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# **NATIONAL TRANSPORTATION SAFETY BOARD**

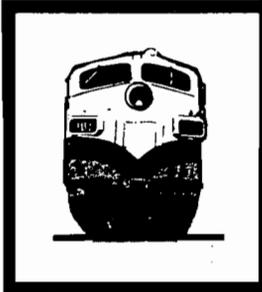
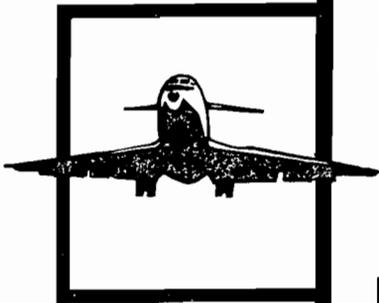
WASHINGTON, D.C. 20594

## **MARINE ACCIDENT REPORT**

**LOSS OF THE  
U.S. FISHING VESSEL AMAZING GRACE  
ABOUT 80 NAUTICAL MILES EAST OF  
CAPE HENLOPEN, DELAWARE  
ABOUT NOVEMBER 14, 1984**

**NTSB/MAR-85/07**

**UNITED STATES GOVERNMENT**



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<p>16. Abstract About November 14, 1984, the 86-foot-long uninspected U.S. fishing vessel AMAZING GRACE sank while on a fishing trip for scallops about 80 nautical miles east of Cape Henlopen, Delaware; there probably were seven crewmembers aboard. A 16-day search by the U.S. Coast Guard resulted in finding only one of the two liferafts on the vessel. The liferaft was empty. The crewmembers are missing and presumed dead. As of the date of this report, the AMAZING GRACE has not been located. The vessel's estimated value was \$500,000.</p> <p>The National Transportation Safety Board is unable to determine the probable cause of the loss of the AMAZING GRACE.</p>					
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WASHINGTON, D.C. 20594**

**MARINE ACCIDENT REPORT**

**Adopted: July 9, 1985**

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**LOSS OF THE U.S. FISHING VESSEL AMAZING GRACE  
ABOUT 80 NAUTICAL MILES EAST OF  
CAPE HENLOPEN, DELAWARE  
ABOUT NOVEMBER 14, 1984**

**SYNOPSIS**

About November 14, 1984, the 86-foot-long, uninspected U.S. fishing vessel AMAZING GRACE sank while on a fishing trip for scallops about 80 nautical miles east of Cape Henlopen, Delaware; there probably were seven crewmembers aboard. A 16-day search by the U.S. Coast Guard resulted in finding only one of the two liferafts on the vessel. The liferaft was empty. The crewmembers are missing and presumed dead. As of the date of this report, the AMAZING GRACE has not been located. The vessel's estimated value was \$500,000.

The National Transportation Safety Board is unable to determine the probable cause of the loss of the AMAZING GRACE.

**INVESTIGATION**

**The Accident**

On November 7, 1984, the 86-foot long U.S. fishing vessel AMAZING GRACE (see figure 1) departed Hampton, Virginia, for about a 17-day fishing trip for scallops off the Virginia, Maryland, Delaware, and New Jersey coasts. (See figure 2.) Aboard the vessel were its captain, its mate, and probably five other crewmembers. Since there was no crew list left ashore, and the Safety Board as of the date of this report has not found anyone who saw the vessel depart from port, the identities and number of persons aboard is uncertain, except for the captain and the mate, both of whom spoke on the radio later to another fishing vessel.

The captain of the ATLANTIC PRIDE, a brother of the captain of the AMAZING GRACE, stated that he returned from a fishing trip on the day that his brother departed, that his brother had just returned from a week-long vacation in Texas, and that he had only talked to his brother briefly that day, while both were in port. On November 8, 1984, the captain of the ATLANTIC PRIDE, which is owned by the same family that owned the AMAZING GRACE, received a radio message from his brother requesting 200 scallop bags, which are used to store the scallops after shucking, and some cleaning supplies for delivery to the AMAZING GRACE. Before the captain of the ATLANTIC PRIDE left Hampton on November 9, a member of the owner's family asked him to buy some spare "V" belts for the freshwater pumps on the AMAZING GRACE and to deliver them to the AMAZING GRACE.

