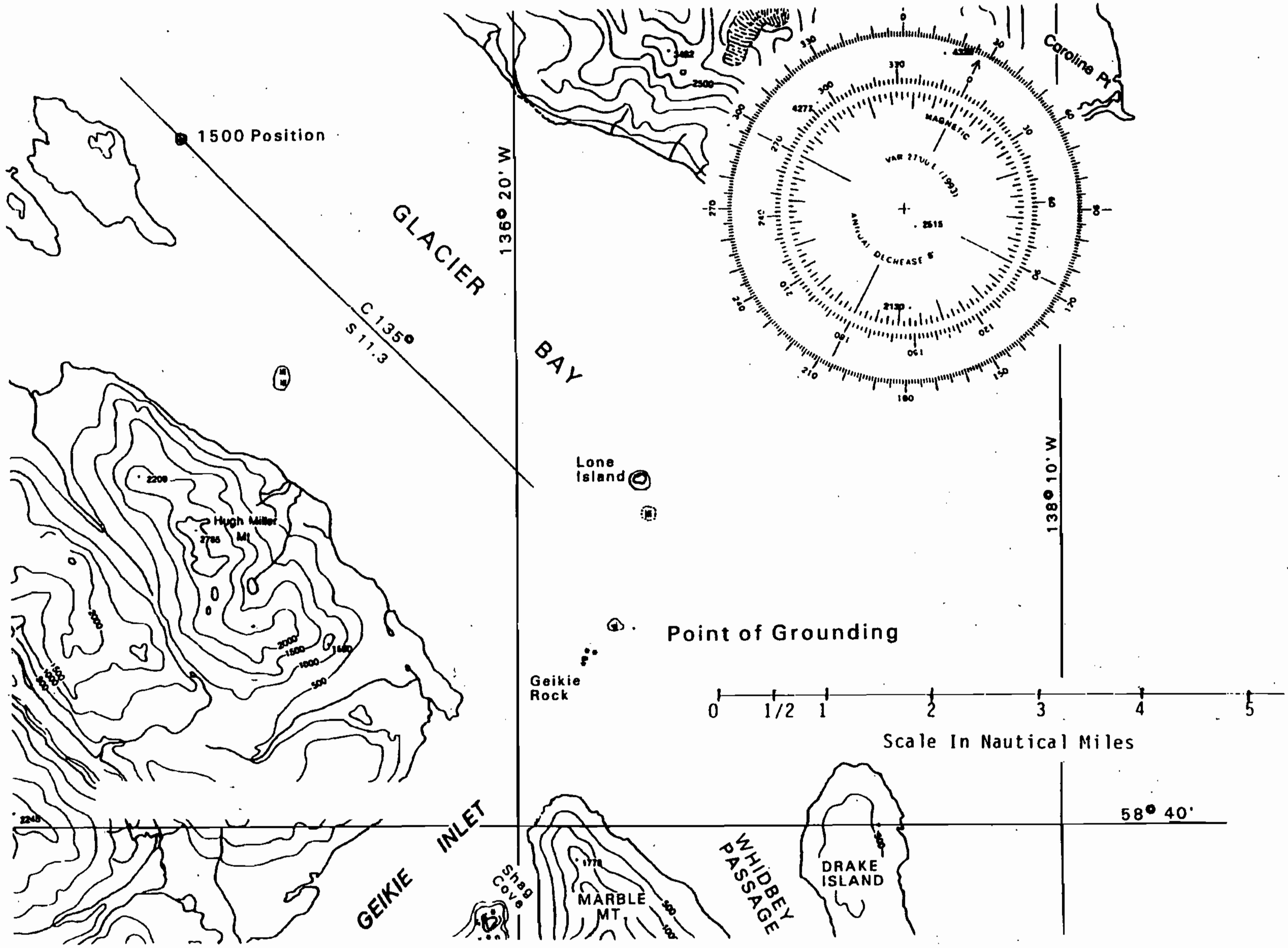

Figure 3.--Area of grounding.

The master stated he did not sound the general alarm because he wanted to evaluate the situation first to avoid unnecessarily alarming the passengers. About 15 minutes after the grounding, he informed the passengers and crew of the situation through the public address system.

The master sent the first officer below to appraise the damage immediately after the grounding. On his way, the first officer encountered crewmembers, and he instructed them to go to their emergency stations. The first officer encountered the chief engineer and accompanied him to the forward hold, where the initial impact had occurred.

When the vessel struck bottom, the chief engineer and his assistant ran to the bow thruster room (see figure 4, frames 9 to 15), where they saw sea water rushing in at the base of the forward bulkhead. Within about 10 minutes of the grounding, they notified the master of the flooding, started the engineroom bilge pumps, and began pumping the flood water overboard. They also set up a portable pneumatically driven pump to assist in the pumping of that compartment and disconnected the local electric switches to the bow thruster motor and to the auxiliary fire pump, which were in the bow thruster room. The chief engineer then went aft into the adjoining storeroom (frames 15 to 21) to inspect for additional damage. As he left, he closed the watertight door behind him at the bulkhead at frame 15 to prevent the rising flood water in the bow thruster room from spreading aft.

To examine the hull bottom beneath the storeroom, the chief engineer removed the manhole cover over the starboard void. He crawled several feet into the void, and his flashlight revealed damage to stiffeners and some buckling of the centerline bulkhead that separated the port and starboard voids. However, he saw no flooding of the starboard void. As he came out of the manhole, he noticed water leaking around the manhole cover over the port void. He used his wrench to tighten the single center bolt, but the cover continued to leak. As he continued to tighten the bolt, the bolt threads stripped and the rate of flooding increased. Eventually the storeroom flooded to nearly its full height.

He called the master by portable radio, gave him a status report, and asked him to close the remaining sliding watertight doors in the bulkheads at frames 21, 31, and 45. (The master could close the doors by remote control from the bridge.) The chief engineer then proceeded to examine the forward crew quarters (frames 21 to 31). Below this compartment were a port and starboard fuel oil tank, a port and starboard void, and an 8-foot-wide centerline duct. He removed the manhole cover over the duct and immediately saw the bottom was covered with diesel fuel oil, indicating that at least one of the fuel tanks had been breached. He crawled aft into the duct, where he saw sea water bubbling in, but he could not see any breach in the hull. He said that he tried to stuff rags into the openings through which the water was flooding and then crawled out and secured the manhole cover in place. He checked the compartments further aft but did not find any other flooding.

He went to the engineroom, started another bilge pump, and then radioed another status report to the master. Then he went back to check the bow thruster room. When he looked into

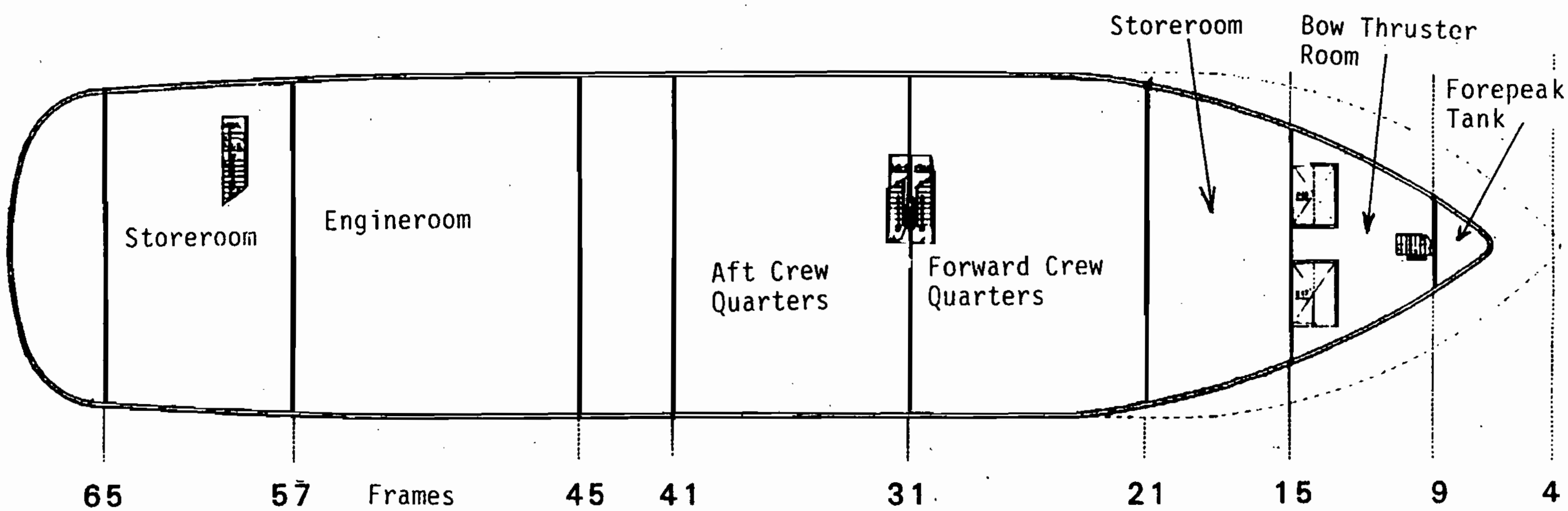

Figure 4.--Watertight bulkheads on the hold deck.

that compartment from above, he saw that the water had risen to a height of about 6 feet. He believed the situation warranted further discussion with the master, so he went to the bridge. Although he later told Safety Board investigators that he believed the vessel would have remained afloat, he and the master agreed that it was advisable to evacuate all the passengers to shore.

As the chief engineer was leaving the bridge, boats from the NPS began to arrive with pumps and engineering personnel. However, as the flooding continued, the water rose enough to reach some electrical circuits that had not been disconnected and shortcircuited the power supply. The vessel's generator circuit breakers opened, and the vessel lost all electric power. The emergency generator started automatically, and within 30 seconds the emergency lights and other vital circuits had power. The engineers identified the problem, isolated the short circuit, and put the vessel back on normal electric power. The transformers in the storeroom, however, had been damaged by the flood water and could not be energized. Consequently, the forward portion of the vessel had only emergency lights during the salvage operations.