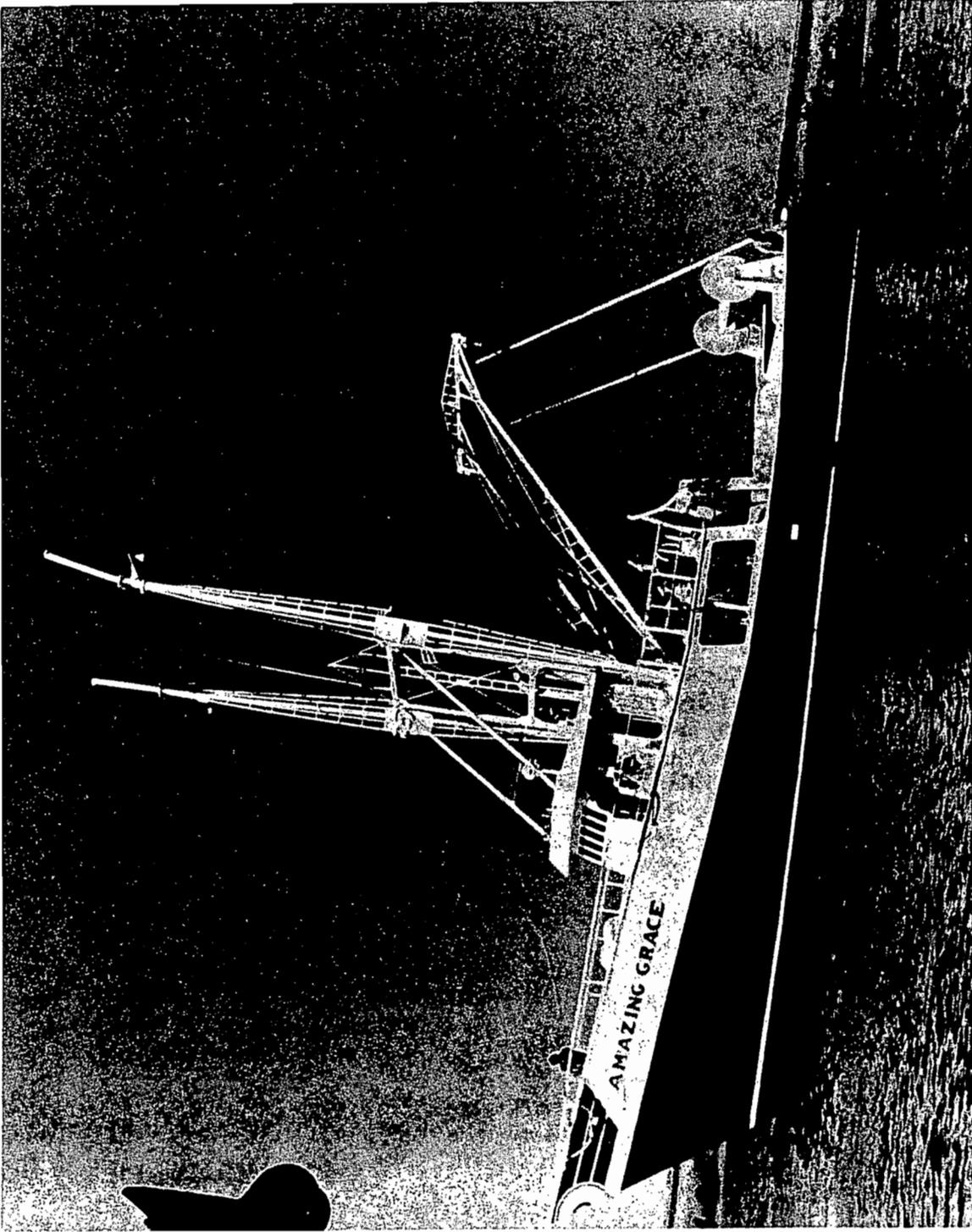


Figure 1.--U.S. fishing vessel AMAZING GRACE.