Because the master was concerned about the safety of the passengers, he tried to find a suitable nearby beach where he could put them ashore. In preparation, they were instructed to put on their lifejackets and to assemble on the Sun Deck, where the master briefed them about the accident. The park ranger suggested that the beach at the north end of Marble Mountain would be a suitable spot, so the master navigated the vessel slowly in that direction. Simultaneously, the vessel's rigid-hull inflatable boats were launched. However, as rescue boats arrived, the master decided to use them instead, because he believed the transfer of personnel to them would be safer.

The passengers were evacuated in groups from the port embarkation station on the main deck. Most of the passengers and crewmembers were evacuated by the WESTERDAM's launch, which had a capacity of 150 persons. By 1722, all the passengers and nonessential crewmembers had been removed and transferred to nearby vessels.

As the master continued to get reports of flooding, he feared the vessel might sink. He told the park ranger and a Coast Guard representative, who was one of several Coast Guard personnel brought by chartered float airplane from Sitka, that he wanted to beach the vessel, rather than have it sink. The park ranger wanted the vessel put in a location where any pollution from the vessel could best be contained and prevented from endangering wildlife. They collectively agreed to head for nearby Shag Cove, so the master slowly maneuvered the vessel into the cove. When the situation did not deteriorate further, he anchored the vessel close to the beach while efforts continued to halt the flooding and dewater the vessel.

The Coast Guard Cutter WOODRUSH arrived about 2200 with additional pumps and damage-control personnel and equipment. The Coast Guard personnel placed a tarpaulin underwater around the bow to restrict the water inflow. They also shored the leaking manhole covers that were accessible, added pumping capacity, and plugged hull fractures as the flood water receded. However, the flooding could not be stopped until commercial divers were able to reach the exterior of the hull and plug the numerous holes in it.

As sea water entered the forward compartments, the vessel increasingly trimmed down by the bow, so the crew attempted to raise the bow by emptying the forward fresh water tanks. There was no direct way to pump the contents of the tanks overboard, so the sink faucets in the staterooms were opened, and the water drained overboard. However, the vessel continued to trim down by the bow until the flood waters could be removed.

The crewmembers also attempted to transfer fuel oil from the forward tanks but were concerned that if a tank had been ruptured in the accident, the fuel it contained might have been contaminated. They tested the tanks and began to pump from those that showed no contamination. However, they soon discovered that those tanks were contaminated and could not be emptied because pumping the contents into other fuel oil tanks would further contaminate the vessel's fuel supply.

The efforts to find and plug the holes in the hull and to dewater the vessel went on concurrently and lasted for several days. The Coast Guard directed and executed all damage-control efforts until the third day after the grounding. In addition to providing pumps and boats, the NPS placed booms around the vessel to confine any oil that was spilled. The Coast Guard provided pumps, damage-control equipment and personnel, and the cutter WOODRUSH. Commercial divers using two-way underwater communications and video transmissions were ultimately needed to locate and plug all the holes in the hull.

At the time of maximum flooding, the forepeak tank (frames 4-9), the bow thruster room (frames 9-15), and the storeroom, including its voids below, (frames 15-21) were flooded to a height of about 10 feet above the keel. The voids, the centerline duct, and the fuel tanks below the forward crew quarters (frames 21-31) were also flooded (see figure 5). Some fuel oil also had entered the forward crew quarters (frames 21-31) from around the manhole cover over the centerline duct, which the engineer had seen filling with fuel oil and seawater. When the crew attempted to check for remaining water in the storeroom by slightly opening the sliding watertight door (frame 21), the storeroom held a considerable amount of flood water, which then flooded the forward crew quarters. Because the water mixed with the fuel oil present, the crew quarters could not be pumped out until special equipment arrived to separate the oil and water.

Injuries

No injuries were sustained by the crew or the passengers as a result of the grounding or the evacuation of the vessel.

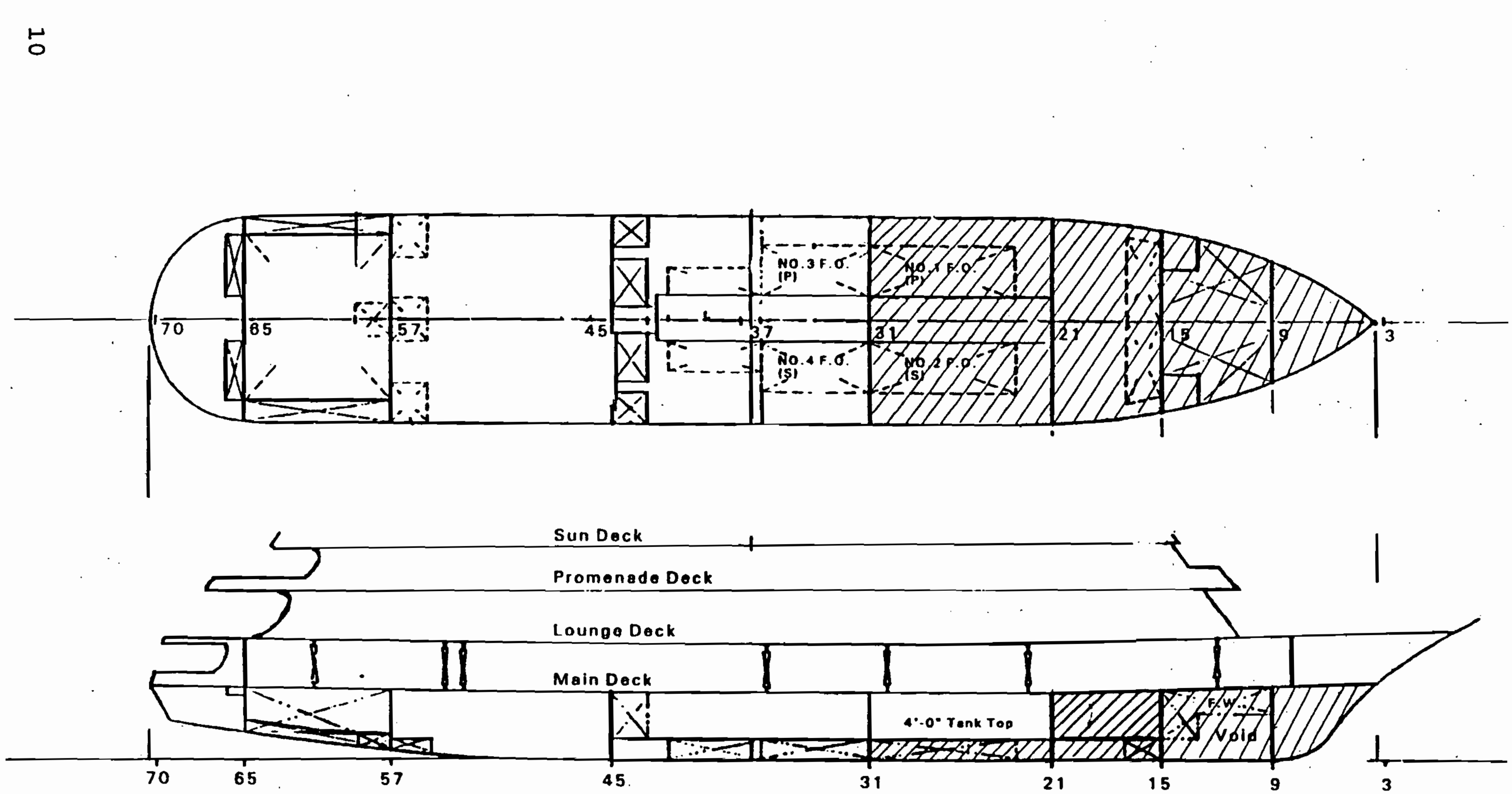

Figure 5.--Flooded spaces.

Crew Information

Manning.--The certificate of inspection (COI) issued by the Coast Guard specified the minimum complement for manning the YORKTOWN CLIPPER as two licensed deck officers (one master and one mate), eight deckhands, and two unlicensed engineers. In addition, the COI authorized the vessel to carry 24 other persons in the crew and 138 passengers.

Clipper Cruise Line elected to supplement the required manning with a second licensed mate to provide for a three-watch system. The company also assigned a licensed engineer who supervised the two unlicensed engineers.

Master.--The master, 36, held a license as Mate of Near Coastal Steam or Motor Vessels of not more than 1,600 gross tons. Under the equivalents provisions of 46 CFR 15.901, that license also authorized him to serve as master on inspected vessels of less than 100 gross tons. He had held a radar observer endorsement on the original issue of his license. He allowed the endorsement to lapse when he renewed his license in December 1988 because he was then serving on smaller vessels that did not require the radar observer endorsement.

The master had been sailing as a profession for 13 years. The first several years of his experience were on towboats and integrated tug-barges operating in the Gulf Coast area. He then worked for almost 5 years as the captain of a 150-passenger dinner-cruise boat out of Jacksonville, Florida. He joined Clipper Cruise Line on March 27, 1993, as master of the NANTUCKET CLIPPER (another Clipper Cruise Line vessel). After sailing for 10 weeks on the Gulf and East Coasts and a short leave period, he joined the YORKTOWN CLIPPER on June 26, 1993, in Alaska. He sailed the first week as observer captain and then assumed command. He stood the 0800-1200 and the 2000-2400 bridge watches.

First Officer.--The first officer, 30, began his maritime career with Clipper Cruise Line about 8 1/2 years ago. He started as a deckhand and worked his way up to boatswain before taking his license exam. He had served aboard the YORKTOWN CLIPPER since shortly after the vessel was launched in 1988. He received his license as Master of Near Coastal Steam or Motor Vessels of not more than 100 gross tons in September 1991. He did not have a radar observer endorsement on his license; an endorsement is not required for that grade license. He stated that he had not attended radar training school but that he had received "hands-on" radar training on the bridge while he was still a boatswain and further training from a previous master after he had obtained his license. He stood the 0400-0800 and 1600-2000 bridge watches.

Second Officer.--The second officer, 25, began employment with Clipper Cruise Line as a deckhand in August 1990. After a year, he was promoted to boatswain. While a boatswain, he received some informal navigational instruction; during his off-duty hours, he "sat watches" with a previous master of the YORKTOWN CLIPPER during the course of "maybe eight" of the master's 2000-2400 bridge watches. The second officer received his license as Master of Near Coastal Steam or Motor Vessels of not more than 100 gross tons in May 1992. He did not have a radar observer endorsement, nor was he required to have one under current Federal regulations.

The second officer first worked under his master's license for 6 weeks in the spring of 1993 aboard the YORKTOWN CLIPPER when it was operating in California and Oregon coastal waters under the command of a former master. The second officer then worked the last 2 weeks of June 1993 on the NANTUCKET CLIPPER in the Saint Lawrence Seaway. Clipper Cruise Line's vice president for marine and passenger operations stated that the second officer sailed all his watches aboard the NANTUCKET CLIPPER with the company's senior captain. (The senior captain is responsible for training and observing new officers.) The second officer rejoined the YORKTOWN CLIPPER in Alaska at the end of July 1993. At the time of the accident, he had a total of 10 1/2 weeks experience as a navigational watch officer and was making his third passage through Glacier Bay. He stood the 0000-0400 and 1200-1600 watches. He was the sole navigational watchstander when the vessel grounded.

Because the YORKTOWN CLIPPER had been docked at Sitka on the evening of August 16, the second officer had not stood the 0000-0400 bridge watch. He said that since he had not had the watch, he had gone to bed instead and slept through the night until he got up at 0800 on August 17. The vessel did not get underway until 1450, so he had to stand only about an hour of his afternoon watch before being relieved at 1600. He then slept from about 1730 until 2315 in preparation for assuming the midwatch. After being relieved at 0400 on August 18, he went to his quarters and slept until 1000.

Neither the master nor the Coast Guard investigating officer who had boarded the YORKTOWN CLIPPER after the accident noticed any signs of impairment of the second officer. The master stated that around 1000 on the morning after the accident, the Coast Guard investigating officer told him "to test whoever was on watch for drugs." The master told Safety Board investigators that no mention was made of alcohol testing and that he, himself, was unfamiliar with postaccident testing requirements. Consequently, he directed the second officer to provide a urine sample. The second officer complied, and the subsequent test results were negative for illegal drugs.

Vessel Information

General.--Construction of the YORKTOWN CLIPPER was completed in Green Cove Springs, Florida, in April, 1988. The steel welded hull consisted of five decks. It was owned by Liberty Cruise Line, Inc., of Wilmington, Delaware, and operated by Clipper Cruise Line of St. Louis, Missouri.

The vessel's principal characteristics were:

Length (feet)	224
Breadth (feet)	40
Depth (feet)	12.5
Draft, full load (feet)	8.5
Gross tons	97
Displacement tons, full load	1,568
Horsepower	1,810

The vessel was subdivided into watertight compartments by seven watertight bulkheads extending from the keel to the main deck. Three compartments, which served as the two crew quarters and the forward storeroom, were designed with watertight double bottoms. The fuel tanks and voids underneath the double bottoms were fitted with manhole covers that were intended to maintain the watertight integrity of the double bottoms.

The YORKTOWN CLIPPER was propelled by two diesel engines through two reduction gears driving two four-bladed propellers, which provided a maximum speed of 12 knots. Electric power was provided by three generators, each rated at 320 kilowatts, and was backed by a 90-kilowatt emergency generator. A 325-horsepower bow thruster could be controlled from the wheelhouse to aid in maneuvering. The engineroom contained bilge pumps, fire pumps, and a condensate pump that could be interconnected to the bilge manifold to dewater any compartment below the main deck.

Navigation Equipment.--The navigation equipment in the wheelhouse included a magnetic compass, two radars, and a gyrocompass. The radars were not gyrostabilized nor were they required to be. Other navigation equipment included loran, satellite navigation, GPS, a radio direction finder, and a fathometer. The vessel was not required to have a course recorder and did not have one. The vessel could be steered either manually or by autopilot. The main engines, the bow thruster, and the electrohydraulic steering pumps could be controlled from the wheelhouse.

Lifesaving Equipment.--The lifesaving equipment aboard the YORKTOWN CLIPPER at the time of the grounding met the requirements stated in its COI. The life preservers were distributed in the upper part of the vessel in passenger cabins and in protected places convenient for the people on board. Each passenger's cabin had two adult-size life preservers and a sign that explained how a preserver should be put on. Twenty adult-size and 20 child-size life preservers were stored in two float-free boxes on the aft promenade deck. All passengers and crewmembers retrieved and donned their life preservers before disembarking.

None of the 14 inflatable life rafts aboard the vessel were used in the evacuation. The life rafts, each with a 25-person capacity, were on the aft Sun Deck and were sufficient to evacuate everyone on board. In the event the vessel sank, the rafts were installed to self-release and inflate. The vessel was equipped with six six-passenger rigid hull inflatable boats (Zodiacs).

The boats were not considered part of the required lifesaving equipment and were not included as required equipment on the vessel's COI. The inflatable boats were launched in the event they were needed to evacuate passengers in conjunction with other private and NPS vessels.

General Alarm and Public Address System.--The vessel was equipped with a general alarm. It was not sounded to alert passengers to abandon ship. Fifteen minutes after the grounding, the captain used the public address system to advise passengers to return to their cabins and don life preservers.

Shipboard Emergency Drills.--At 1420 on August 15, 3 days before the accident, the master had held a fire and abandon-ship drill during which he had the passengers return to their cabins, don their life preservers, and remain at their cabin doors until their life preservers were inspected by crewmembers. Afterwards he conducted a fire drill for the crew only. The drill simulated a fire in the air handling room.

Company Operations

Clipper Cruise Line, Inc., operates the 138-passenger YORKTOWN CLIPPER and the 100-passenger NANTUCKET CLIPPER under the U.S. flag and operates another 138-passenger vessel under a foreign flag. The U.S. flag vessels provide weekly and longer cruises along the Alaskan coast, the U.S. west coast, the Caribbean coast, the St. Lawrence Seaway and the eastern seaboard.

Waterway Information

Glacier Bay is in southeast Alaska and forms part of the Glacier Bay National Park and Preserve, which is administered by the NPS of the U.S. Department of the Interior. Glacier Bay extends in a northwest to southeast direction for a distance of about 75 miles. The portion of the bay in the vicinity of Geikie Rock is more than 5.5 miles wide; most of the bay in that area is more than 100 fathoms deep. The *U.S. Coast Pilot* indicates that currents have little velocity north of Willoughby Island, which is about 7 miles south of the accident site.

Glacier Bay is not marked with buoys or other such visual navigational aids. Electronic navigation signals, such as loran, GPS, and satellite navigation, are available. The *U.S. Coast Pilot* and tide and current tables provide additional information about navigating the bay.

NOAA (National Oceanic and Atmospheric Administration) chart No. 17318,[3] issue date December 15,1990, which was in the wheelhouse on the date of this accident, shows the hydrography and topography in the area of the accident. The chart shows Geikie Rock and Lone Island and their surrounding submerged rocks, including the rock struck by the YORKTOWN CLIPPER. At low tide, the rock is exposed to a height of about 11 feet, but at the time of the accident, it was covered by water.

Survival Aspects

After the master of the YORKTOWN CLIPPER broadcast the Mayday, he did not sound the general alarm. He stated that he wanted to evaluate the situation first to avoid unnecessarily alarming the passengers. About 15 minutes after the grounding, he informed the passengers and crew of the situation through the public address system. He then tried to find a suitable beach where he could put them ashore.

About 45 minutes after the grounding, he tried to use the public address system again to advise the passengers to muster. However, the system was inoperable because of opened electrical circuits. Subsequently, crewmembers advised passengers to assemble on the Sun Deck, where the master briefed them about the grounding. The passengers were evacuated from the main-deck port embarkation station. No passengers or crewmembers had to enter the water during the evacuation.

Sixty-seven passengers responded to 134 written inquiries from the Safety Board about their observations of the accident. Their observations included the following:
No panic was evident among crewmembers or passengers. Passengers returned to their cabins and retrieved life jackets as they had done on the day of the drill. Passengers waited 15 minutes before information was given over the public address system about the grounding. The crew helped passengers don life jackets and assisted them during the evacuation.

At 1541, the NPS at Glacier Bay monitored the distress call from the YORKTOWN CLIPPER. At the same time, the North Pacific Search and Rescue (SAR) Coordinator in Juneau, who received the distress call, notified the NPS that the NPS would be the SAR mission coordinator. At 1602, four NPS boats and several private boats responded to assist in the evacuation.

By 1605, one Coast Guard helicopter had arrived on scene, and another Coast Guard helicopter and the WOODRUSH were on route to the scene. The helicopters delivered seven dewatering pumps and oil spill containment equipment to the YORKTOWN CLIPPER.

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[3]NOAA charts are published by the U.S. Department of Commerce.

At 1722, a Coast Guard helicopter reported that all passengers had been removed from the YORKTOWN CLIPPER.

Damage to Vessel

Examination of the YORKTOWN CLIPPER in drydock showed the forefoot was heavily buckled and holed between frames 7 and 10. The bottom hull plating and keel plate were holed, scraped, and pushed inward to varying degrees on both the port and starboard sides as far aft as frame 48, near the forward end of the engineroom. Internally, the steel frame and bulkheads were buckled as far aft as frame 48. Electric circuits, motors, and other equipment in the flooded spaces were damaged by the salt water. The fuel and water that entered the forward crew quarters extensively damaged the furnishings and stateroom bulkheads.

The repair costs were estimated to be $1.16 million, and the loss of revenue, $1.64 million.