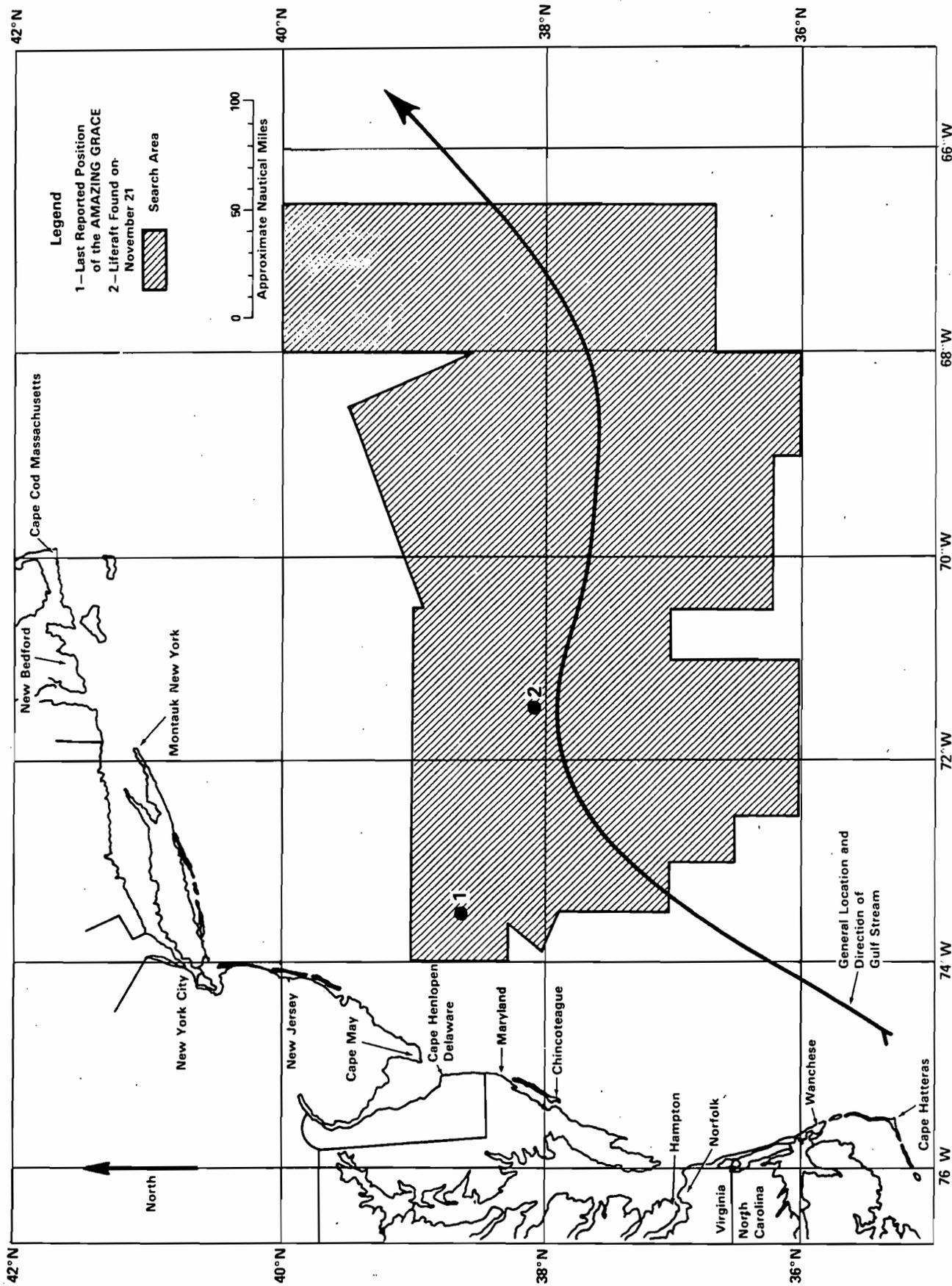


Figure 2.--Search area from November 15 to November 20, 1984, and position of liferaft found on November 21, 1984.

Sometime between 0100 <sup>1/</sup> and 0600 on November 14, the mate on the AMAZING GRACE and the mate on the ATLANTIC PRIDE were in radio contact to arrange a meeting to transfer supplies. The ATLANTIC PRIDE was at LORAN-C <sup>2/</sup> coordinates 42630 and 26630 (38°42' N latitude, 73°41' W longitude). The AMAZING GRACE was at LORAN-C coordinates 42585 and 26580 (38°37' N latitude, 73°30' W longitude), about 10 nautical miles to the southeast of the ATLANTIC PRIDE. The captain of the ATLANTIC PRIDE said that, at the time of the radio conversation, the winds were blowing from the northwest at about 40 mph (35 knots) and the seas were about 10 feet high. He told his mate to head toward the AMAZING GRACE to deliver the supplies.

About 0720, the captain of the ATLANTIC PRIDE contacted his brother via radio, and his brother reported that the AMAZING GRACE had taken a wave over its bow, that there was water on the after deck, that the crew was to open the freeing ports, and that he was going below to the engineroom to pump out the fish hold. The captain of the ATLANTIC PRIDE testified that his brother did not express any sense of concern or that there was a problem.

The captain of the ATLANTIC PRIDE said that, at the time of their conversation about 0720, the AMAZING GRACE was not fishing but was jogging <sup>3/</sup> toward shore and that the vessels had put off their rendezvous because of bad weather and because the mate on the AMAZING GRACE said they did not need the supplies being delivered immediately. The captain of the ATLANTIC PRIDE resumed fishing during the morning and attempted periodically to call his brother on the AMAZING GRACE via VHF-FM radiotelephone until 1200 without success. The captain of the ATLANTIC PRIDE had some concern at that time because his brother's boat should have been only 7 or 8 miles away, yet he could not make radio contact. The captain of the ATLANTIC PRIDE decided to take his mate's watch from 1200 to 1800 and his own watch from 1800 to midnight. From 1200 to midnight, the captain of the ATLANTIC PRIDE tried repeatedly to call the AMAZING GRACE without success, and then retired for the night.

The captain of the ATLANTIC PRIDE stated that about 0300 on November 15, he awoke and noticed that the wind had changed direction from the northwest to the southwest at 25 to 30 mph and there were 8- to 10-foot seas on the morning of November 15. When he awoke at 0600 on November 15 and learned that there was still no radio communication with the AMAZING GRACE, the captain of the ATLANTIC PRIDE decided to call the U.S. Coast Guard (USCG). He tried about 0700 on his VHF-FM radiotelephone to call the USCG but was unsuccessful, so he asked the captain of the CAROLINA PRINCESS, another fishing vessel in the area, to call the USCG.

At 1037 on November 15, the USCG Station Cape May, New Jersey received the following transmission from the captain of the CAROLINA PRINCESS:

<sup>1/</sup> All times are eastern standard time and are based on the 24-hour clock.

<sup>2/</sup> LORAN-C is a pulsed, low-frequency, hyperbolic radionavigation system maintained by the U.S. Coast Guard. LORAN-C position lines are overprinted on most charts published by the National Oceanic and Atmospheric Administration.

<sup>3/</sup> Jogging denotes that the vessel is underway at about half speed during bad weather and attempting to move slowly toward shore where the waves are less severe.

Group Cape May, Group Cape May, this is the (Garbled) the CAROLINA PRINCESS, Group Cape May can you hear me over? What we are calling you about (Garbled) is if you have seen or heard of the AMAZING GRACE. The trawler AMAZING GRACE. Yesterday morning at seven thirty was the last time anyone had contact with him. He had water in his ice box, water in his engine room (Garbled) but he was not going to worry about it, to see if he could pump it out. But no one has had real contact with him since. We need to see if you can locate him or to look around to see if he is in Cape May. We haven't been able to get no radio contact out of the man whatsoever. And we don't know what to do about it. The last (Garbled) was at 4085 but we don't know exactly what the 23 degree was, somewhere around the (Garbled) we don't know 580 or something like that. But we don't know. He cut out when he found out what happened and he said he'd get back. We called the ATLANTIC and everyone has called him, but we have not been able to get him over.

42585 26580 was the last position we know, the last known position. Over. What time what? (Garbled) behind Cape May within the last twenty-four hours. He should be at one or the other and he's not at either one. He had a VHF, CB, and the (Garbled) that's the one we were talking on and we haven't been able to get him on any of them. So, we'll be standing by listening up for you (Garbled) if you could let us know. His boat is maroon, trimmed with white rigging. The hull of the boat is maroon, rusty maroon trimmed white, she is about eighty foot long. About twenty five feet wide. With a bluish superstructure. Well is [sic] is Cold Springs (Garbled) Cold Springs we had (Garbled) and he said something about Cold Springs. That's what we talked about we don't know if where he went he should have gone to Cold Springs, or (Garbled) we don't know which one he's at over we talked to him on the radio and he said he hadn't seen him (Garbled) interested in getting on home if you know what I mean. The last contact was at seven thirty yesterday morning.

The radio transmission lasted until about 1111. The captain of the CAROLINA PRINCESS later testified that he meant the AMAZING GRACE's ice box or fish hold and not the engineroom had water in it. After the transmission, and as requested by the USCG, the ATLANTIC PRIDE, the CAROLINA PRINCESS, and the CAPT MALC, another fishing vessel, stopped fishing and proceeded to the last reported position of the AMAZING GRACE to search for the vessel. During the night of November 15-16, the CAROLINA LADY, the CAROLINA GIRL, the CAROLINA TARHEEL, and the CAROLINA DREAM arrived in the area to search. On the morning of November 16, the CAROLINA PRINCESS departed the search area to resume fishing.

The following is a summary of the USCG search efforts on November 15 concerning the AMAZING GRACE:

- 1125 - Station Cape May began a preliminary telephone check of harbors where the AMAZING GRACE might have sought refuge.
- 1129 - Station Cape May notified the USCG rescue coordination center (RCC) in New York, New York, of the situation, including the last reported position of the AMAZING GRACE.

- 1210 - Station Cape May initiated an urgent marine broadcast to all vessels off the New Jersey, Delaware, and Maryland coasts to be on the lookout for the AMAZING GRACE.
- 1235 - Station Cape May requested USCG stations at Chincoteague and Hampton Roads, Virginia, and at Cape Hatteras, North Carolina, to initiate a similar urgent marine broadcast.
- 1306 - RCC New York assumed control of the search, began an extended check of harbors, and decided to deploy search craft.
- 1330 - RCC New York requested the launch of an HU-25 jet aircraft from the USCG air station at Cape Cod, Massachusetts, to search at the last reported position of the AMAZING GRACE.
- 1343 - HH-52 helicopter 1418 from Cape May was airborne to search the area near the last reported position of the AMAZING GRACE.
- 1352 - The 95-foot cutter CAPE STARR, which had been underway from Cape May, was diverted to the search area.
- 1357 - HH-52 helicopter 1463 from Cape May was airborne to join the search.
- 1358 - The 82-foot cutter POINT BATAAN was underway from Cape May for the search area.
- 1358 - USCG was advised by the owner that the AMAZING GRACE had seven to nine persons aboard, one 12-person Givens liferaft, and no EPIRB. 4/
- 1525 - Helicopter 1418 departed the search area.
- 1530 - The jet aircraft from Cape Cod arrived at the search area.
- 1535 - Helicopter 1463 deployed a datum marker buoy 5/ near the last reported position of the AMAZING GRACE.
- 1545 - Helicopter 1463 departed the search area.
- 1600 - RCC New York began a search using computer programming.