Other Information

Small Passenger Vessels.--The term "small passenger vessel" generally includes any vessel less than 100 gross tons that is certified to carry more than six passengers for hire. The first Federal regulations governing such vessels became effective June 1, 1958. The YORKTOWN CLIPPER is one of the largest vessels governed by these regulations and one of the few that is permitted to carry 50 or more overnight passengers on oceans or coastwise routes. The YORKTOWN CLIPPER measures less than 100 gross tons under U.S. National Tonnage Rules and therefore qualifies as a small passenger vessel; however, under the 1969 International Convention on Tonnage Measurement of Ships, its tonnage is 2,354 gross tons.

If a vessel's gross tonnage has been reduced to less than 100 gross tons by the extensive use of exemptions, reductions, or other means allowed by the tonnage formulation in order to circumvent or be incompatible with the safety standards required for passenger vessels of such physical size, Federal regulations (46 CFR 175.05-15) require the Coast Guard to prescribe additional requirements. In 1983, the Coast Guard issued *Navigation and Vessel Inspection Circular No. 11-83*, which provided guidance for applying stricter safety standards to such vessels by invoking appropriate regulations applicable to larger passenger vessels. As a result, the builders of the YORKTOWN CLIPPER were required to construct the vessel according to safety standards that were more rigorous than those in Subchapter T (CFR regulations that govern small passenger vessels) in the following areas: structural fire protection, life rafts, watertight doors, bilge pumps, electrical circuitry, and stability. As a further precaution, the vessel's COI restricts the vessel's ocean voyages to not more than 50 miles from a harbor of safe refuge. The certificate also restricts coastwise voyages to not more than 50 miles from a harbor of safe refuge and not more than 20 miles from land. To reduce the risk of the vessel encountering severe weather conditions, it is allowed to use some routes only during the months when the weather on those routes is likely to be most favorable, and it is not allowed to use some routes while it is carrying passengers.

Regulation Updates.--On January 30, 1989, the Coast Guard issued a Notice of Proposed Rulemaking (NPRM), proposing a complete revision of Subchapter T, which had become outdated. Based on the numerous comments received in response to this NPRM, including those from the Safety Board, the Coast Guard revised the NPRM extensively and published the new proposed regulations in its Supplemental Notice of Proposed Rulemaking (SNPRM) on January 13, 1994.

This SNPRM, titled "Small Passenger Vessel Inspection and Certification," attempts to establish a more rational approach for achieving appropriate safety standards for the great variety of inspected small passenger vessels. The SNPRM proposes that the Coast Guard classify small passenger vessels according to the number of passengers they carry, the number of overnight accommodations they have, and their length. Those vessels that are longer, carry more passengers, and have more overnight accommodations will be subject to more safety requirements. If the rulemaking is adopted, a new small passenger vessel that can carry more than 49 passengers will have to meet more stringent requirements. The Safety Board has been consistent in recommending that the stringency of safety standards depend on the number of passengers at risk and the degree of risk involved.

New Technology.--The development of the NAVSTAR GPS now provides a navigational aid of great accuracy available worldwide. The GPS navigation receivers are capable of displaying position, speed and heading, distance to selected waypoints, and course made good. The YORKTOWN CLIPPER had a GPS receiver on board. The degree of precision required for navigating in restricted waters is provided by "differential" GPS, or DGPS, which relies on nearby reference stations for upgrading the satellite signals. DGPS is scheduled to be operational for the entire United States, including Alaska, by January 1996.

Electronic video display systems with chart data bases also have been developed that can be combined with GPS or other position-fixing systems to give vessel navigators their current position superimposed on the chart. A large effort is ongoing nationally and internationally in the development of system specifications, performance standards, testing, and the means for updating this Electronic Chart Display Information System (ECDIS).

The International Maritime Organization (IMO) has drafted performance standards for ECDIS that are currently scheduled for adoption in 1995. When adopted, ECDIS can be considered equivalent to paper charts required by the 1974 Safety of Life at Sea Convention (SOLAS). The International Hydrographic Organization has developed technical standards and specifications related to digital data format and ECDIS content and display. A number of

European countries are also very active in the development of ECDIS.

Federal agencies and private organizations in the United States have made a consolidated effort to promote the development of ECDIS under the U.S. ECDIS Testbed Project. The project is administered by the Woods Hole Oceanographic Institution. The other primary participants are the Defense Mapping Agency, the U.S. Army Corps of Engineers, the Coast Guard, the Coast and Geodetic Survey/National Oceanic and Atmospheric Administration, the Maritime Administration, and the Intergraph Corporation. The Coast Guard has been conducting a comprehensive test and evaluation program to assess the operational capabilities and limitations of ECDIS. Under this program, 2 years of at-sea evaluations have been completed, including trials comparing ECDIS performance with traditional navigation techniques in confined waterways. Human factors evaluation of ECDIS has been conducted using a bridge simulator facility.

The United States and Canada have been cooperating since February 1992 in studying, developing, testing, and evaluating electronic chart-related technologies. A key objective is determining the requirements for producing, distributing, and updating electronic navigational charts. This project is also intended to provide the knowledge for recommending changes to U.S. or Canadian laws that would promote or mandate the use of electronic chart systems. Several bills have already been introduced in the U.S. Congress since 1991 that would mandate the use of electronic charts for a certain class of vessels.

Electronic charts that simply depict the pictorial aspects of navigation charts are available commercially. These Electronic Chart System (ECS) charts, also known as digital raster charts, are not intended to meet the IMO-proposed standards as required for ECDIS. The U.S. Radio Technical Commission for Maritime Services (RTCM) has drafted standards for ECS charts. They are not considered the equivalent of a replacement for a hydrographic office-issued chart. The ECS charts have no capability to display a vessel's safety depth contour or to give alarms when crossing danger boundaries. They have limited chart updating capability. However, many companies have equipped their vessels with such electronic charts.

NOAA has completed production of about 400 digital raster versions of its nautical charts. It will complete the remainder of its approximately 1,000 charts by the end of 1995. These raster charts will be issued, in cooperation with a commercial enterprise, on 3.5-inch floppy disks beginning in the fall of 1994 and will cost about the same as the corresponding paper charts.

Electronic charts suitable for ECDIS are based on "vector" data that describes each point, line, and symbol. ECDIS systems using such charts can selectively display features such as shorelines or selected water depths. Because of this discrimination capability, these systems can provide automatic warning of approaches to charted hazards, including underwater rocks. Such charts take a long time to create, and very few official government electronic vector charts are available. Clipper Cruise Line purchased such a system from a commercial vendor after the grounding of the YORKTOWN CLIPPER.

ANALYSIS

Exclusions

The Safety Board was able to readily exclude some factors as causal to the accident. Because the visibility in the vicinity of the accident was clear to a distance of 10 miles, the sea was calm, and the wind was moderate at 10 knots from the south, the weather was not a factor in this accident. The steering gear and propulsion engines functioned satisfactorily before and after the accident and are not considered to have contributed in any way. All the electronic equipment used for locating the vessel's position, including loran and GPS, was reported to be functioning satisfactorily. The Safety Board concludes that the grounding of the YORKTOWN CLIPPER was not caused by the weather or any equipment failures.

The Safety Board reviewed the work-rest history of the second officer and determined that he was adequately rested. The Board concludes that crew fatigue was not a factor in this accident. The second officer was fully qualified under Coast Guard regulations as a licensed deck officer on small passenger vessels. The Safety Board believes that the current regulations are inadequate in that the second officer was not required to be, nor was he, formally trained and certified as a radar observer. The issue of radar training is discussed below.

Navigation of the YORKTOWN CLIPPER

The following discussion will examine how the second officer of the YORKTOWN CLIPPER maneuvered the vessel as it approached Geikie Rock and Lone Island from the base course of 135°. The Safety Board does not know for certain what maneuvers the second officer actually made because his statements about when he turned and what turns he initiated are vague, contradictory, and confusing. However, the physical evidence indicates that he turned the vessel to the right prematurely, to a course that led directly over a water-covered rock in shallow water. This rock is shown on the applicable NOAA charts.

At low tide, the rock that the YORKTOWN CLIPPER struck became visible and showed a distinct impact line (see figure 6) that had a true bearing of 151°. The Safety Board plotted a line with this bearing on NOAA chart 17318 at the grounding site and extended its reciprocal bearing line, 331°, up Glacier Bay. (The NOAA chart was on the bridge on the day of the