4/ EPIRB is the acronym for an emergency position indicating radio beacon. An EPIRB, which may be either manually or automatically operated, will send a distress signal when activated on a frequency that commercial aircraft, some military aircraft, and some satellites monitor.

5/ A datum marker buoy is a floating radio beacon which can be dropped from an aircraft and which transmits on UHF radio frequencies. Since datum marker buoys are not affected by the wind, their movement provides a measure of surface currents.

- 1614 - The POINT BATAAN and CAPE STARR were recalled to Cape May because they were not considered to be effective search platforms in the 8- to 10-foot seas.
- 1631 - The 210-foot USCG cutter CHILULA was diverted from its fisheries patrol to the search area as onscene commander.
- 1642 - USCG was advised by the owner that there probably were nine persons aboard the AMAZING GRACE.
- 1713 - The HU-25 jet aircraft departed the search area.
- 2053 - A C-130 aircraft arrived in the search area to search for flares.
- 2312 - The C-130 aircraft departed the search area.

When the captain of the CAROLINA PRINCESS first contacted USCG Station Cape May, the captain gave the last reported position of the AMAZING GRACE in terms of LORAN-C coordinates, 42585 and 26580 or 38°37' N latitude, 73°30' W longitude. The watchstander at Cape May incorrectly converted the LORAN-C coordinates to 38°39' N latitude, 73°41' W longitude or the approximate position of the ATLANTIC PRIDE, about 10 nmi to the northwest of the last reported position of the AMAZING GRACE. RCC New York used these incorrect latitude and longitude coordinates as the position from which to begin its search. In fact, however, the actual last reported position of the AMAZING GRACE was the center of the search area on November 15, and the datum marker buoy was deployed in position 38°41' N latitude, 73°30' W longitude.

The USCG has developed a computer program, Computer Assisted Search Planning (CASP), to aid RCC personnel to maximize the effectiveness of the search resources available to them. During the search for the AMAZING GRACE, the USCG search planner entered into CASP such information as the number of hours of aircraft flying time available the next day, drift information from the datum marker buoy, and environmental data. The CASP program then computed the drift 6/ from the AMAZING GRACE's last reported position of the fishing vessel, of a liferaft with a drogue which would have similar characteristics to the liferafts aboard the AMAZING GRACE, a liferaft without a drogue, and a person in the water. CASP then calculated the search areas with the highest probability of finding each search object. The search planner then assigned altitudes and space trackings for each aircraft.

At 0310 on November 16, the CHILULA arrived onscene. During the morning of November 16, the captain of the ATLANTIC PRIDE asked the USCG for the coordinates it had computed for the drift of the AMAZING GRACE, a liferaft with a drogue, and a person in the water. The ATLANTIC PRIDE proceeded to search near the coordinates for a liferaft with a drogue, the CAROLINA LADY proceeded to search near the predicted coordinates for the AMAZING GRACE, and the other fishing vessels searched other areas.

During the day on November 16, three USCG and two U.S. Navy (USN) aircraft, using the results of the CASP program, searched over 5,000 square nautical miles. The USCG determined that there was a 66-percent probability of detecting the AMAZING

6/ Drift refers to both the speed and direction of an object due to currents as well as leeway (the speed and direction of an object due to local winds).

GRACE within the area searched. At 2000, RCC New York was notified that the CAPT LIS, another fishing vessel which had joined the search, had sighted three flares about 22 nautical miles to the northwest of the last reported position of the AMAZING GRACE. From 0230 to 0530 on November 17, a USCG aircraft conducted a search in the area where the flares had been sighted. All the fishing vessels also converged on this area to search. During the day on November 17, the search area covered 18,861 square nautical miles using four USCG, four USN, and one U.S. Air Force (USAF) aircraft. Although the weather conditions continued to be unfavorable for searching, the USCG determined that the probability of detecting the AMAZING GRACE was 77 percent. On the morning of November 17, the ATLANTIC PRIDE and the CAROLINA LADY searched near the coordinates determined by the USCG for a person in the water.

In planning the search for November 18, the USCG began to consider the influence of the Gulf Stream <sup>7/</sup> which was running in a northeasterly to easterly direction about 75 nautical miles southeast of the last reported position of the AMAZING GRACE. (See figure 2.) The USCG estimated that, by November 17, search objects from the AMAZING GRACE might have been affected by the Gulf Stream. On November 18, five USCG and one USN aircraft searched 19,200 square nautical miles. The USCG determined that the probability of detection for the AMAZING GRACE was 90 percent. The ATLANTIC PRIDE resumed fishing near the last reported position of the AMAZING GRACE. The ATLANTIC PRIDE maintained radio contact with the USCG and returned to Hampton about December 1. On November 18, the USCG learned from the owner that there were two 6-person Givens liferafts aboard the AMAZING GRACE, rather than the one 12-person Givens liferaft as reported earlier.

On November 19, the owner advised the USCG that there were seven persons aboard the AMAZING GRACE, rather than the nine persons previously reported. Also on that day, the USCG completed its search of harbors from Montauk, New York, to Cape Hatteras. During the day on November 19, four USCG and one USAF aircraft searched 17,632 square nautical miles. Since the probability of detecting the AMAZING GRACE was nearly 100 percent, the USCG concentrated its search planning for November 20 on finding one of the vessel's liferafts. The USCG determined at the completion of the search on November 19 that the probability of detecting a liferaft in the areas it had scheduled to be searched was 90 percent. However, one portion of its planned search area on November 19 was not covered because the assigned aircraft ran low on fuel and had to leave the search area.

The USCG Chief of Search and Rescue (SAR) in New York later testified that, since a 78-percent probability of detection (POD) was the norm for a search effort and, as of November 19, the POD had exceeded 90 percent, the USCG decided to concentrate its efforts on searching farther to the east on November 20 in case it had underestimated the influence of the Gulf Stream. At the completion of the search on November 20, the USCG Chief of Search and Rescue in New York recommended that the active search be terminated. However, his superior told him to search one more day. The USCG suspended its active search at 1950 on November 21. The 22,260-square nautical mile search on November 20 was conducted 150 to 200 nautical miles to the east of where a liferaft from the AMAZING GRACE, unbeknown to RCC New York, was found on November 21.

At 0915 on November 21, the 561-foot-long Danish containership CLIFFORD MAERSK recovered a Givens liferaft in position 38°3.5' N latitude, 71°27.8' W longitude.

<sup>7/</sup> The Gulf Stream is a strong current, originating in the Gulf of Mexico, which runs northward along the east coast of the United States and sweeps eastward across the Atlantic Ocean at about 38° N latitude.

At 1045, the vessel's master sent a message addressed to the USCG via Chatham Radio, a commercial radio station, that serves commercial marine vessels advising that the liferaft had been recovered and giving the data plate information. The message was misrouted through the Radio Corporation of America (RCA) telecommunications network to the USCG AMVER 8/ Center in New York instead of to the USCG Operations Center in New York. The message was transmitted to the AMVER Center at 1252 and processed routinely as an AMVER position message. It was not recognized by an AMVER watchstander as other than a routine position message until 1931 when it was sent to the USCG Operations Center's Communications Center. By 2100, the message had been forwarded to the RCC New York personnel controlling the search for the AMAZING GRACE, but either it was not properly screened or it was not recognized by either of the two controllers on duty as referring to a liferaft that might have come from the AMAZING GRACE. At 0720 on November 22, when the relief watch reviewed all the messages received during the previous watch, the message was recognized as referring to a liferaft in the area where the USCG had been searching. The message contained the serial number of the liferaft, and the USCG was able to trace the liferaft through the manufacturer to the AMAZING GRACE. At 1400, the USCG resumed an active search and an aircraft was sent to search the area to the southeast of the location where the liferaft was found. A night search for flares in the immediate area also was conducted. (See figure 3.)

The liferaft was found near the portion of the planned search area on November 19 that was not completed because the assigned aircraft ran low on fuel. On November 21, the USCG had searched areas to the north and to the south of the location where the liferaft was found.

On November 23, the USCG conducted a 10,950-square nautical mile search near the location where the liferaft was found using two USCG, one USN, and one USAF aircraft. The CHILULA, which still was in the area, resumed its role as onscene commander. The weather conditions were ideal for searching, and the USCG calculated a 90-percent probability of detecting a liferaft in the search area. The USCG also requested the USAF to conduct a photographic reconnaissance flight in the area and the USAF agreed, although this was not a normal procedure. By November 25, because the USCG-conducted searches had unproductive results in spite of ideal search conditions and the probability of detecting the liferaft approaching 100 percent, the USCG intended to suspend the active search again. However, at 1702, the USAF reported photographing an orange object at 38°37' N latitude, 68°7' W longitude. At 1726, a USCG plane was sent to the location, deployed a datum marker buoy, and conducted a search of the area. (See figure 3.)

The search on November 26 located several pieces of debris, including a 14-foot-long open boat in the area where the USAF had reported an orange object, but no liferaft. The search conditions were excellent, and the USCG determined the probability of detection at 87 percent. On November 27, another 14- to 15-foot-long boat was located, but no liferaft. The search conditions again were ideal. Also on November 27, a USAF photographic reconnaissance flight located an object in position 38°12' N latitude, 67°54' W longitude, which was reported to the USCG at 0738 on November 28. The USCG search continued on November 28 and November 29. Although the USCG had determined the probability of detection of a liferaft at 98 percent, the USCG decided to search one more day. At 2205 on November 30, the USCG's active search again was suspended. The 16-day search had covered 192,146 square nautical miles. There had been 106 aircraft

8/ AMVER is an acronym for Automated Mutual-Assistance Vessel Rescue System. AMVER is a voluntary international mutual assistance program for commercial vessels.