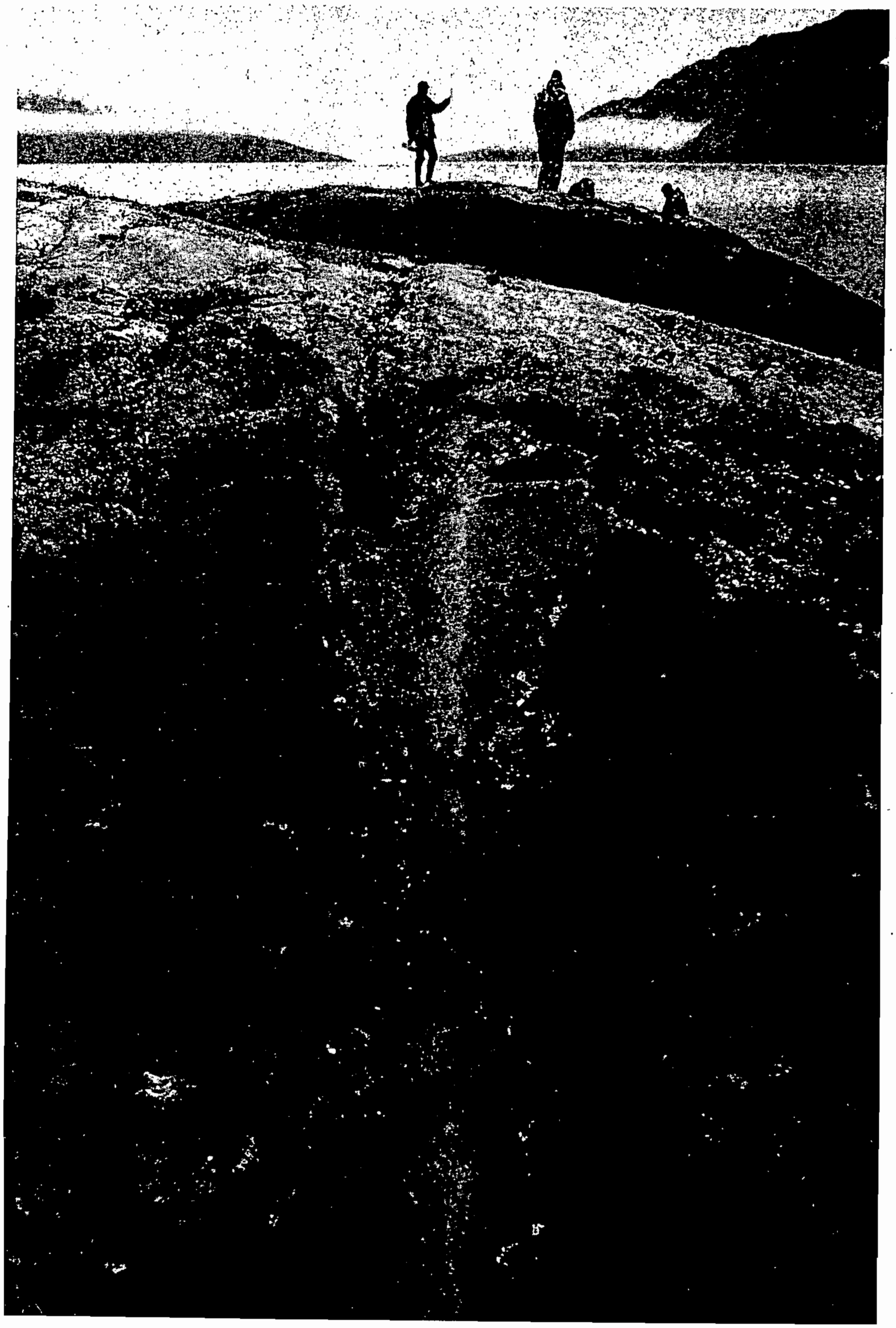

Figure 6.--Impact line at grounding site.

accident.) The track line of the YORKTOWN CLIPPER was also extended from its position as logged at 1500 on its reported course of 135°. The 135° course line and the 151° bearing line from the grounding site intersected at a distance of 1 1/2 miles from Geikie Rock (see figure 7).

The second officer stated that he had set two adjustable range markers on the radar. When the inner one, set at 3/4 miles, touched Geikie Rock, it was supposed to alert him to turn left in order to pass between Geikie Rock and Lone Island. When the outer one, set at 1 1/2 miles, touched Drake Island, it was supposed to alert him to turn to the right and head for Whidbey Passage.

As the YORKTOWN CLIPPER advanced on its course of 135°, the markers moved ahead of it on the radar screen. The outer marker touched Geikie Rock on the radar before the inner marker did. Because the second officer had previously set the radar on the 3-mile scale, when the outer marker touched Geikie Rock, Drake Island was 3.8 miles away from the vessel and consequently did not show on the radar. Had it shown up, its presence might have reminded the second officer that he had intended to change course when the outer marker reached Drake Island, not Geikie Rock.

When the outer marker touched Geikie Rock, the second officer probably changed course to 151°. Supporting this theory is the fact that the reciprocal of the 151° bearing line from the grounding site and the vessel's 135° course line intersect where the vessel would have been when the outer marker touched Geikie Rock.

Another reason for suspecting that the second officer changed course to about 151° when the outer marker touched Geikie Rock is that when the marker touched the rock, Whidbey Passage was clearly visible from the YORKTOWN CLIPPER and the approach course to the passage was about 151° (see figure 7).

Assuming that the second officer changed course to 151° when the outer marker touched Geikie Rock, the inner marker touched it 4.2 minutes later. It is evident that the second officer did not turn left at that point because had he turned to the left as little as 8°, the grounding would not have happened. Perhaps he did not turn left when the inner marker touched Geikie Rock because, having already made a right turn to reach Whidbey Passage, he no longer expected to have to turn left.

There is an additional reason why the second officer may not have used the inner marker as a cue to turn left. He had navigated the YORKTOWN CLIPPER while approaching Geikie Rock from the northwest twice during the preceding 2 weeks. A plot of his logged positions from those prior passages indicates that in those cases he sailed the vessel in about the middle of the right half of the bay on course 135°, as he did on this occasion. As figure 7 shows, a projection of the course line from the 1500 position on the day of the accident results in a track line that passes northeast of Geikie Rock and its surrounding shoals, suggesting that a vessel approaching from the northwest does not have to change course to the left to avoid the shoals

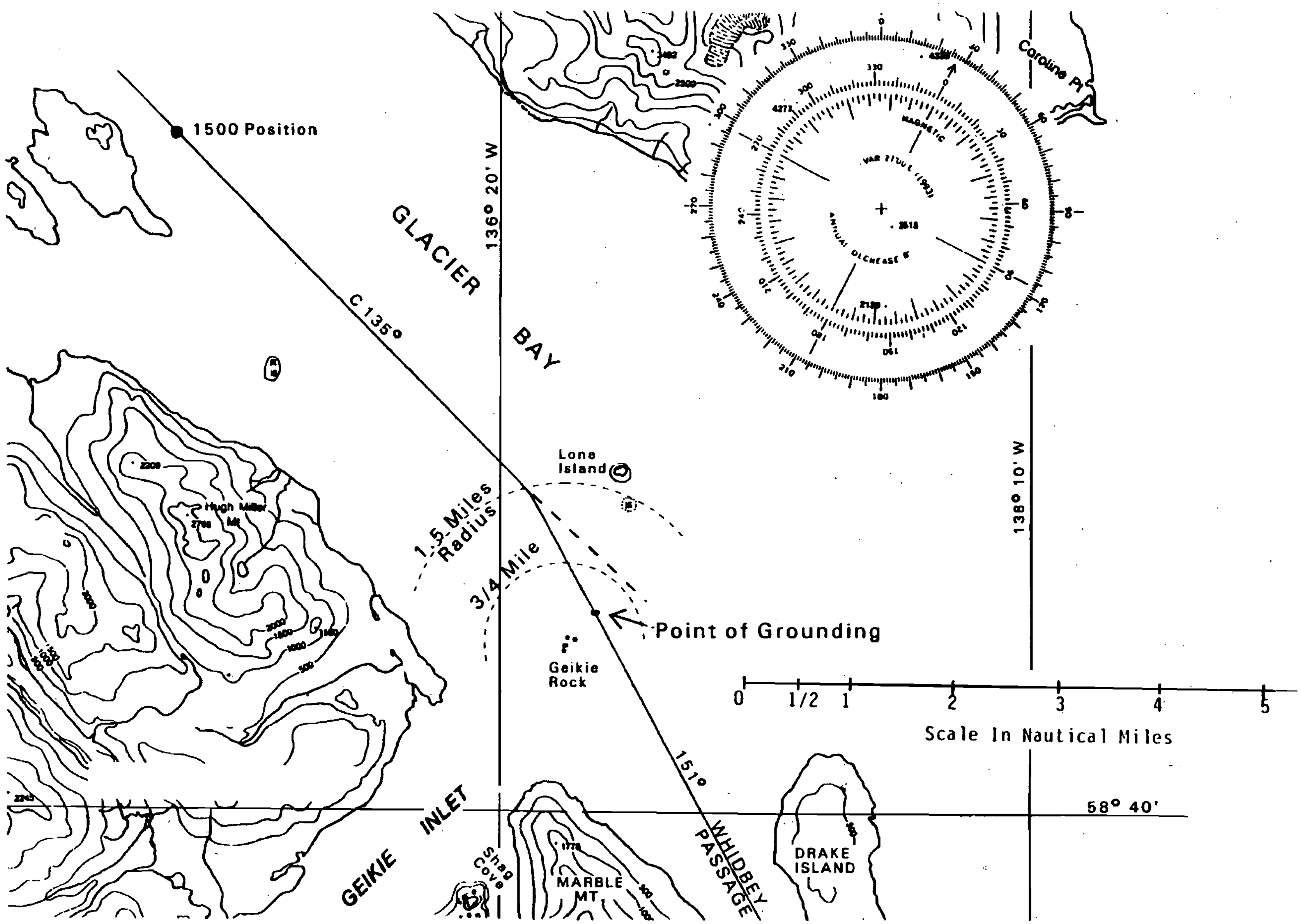

Figure 7.--Probable track line.

between Geikie Rock and Lone Island. In fact, the track line passes outside the 3/4-mile boundary the second officer had set for himself for beginning a turn to the left. Therefore, the inner marker he had placed on the radar would not have intersected Geikie Rock had he remained on course 135°. Had he plotted his intended course from the 1500 position, he might have seen that a turn to the left was not required and that, consequently, he would not have to use the inner marker as a cue to turn. Under such circumstances, a turn to the right directly from course 135° would have been proper. That would have left only the outer marker as the effective cue, and when it touched Geikie Rock, he probably turned to the right prematurely instead of waiting until the marker touched Drake Island.

Navigational Practices

A copy of the Clipper Cruise Line operations manual was kept on the bridge of the YORKTOWN CLIPPER. The manual mentioned navigational procedures only in connection with the maintenance of the vessel's official logbook. According to the manual, whenever a vessel is under way, navigational entries are to be logged "at intervals not to exceed 1 hour." It also stated that "course changes should never be logged without a fix...." The manual sets no standards for the quality of the fixes, the charting of fixes, putting course lines on the chart, or other navigational factors that decrease the risk of grounding. The master had not issued any written standards for navigational procedures.