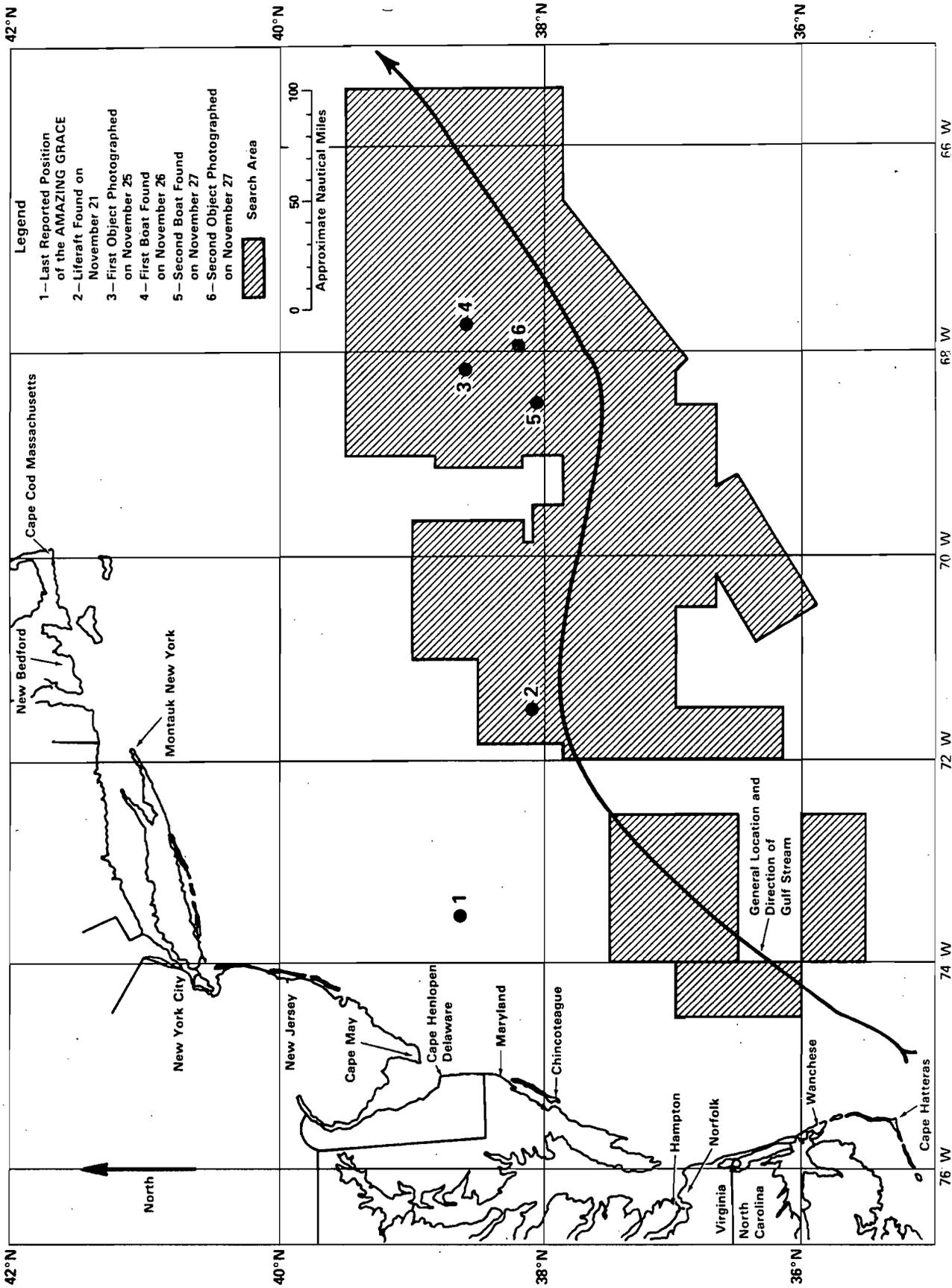


Figure 3.-- Search area from November 21 to November 30, 1984.

sorties resulting in 564 hours of aircraft search time. The estimated cost to the USCG and U.S. Department of Defense units involved in the search effort was \$2.1 million; the two USAF reconnaissance flights cost an additional \$10 million. The USCG Chief of Search and Rescue in New York stated that this search was the longest search effort he had ever been involved with during his 18 years in USCG search and rescue assignments.

### Injuries to Persons

The captain, mate, and all (possibly five) crewmembers aboard the AMAZING GRACE are missing and presumed dead. The Safety Board was not able to determine the exact number of persons who were aboard the AMAZING GRACE when it was lost.