During the passage south in Glacier Bay, the YORKTOWN CLIPPER watch officers did not plot the vessel's position on the chart. They only entered the fix information--a radar range and radar bearing--hourly in the log. They did not attempt to project their courses on the chart. Had they done so, they would have known the hazards that lay ahead and how close the vessel would pass to them. They did not determine or show on the chart the expected times of arrival at the waypoints for course changes and the new courses. Consequently, as the second officer approached Geikie Rock, he did not have a fix on the chart to show him the vessel's position. He did not know what the next course was going to be or when it would occur. Had he plotted several fixes, he could have determined whether the vessel was being affected by currents. Had he known the time or time interval to the next course change, he could have recognized that he should not begin his turn when he did. Had he plotted the course that the YORKTOWN CLIPPER would have to take to reach Whidbey Passage if he turned the vessel right when it was 1 1/2 miles from Drake Island, it would have been immediately obvious to him when he turned prematurely that the vessel was not aligned for the approach to Whidbey Passage and that therefore the vessel was not where he thought it was. And had he plotted a fix right after he did make his right turn and advanced his new course line, he would have seen that it would take the vessel perilously close to the rocky shoals. There would have been time, about 5 minutes, to change the vessel's course and prevent the grounding.

Even if the second officer had plotted the information for the fixes, the quality of the fixes would have been suspect. Most of the hourly positions recorded in the vessel's log consisted of a single range and a single bearing taken on identifiable objects on the radar screen. The accuracy of radar bearings depends to some extent on the skill of the operator. Furthermore, the radar manufacturer's manual states, "The simultaneous measurement of the ranges to two or more fixed objects is normally the most accurate method of obtaining a fix with radar alone. Preferably at least three ranges should be used." The manual adds, "A distinct disadvantage [of fixing position by a single range and a single bearing] however is that this method is based upon only two intersecting position lines...." By using three or more lines of position and plotting the intersecting lines, the accuracy of the fix is improved and any significant error may be detected.

Because the vessel's watch officers were not plotting the fixes but were merely entering the readings in the log, they may not have been sensitive about the quality of the fixes. Single range and bearing fixes can be taken quickly and easily, but provide less accuracy. They also had the option of taking and plotting fixes using the GPS. Had either the Clipper Cruise Line or the master provided written standards for taking fixes, the watch officers might have plotted the fixes more often and more accurately. Consequently, they could have known when they were heading into danger.

The Safety Board recognizes that the taking and plotting of fixes alone will not ensure safe navigation and sometimes may not even be feasible. In some circumstances, such as when the vessel is transiting winding, narrow channels, the watch officer will not have time to plot frequent fixes or establish course lines. However, where the conditions permit, such as when the vessel was in Glacier Bay and approaching Geikie Rock, plotting fixes and course lines is vital to safe navigation and should be done.

Fixes must be taken and charted frequently on vessels of 1,600 gross tons or more (33 CFR 164.11). After the investigation of the grounding of another passenger vessel of less than 100 gross tons,[4] the Safety Board recommended that the Coast Guard:

<u>M-86-55</u>
Require that masters and watchstanding officers on all passenger vessels that have overnight accommodations for 50 or more passengers on other than river routes comply with navigation procedures similar to those found at 33 CFR 164.11.

In its January 13, 1994, SNPRM, the Coast Guard proposes to implement this recommendation by requiring that the master ensure that periodic fixes are plotted on a suitable chart as necessary if the vessel is a small passenger vessel with overnight accommodations for more than 49 passengers. If adopted and properly implemented, this proposal can reduce the risk of grounding accidents significantly.

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[4]Marine Accident Report--*Grounding of the U.S. Passenger Vessel PILGRIM BELLE on Sow and Pigs Reef, Vineyard Sound, Massachusetts, July 28, 1985* (NTSB/MAR-86/08).

As NOAA-certified electronic chart systems become available and the DGPS is extended to include Alaska, it will be possible to fully utilize electronic charts. Watch officers on vessels traversing Glacier Bay and nearby waters can have a continuous, accurate display of their position. The system will also establish a guard zone. Watch officers will not have to calculate and plot their positions on the paper chart. They will have more time and better information for projecting any proposed maneuver and judging its consequences. Thus, the risk of groundings will be reduced.

The radar on board the YORKTOWN CLIPPER also could have been used to establish "guard zones," which define areas that a watch officer does not want any targets to enter. In this case, the second officer could have established a guard zone for Geikie Rock and the surrounding shoals. Had he done this, an alarm would not have sounded when the outer marker touched Geikie Rock, and this lack of an alarm might have helped him realize that the vessel was not yet in the correct position to begin its turn. Further, even after he had made the incorrect turn, when the inner marker touched Geikie Rock, the automatic alarm would have sounded to alert him to the danger, which might have caused him to react in time to avoid the grounding. The vessel's radar manual points out that the guard zone feature may be used to avoid "vessels [collisions], landmasses [groundings], etc." The manual also points out that using the feature does not relieve the watchstander of the responsibility for avoiding collisions and that the feature should not be used as a primary means of detecting possible collision situations. Similarly, the Safety Board believes that the feature does not relieve the watchstander of the responsibility for avoiding groundings and that neither the guard zone feature nor a range marker should be used as the primary means of detecting possible grounding situations.

While plotting quality fixes and using guard zones can reduce the chance of grounding, safe navigation also requires that the master and the watch officers plan routes in detail and evaluate the risks they may encounter. Neither Clipper Cruise Line nor the master required any passage planning. Such planning would have involved the vessel's officers in selecting safe routes, placing course lines on the chart, selecting waypoints where courses would be changed, selecting safe speeds, and determining tide and current conditions along the routes. The planning was particularly needed in this case because the master and the other two watch officers were relatively new to navigating the YORKTOWN CLIPPER in these waters. The need for such passage planning also was demonstrated on the voyage 2 weeks earlier, the second officer's first voyage through this area. He was uncertain whether he should navigate between Geikie Rock and Lone Island or between Geikie Rock and the land to the west. He asked the first officer, who happened to be on the bridge. But the first officer did not know. He had not navigated through that area either. Had the Clipper Cruise Line or the master required passage planning, the officers would have been forced to resolve such questions earlier when there was ample time to evaluate the risks and review the decisions.

The following techniques are the primary ones needed to protect vessels from grounding: planning the passage, frequently taking fixes and plotting them on the chart, and advancing course lines ahead of the vessel to the next course change and estimating when the vessel will arrive at the point where its course is to be changed. The Safety Board determines that the second officer was capable of taking and plotting fixes if so directed. Fixes, chart navigation, dead reckoning, and electronic navigation are all topics on the Coast Guard examination that he had passed for his master's license. Moreover, he demonstrated his ability when he took several GPS fixes and plotted them in response to the master's request shortly after the accident. The Board believes that vessel owners and operators need to establish and enforce high standards of navigation practices that include these safeguards for all their vessels. This is particularly critical when the navigating watch officers are rotated frequently and thus may be unfamiliar with the hazards and risks along their routes.

The Safety Board concludes that the navigational planning and positioning procedures used by the second officer were inadequate to accurately identify the vessel's position or to warn him of the danger of running aground. The Safety Board also concludes that had Clipper Cruise Line and the master exercised more oversight over the navigation of the vessel, including requiring passage planning in preparation for every voyage and setting standards for the accuracy and plotting of fixes, the vessel would have been navigated more safely in the vicinity of Geikie Rock.

Radar Training

Throughout his 3 hours on watch preceding the grounding, the second officer was navigating the vessel by using radar--a piece of equipment with which he had little training or experience. He had had no formal training in using radar. His on-the-job instruction had been limited, and he had not had to demonstrate any radar navigation skills to pass his Coast Guard license examination. He did not have and was not required to have a radar observer's endorsement. Radar endorsements are required[5] for licensed deck individuals only if they are serving on radar-equipped inspected vessels of 300 gross tons or over.

To qualify for a radar observer endorsement, an individual must successfully complete a formal training course. The Coast Guard approves both the training school and its curriculum and prescribes a minimum course length of 5 days. The course is meant to prepare the student to use radar as a tool for navigation and collision avoidance. The curriculum must include classroom instruction, demonstrations and practical exercises using simulators, and examinations in a number of radar-related subjects. The subjects are prescribed in the Federal regulations,[6] but can be summarized here as covering four topics: (1) fundamentals of radar and factors affecting its performance and accuracy, (2) operation and use of radar, (3) interpretation and analysis of radar information, and (4) plotting. Radar observer endorsements expire 5 years after the course completion date. The individual must then attend a formal training course to

[5]46 CFR 15.815, "Radar observers."

[6]46 CFR 10.305, "Radar observer qualifying courses."

renew the endorsement. The course must be at least a day long, and some students choose a 3- or 5-day version.

If the second officer had attended an approved course, he would have received training that specifically addressed the deficiencies he exhibited in this accident. For example, the course would have described the limitations in radar range and bearing measurements imposed by equipment design factors. Had he received such instruction, he might have understood the hazards of relying solely on his single-point radar range and bearing fixes. As another example, the course would have provided instruction about radar phenomena, such as false shore lines, that yield spurious radar ranges. That knowledge might have prompted him to verify his position with more frequent fixes, using different charted objects.

The Safety Board concludes that had the second officer been properly trained as a radar observer, he might have made more effective use of the radar and thus might have prevented his navigational errors.

The Safety Board has repeatedly addressed the issue of inadequate radar training and qualifications for operators of small passenger vessels that are equipped with radar. The history of those recommendations spans more than 15 years without satisfactory resolution of this passenger safety issue.

On October 12, 1978, the Safety Board issued its report of a collision between a crewboat and a tank vessel[7] in which two persons lost their lives. As a result of its investigation of the accident, the Safety Board made the following recommendation to the Coast Guard:

> <u>M-78-76</u>
> Require that the operator of every radar-equipped vessel carrying more than six passengers for hire and engaged in the offshore oil industry be qualified as a "radar observer."

The Coast Guard responded that since radar is not required to be on such vessels, there is no justification for establishing a mandatory radar observer qualification. The Safety Board is aware that small passenger vessels are not required to have radar. Many owners of such vessels, however, voluntarily equip their vessels with radar. The safety concern which then arises is that an untrained operator may improperly use or unduly rely on the radar for safe navigation.

In 1985, the Safety Board investigated the ramming of a charter fishing vessel by a crewboat in which one passenger died and two passengers suffered fractured bones. The Safety

[7]Marine Accident Report--*Collision of the Liberian Tankship M/V STOLT VIKING and U.S. Crewboat CANDY BAR in the Gulf of Mexico, January 7, 1978* (NTSB-MAR-78-9).

Board noted in its accident report[8] that, despite his lack of formal radar training, the crewboat operator was navigating his vessel at a speed of 18 knots or more in fog and depending solely on radar as a method of maintaining a proper lookout.

In the same accident report, the Safety Board noted an inconsistency in radar observer requirements. The Coast Guard does not require radar observer endorsements for licensed operators of radar-equipped inspected passenger vessels under 300 gross tons because the vessels are not required to have radar. By contrast, the Coast Guard does require[9] radar observer endorsements for licensed deck officers on radar-equipped inspected vessels of 300 gross tons and over (but less than 1,600 gross tons) even though vessels of that size are also not required to have radar. Passengers aboard small passenger vessels should be afforded the same level of safety as passengers aboard larger vessels. To address the inequity in standards, the Safety Board superseded Safety Recommendation M-78-76 on March 4, 1986, with a recommendation that the Coast Guard:

> <u>M-86-27</u>
> Require that ocean operators of all inspected radar-equipped, mechanically propelled passenger vessels under 300 gross tons be qualified as radar observers.

In its response of February 13, 1987, the Coast Guard concurred with the intent of the recommendation and stated that it had initiated two relevant regulatory projects. Under the first project, the Coast Guard would consider the need for radar aboard small passenger vessels as a part of the forthcoming revisions to 46 CFR, Subchapter T. Should the Coast Guard decide to require radar on such vessels, the second regulatory project, which would address manning and personnel qualification issues, would propose requiring the vessels' masters and mates to be qualified as radar observers. On May 11, 1987, the Safety Board classified Safety Recommendation M-86-27 "Open--Acceptable Response," pending the outcome of the Coast Guard's regulatory initiatives.

The Safety Board subsequently investigated still another collision between two small passenger vessels in which 17 passengers and 1 crewmember were injured.[10] The operators of both vessels were relying on their radar for navigation and collision avoidance. Noting the expansion of the small passenger vessel industry, the Safety Board urged the Coast Guard to amend the regulations to better conform with the use of radar aboard small passenger vessels. As a result of its investigation, the Safety Board superseded Safety Recommendation M-86-27 and on March 14, 1988, issued the following recommendation to the Coast Guard:

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[8]Marine Accident Report--*Collision Between the Fishing Vessel GULF QUEEN and the Crewboat ALAN McCALL in the Gulf of Mexico, March 9, 1985* (NTSB/MAR-86/04).

[9]46 CFR 15.815.

[10]Marine Accident Report--*Collision of the Commuter Ferries JACK W and JAMEY DOWNEY, Lower New York Bay, June 22, 1987* (NTSB/MAR-88/02).

M-88-9
Require that operators of all inspected radar-equipped passenger vessels under 300 gross tons be qualified as radar observers.

The Coast Guard responded to Safety Recommendation M-88-9 on July 29, 1988, by stating, as it had to Safety Recommendation M-86-27, that it concurred with the intent of the recommendation and that it had initiated two relevant regulatory projects. On October 25, 1988, the Safety Board replied to the Coast Guard, stating that it had classified Safety Recommendation M-88-9 "Open--Acceptable Response" and that it urged the Coast Guard to expedite publication of the proposed rule changes.

The Coast Guard's SNPRM published on January 13, 1994, proposes rules about small passenger vessel inspection and certification. The rules do not address any aspect of manning the vessels or of determining the qualifications of personnel assigned to them. In May 1994, the Safety Board emphasized the high priority it places on this vital safety area by adding "small passenger vessel safety" to its "Most Wanted" list of transportation safety improvements.

It has been nearly 6 years since the Safety Board last urged the Coast Guard to address personnel qualification issues. Action is long overdue. Because it has not seen any significant progress in this area, the Safety Board has reclassified Safety Recommendation M-88-9 "Open--Unacceptable Response." In view of the circumstances of this accident and because the Coast Guard has not yet agreed to require radar observer endorsements for operators of small passenger vessels, the Safety Board reiterates Safety Recommendation M-88-9.

Radar Stabilization

When the radar aboard the YORKTOWN CLIPPER was used to take bearings for recording the vessel's position, the bearing of the charted object selected was automatically depicted on the radar screen numerically. This bearing, however, was a relative bearing and had to be combined with the vessel's heading to convert it to a true bearing if it was to be plotted on the chart. Such calculations not only delay getting the results, but also increase the probability of making arithmetic errors and add to the workload of the navigating watch officer.

Any yawing (oscillations of the vessel's heading about its intended course), which occurs normally because of sea motion or steering errors, would also adversely affect the timeliness and accuracy of the radar bearings used for obtaining fixes. The yawing causes the relative bearings to change constantly and also smears the radar picture, making the location of the radar bearing uncertain. The problem can be minimized by having a second person (usually the helmsman) read the compass heading while the watch officer operates the radar. As the sole member of the navigational watch, however, the second officer would have had to perform the two tasks sequentially, thus introducing time delays and possible errors into the fix data.

These handicaps can be readily eliminated by connecting the gyrocompass output to the radar, which normally is designed to accommodate this input. The radar then becomes stabilized so that the radar presentation does not smear as the vessel yaws, and all bearings are shown as true bearings that can be plotted without being modified, assuming the gyrocompass has no error. Such direct, rapid reading of radar bearings may encourage the taking and plotting of fixes. Also, such radar stabilization provides other safety benefits when the radar is used for collision avoidance.

The YORKTOWN CLIPPER was equipped with a gyrocompass, and the installed radar was designed to accept the gyrocompass input with slight modification. However, Clipper Cruise Line had not installed the modification that would have stabilized the radar. The Safety Board concludes that had the radar been gyrostabilized, it would have facilitated the taking and plotting of accurate fixes. To improve the safety of its vessel operations, Clipper Cruise Line should gyrostabilize the radars on its vessels.

The Safety Board has previously made a number of safety recommendations requiring that small passenger vessels be equipped with radar and, in particular, with gyrostabilized radar. In its report on a collision between the U.S. passenger vessel M/V YANKEE and the Liberian freighter M/V HARBEL TAPPER,[11] the Safety Board concluded that one of the contributing causes of the accident was the overreliance of the YANKEE's master on his nonstabilized radar equipment, which could not be used for accurate radar contact plotting and evaluation. On August 23, 1984, as a result of its investigation, the Safety Board recommended that the Coast Guard:

> <u>M-84-24</u>
> Require passenger vessels subject to 46 CFR Subchapter H and small passenger vessels subject to 46 CFR, Subchapter T, which carry more than 150 passengers, engaged in coastwise, bays, sounds, or offshore service on extended routes, to be equipped with a gyrostabilized radar suitable for rapid plotting of radar contacts and for navigation.
>
> On February 26, 1985, the Coast Guard responded:
>
> This recommendation is not concurred with. Current regulations require passenger vessels of 1,600 gross tons and over in ocean or coastwise service to have a marine radar. The need for a gyrostabilized radar is not justified. The desired effect can be attained by a general marine radar when used by a competent mariner.
>
> The Coast Guard is currently reviewing its regulations concerning small passenger vessels. During this study, the need for radar on these vessels as well as on

[11]Marine Accident Report--*Collision of the U.S. Passenger Vessel M/V YANKEE and the Liberian Freighter M/V HARBEL TAPPER in Rhode Island, July 2, 1983* (NTSB/MAR-84-05).

passenger vessels of less than 1,600 gross tons will be examined. Depending on the results of this study, the applicable regulations may be amended.

On July 22, 1985, the Safety Board classified Safety Recommendation M-84-24 "Open--Unacceptable Action," pending the results of the study. The Board subsequently classified the recommendation "Closed--Unacceptable Action" on August 1, 1988, because the Coast Guard had not yet completed its study.

As a result of its investigation of the grounding of the U.S. passenger vessel M/V PILGRIM BELLE,[12] the Safety Board reaffirmed its view that gyrostabilized radar would enhance the level of safety for small passenger vessels. On July 24, 1986, the Board issued Safety Recommendation M-86-52 to the Coast Guard:

> Require all passenger vessels that have overnight accommodations for 50 or more passengers and that operate on all routes other than rivers be equipped with a gyrostabilized radar.

The Coast Guard's response of February 19, 1987, partially concurred. The Coast Guard stated that the need for radar requirements on small passenger vessels would be considered as part of the forthcoming revisions to 46 CFR, Subchapter T, but that it would not consider requiring that radar equipment be gyrostabilized. On October 2, 1987, the Safety Board classified Safety Recommendation M-86-52 "Closed--Unacceptable Action"; however, the Board asked that the Coast Guard reconsider its position.

In its report on the collision between the commuter ferries JACK W and JAMEY DOWNEY,[13] discussed above in connection with radar observer qualifications, the Safety Board also recommended that the Coast Guard:

> <u>M-88-11</u>
> Require, in the current regulatory project (CGD 85-080) concerning small passenger-carrying vessels, that all inspected passenger vessels that carry 50 or more passengers be equipped with radar.
>
> The Coast Guard responded on July 29, 1988, that:
>
> The Coast Guard partially concurs with this recommendation. As part of the project to rewrite 46 CFR, Subchapter T, Small Passenger Vessels, the Coast Guard is considering proposing that certain vessels be required to have radar dependent upon number of passengers carried, route, and type of operation. We do not intend to require all vessels carrying 50 or more passengers to have radar

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[12]See footnote 4.

[13]See footnote 10.

since many such vessels do not operate in a manner which would make radar necessary.

On October 25, 1988, the Safety Board classified Safety Recommendation M-88-11 "Open--Acceptable Response," pending publication of the Final Rule for 46 CFR, Subchapter T. In the SNPRM published on January 13, 1994, the proposed rules at 46 CFR 121.404 and 184.404, "Radars," require that a "general marine radar system for surface navigation" be fitted on specified small passenger vessels. The Safety Board believes that sections 121.404 and 184.404 are a significant improvement over existing regulations and urges their adoption. But the SNPRM does not require that radar be installed on small passenger vessels already in operation, nor does it require that radar be gyrostabilized on existing or future small passenger vessels. Because the Safety Board believes that existing vessels, such as the YORKTOWN CLIPPER, that carry 50 or more passengers should be equipped with a radar, the Safety Board has reclassified Safety Recommendation M-88-11 "Open--Unacceptable Response."

Most passenger vessels that carry more than 49 passengers and operate on other than river routes are already fitted with radar, and many of those vessels are also equipped with gyrocompasses. Most radar can be readily modified to accept stabilizing inputs from the gyrocompass at reasonable cost. The Safety Board believes that existing and future small passenger vessels should be required to have gyrostabilized radar.

Informing Passengers and Crew

The grounding impact was felt and heard throughout the vessel. The master did not sound the general alarm and waited about 15 minutes before making a public address announcement. He wanted to assess the situation and inform the passengers in a way that would not cause unnecessary alarm. At the moment of impact, one large group of passengers was meeting in the vessel's dining room. After the impact, they continued to meet even after the vessel began to list, until they heard the master's announcement about preparing to evacuate. Most crewmembers were prepared to react to the emergency, but the lack of a general alarm signal created uncertainties about their actions. In fact, the first officer had to instruct crewmembers he encountered to go to their emergency stations.

The Safety Board evaluated the stability of the YORKTOWN CLIPPER at various flooding stages and for different conditions of vessel loading. The vessel met the Coast Guard standards for subdivision and stability. In this accident, the total area of hull ruptures was not large and the penetrations were not deep into the hull. However, the ruptures to the hull affected four spaces formed by four watertight bulkheads and the bow. The Safety Board concludes that the crew, the Coast Guard, and the NPS responded effectively in preventing harm to the passengers and in saving the vessel from possible sinking. Safety Board calculations show that had the crew and all those who assisted them not been able to keep the flood water from rising above the top of the bow thruster room, flooding would have progressed along the main deck, submerging the bow and sinking the vessel. Furthermore, had the vessel been loaded with fuel and stores to its maximum authorized draft, the same dewatering efforts might not have been sufficient to prevent the vessel from sinking. Because assessing risks such as these is difficult and time consuming, it is important that the master communicate with the passengers and crew either by the general alarm or the public address system without delay. The Safety Board believes that informed passengers are less likely to panic and are better prepared to act if need be.

In this accident, the procedure used by the master to assess the danger before using the public address system did not adversely affect passenger safety. However, under other circumstances, a delay in getting the passengers into their life jackets and getting the crew and passengers to their emergency stations could be critical to their survival. The Safety Board believes that precisely because the seriousness of the situation is unknown immediately after an accident, the general alarm should be sounded. Rather than creating confusion, sounding the alarm will inform the passengers and crew that the master is aware of the emergency and is taking action. Further, time spent making an evaluation before making a public announcement cannot be recovered, and if a vessel is about to sink, there may be insufficient time left to conduct a safe and orderly abandonment. After immediately sounding the general alarm to alert the passengers and sending the crew to the emergency stations, the master can then make any reassuring or explanatory announcements he deems necessary. The Safety Board concludes that the passengers and crew would have been better prepared to respond to the emergency if they had been informed of the situation immediately after the grounding. If for some reason the master does not sound the general alarm, however, the Safety Board believes that masters on Clipper Cruise Line vessels should be required to use the public address system without delay to alert passengers and crew of an emergency.

Manhole Covers

The hold deck which extended from the forward boundary of the engineroom (frame 45) to the bow thruster room (frame 15) was designed to be watertight. If any space below this deck were to flood accidentally, the flooding would be contained and the ship could survive. The manhole covers installed in this deck were crucial to the watertight integrity of the vessel and, therefore, to the vessel's safety.

Water leaking through the single center-bolt manhole cover over the port void, which the engineer tried to tighten, caused the storeroom to flood. This flooding caused the bow to sink more and increased the risk that the bow thruster room would overflow and sink the vessel. Fuel oil leaking through the single center-bolt manhole cover over the duct in the forward crew quarters caused oil damage to the crew quarters and led to dewatering complications. The Safety

Board concludes that the single center-bolt manhole cover is not an adequate design for use as part of a watertight boundary.

The Coast Guard guides its inspectors concerning the acceptance of "single-dogged" hatches and scuttles, similar to manhole covers, through instructions in its *Marine Safety Manual*, Volume IV. The manual points out under "Hull Fittings and Closures" that approval of the installation of such closures is left to the discretion of the local inspector. Further it states that "these fittings should be accepted as being watertight and, therefore, may be used in compartments such as voids and ballast tanks in any type of vessel or service, subject to the approval of the OCMI [Officer In Charge of Marine Inspection]." The manual cautions, however, that "these fittings are difficult to maintain gastight, and shall not be used in cargo or fuel tanks where lack of a gastight seal poses a serious hazard." This accident shows that the known maintenance difficulty may also pose a serious hazard to the watertight integrity of passenger vessels. In this case, the tops of the vessel's voids and ducts formed part of the watertight boundary, and the manhole covers needed to be as effective and reliable as the rest of the boundary to prevent progressive flooding. This was essentially confirmed when the Coast Guard required that these covers be welded closed before the vessel was permitted to depart for its shipyard repairs. In addition, the company representative stated that the company intended to replace all such single center-bolt manhole covers on watertight boundaries with covers that rely on multiple periphery bolts to keep them tight. Given the known maintenance difficulty of single-dogged center-bolt manhole covers, the Coast Guard needs to reexamine its policy of permitting their use in double bottoms that are required to be watertight. The Coast Guard should require compliance with a suitable watertight reliability performance standard or prohibit the use of such covers where the boundaries are required to be watertight.

Toxicological Testing

Toxicological testing was not conducted until about 1000 the next morning, 18 1/2 hours after the grounding. Because of the delay in collecting the urine specimen and the absence of breath or blood alcohol test results, the Safety Board cannot conclusively rule out impairment by drugs or alcohol as a factor in the accident.

The Safety Board recognizes that the foremost concern after an accident is the safety of people, property, and the environment. However, the Safety Board regards the 18 1/2 hour delay in testing as excessive. The Board has investigated several accidents[14] in which there were

[14]Some recent examples are 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); Highway-Marine Accident Report--*Collision of the U.S. Towboat CHRIS and Tow with the Judge William Seeber Bridge, New Orleans, Louisiana, May 28, 1993* (NTSB-HAR-94/03); and Railroad Accident Report--*Derailment of National Railroad Passenger Corporation (Amtrak) Train 2, the Sunset Limited, on the CSXT Big*

significant delays in collecting toxicological specimens from marine employees. The Board determines that the delays arise in part from the lack of specificity in the regulations. Marine employers are required[15] to ensure that toxicological test specimens are collected "as soon as practicable" from employees who are involved in a serious marine accident. The determination of what that means in terms of elapsed time is left to the marine employer and is open ended.

Bayou Canot Bridge near Mobile, Alabama, September 22, 1993 (forthcoming).

[15]46 CFR 4.06-20(c).

CONCLUSIONS

Findings

1. The grounding of the YORKTOWN CLIPPER was not caused by the weather, equipment failures, or crew fatigue.

2. The navigational planning and positioning procedures used by the second officer were inadequate to accurately identify the vessel's position or to warn him of the danger of running aground.

3. Had the second officer been properly trained as a radar observer, he might have made more effective use of the radar and thereby prevented his navigational errors.

4. Had the radar been gyrostabilized, it would have facilitated the taking and plotting of accurate fixes.

5. Had Clipper Cruise Line and the master exercised more oversight over the navigation of the vessel, including requiring passage planning in preparation for every voyage and setting standards for the accuracy and plotting of fixes, the vessel would have been navigated more safely in the vicinity of Geikie Rock.

6. The passengers and crew would have been better prepared to respond to the emergency if they had been informed of the situation immediately after the grounding.

7. The crew, the Coast Guard, and the National Park Service responded effectively in preventing harm to the passengers and in saving the vessel from possible sinking.

8. The single center-bolt manhole cover is not an adequate design for use as part of a watertight boundary.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the grounding of the YORKTOWN CLIPPER was the failure of the second officer to plot his courses and positions, due to the Clipper Cruise Line's and master's inadequate oversight of the watch officers' navigational planning and procedures. Contributing to the accident was the Coast Guard's lack of a requirement that watch officers on small passenger vessels equipped with radar be qualified in radar navigation.

Recommendations

As a result of this investigation, the National Transportation Safety Board reiterates Safety Recommendation M-88-9 made to the Coast Guard on March 14, 1988:

> Require that operators of all inspected radar-equipped passenger vessels under 300 gross tons be qualified as radar observers.

Also, as a result of this investigation, the National Transportation Safety Board makes the following recommendations:

--to the U.S. Coast Guard:

Require that radar be gyrostabilized on any small passenger vessel that is constructed after the Final Rule for 46 CFR, Subchapter T, becomes effective if the vessel carries more than 49 passengers and operates on routes other than rivers. (Class II, Priority Action) (M-94-15)

Require that radar be gyrostabilized on any existing small passenger vessel that carries more than 49 passengers and operates on routes other than rivers. (Class II, Priority Action) (M-94-16)

Require manhole covers installed in watertight double bottoms on small passenger vessels to meet a suitable watertight reliability performance standard. (Class II, Priority Action) (M-94-17)

--to Clipper Cruise Line, Inc.:

Develop written instructions specifying safe standards for passage planning, radar navigation, dead reckoning, and charting, and require that the masters and navigating watch officers aboard your vessels adhere to these standards. (Class II, Priority Action) (M-94-18)

Modify the radar on your vessels to accept input from the gyrocompass so the radar can be used in the stabilized mode, and require that it be used in the stabilized mode when plotting. (Class II, Priority Action) (M-94-19)

Encourage the masters of your vessels to use the public address system without delay to alert passengers and crew of an emergency in the event the general alarm is not sounded immediately. (Class II, Priority Action) (M-94-20)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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July 19, 1994