### Damage to Vessel

As of the date of this report, the AMAZING GRACE has not been found. The vessel's estimated value was \$500,000.

### Crew Information

The captain of the AMAZING GRACE began his seagoing career in 1972 at the age of 14 when he went to work for his brother as a deckhand. By 1981, he had progressed to captain of his own fishing vessel out of Newport News, Virginia. In 1982, he obtained his USCG license as an operator of mechanically propelled vessels less than 100 gross tons not more than 100 miles offshore between New Orleans, Louisiana, and Brownsville, Texas. In June 1984, he became captain of the AMAZING GRACE after having served as mate for his brother on another fishing vessel owned by the same family.

A close friend with whom the captain of the AMAZING GRACE lived in Virginia; a person who had been a cook for him over a 5-year period; his brother, the captain of the ATLANTIC PRIDE; and the captain of the CAROLINA PRINCESS provided information about the captain of the AMAZING GRACE. He did not have any known mental or physical problems. In August 1984, he had some wisdom teeth removed. He was described as "very easy going," "very happy at home," and "happy" with his job. There had been no changes in his mood or personality. He was said to have had no significant financial problems.

The captain of the AMAZING GRACE was said to be a casual drinker. The person with whom he lived said that he usually smoked "one joint" of marijuana each evening when he was home. The person said that marijuana use on the boat was prohibited, and that the captain did not use, nor did he allow others to use, illegal drugs aboard the boat because "it's too dangerous . . . it's really serious out there and [he's] serious about it." The captain of the CAROLINA PRINCESS, who had known the captain of the AMAZING GRACE since the early 1970's, said that "he didn't allow anyone on the boat with him that was a doper."

According to the owner of the AMAZING GRACE, a captain is selected based on his fishing and navigation experience. A candidate's knowledge of lifesaving and firefighting equipment is not considered. The company does not provide any formal crew training. A captain is not examined for or given any guidance concerning the proper loading of vessels. Rather than monetary remuneration for high productivity, a captain is given promotions to the command of the better vessels in the company fleet, where the captain's earning potential is greater.

The owner of the AMAZING GRACE hired the captain, and the captain recruited his own crew. The captain of the AMAZING GRACE had dismissed some of his crew and hired replacements shortly before departing on the trip. The owner provided a crew list to investigators on December 4, 1984, showing that six persons besides the captain were aboard the AMAZING GRACE. Later, on January 16, 1985, the owner informed the USCG that one crewmember on the list was not aboard. The brother of the captain of the AMAZING GRACE stated that he was not certain of the crew complement. He had recognized his brother's voice and that of the mate during radio conversations on November 14. The names of other crewmembers were inferred on the basis of second-hand information or sightings of individuals before the departure of the AMAZING GRACE. Most scallop boats operate with a crew of seven: a captain, a mate, a cook, and four deckhands. The exact number of persons aboard still is unknown. (See appendix B.)

### Vessel Information

Description.--The AMAZING GRACE, O.N. 591163, was constructed of welded steel as hull No. 105 by Deep Sea Boat Builders, Inc., of Bayou LaBatre, Alabama, in 1978 and was admeasured by the USCG on April 4, 1978. It was 86 feet long and 22 feet wide with a depth amidship of 11 feet 8 inches and a design full load draft of 8 feet. Its gross tonnage was 145.6 tons, and its net tonnage was 108 tons. The vessel was propelled by a single propeller in a Kort nozzle <sup>9/</sup> driven by a 700-horsepower diesel engine; it had a single rudder. The AMAZING GRACE had a maximum speed of about 8 knots. The stem of the hull was raked and the stern was square. The vessel had accommodations for 12 persons. The vessel was not inspected or certificated by the USCG, nor was it required to be.

The pilothouse, the uppermost level of the vessel, was located about the one-third ship length aft of the bow. Starting outboard and forward of the after end of the pilothouse, a bulwark of gradually increasing height extended forward to the stem, where it was about 40 inches high. Liferails about 40 inches high extended around the entire pilothouse deck level. Forward of the pilothouse were two gooseneck-type vents, which extended up from the engineroom and which were about 30 inches high with openings about 24 inches above the deck facing aft.

On the next lower level, the main deck, a galley and berthing spaces extended forward of the pilothouse. Access to the main deck from the accommodations was through a door on the port side with a 12-inch sill about 4 feet inboard from the side of the vessel. Aft of the pilothouse was a wooden hatchcover on the centerline about 5 feet long and 4 feet wide set over a raised 2-foot-high coaming, which provided access to the fish hold below. There were also seven 14-inch-diameter deck fittings on each side of the hatch opening, but these openings were not used. The vessel was rigged with a single mast fitted with outriggers on either side and twin booms facing aft. Aft of the fish hold hatch cover was a gallows frame <sup>10/</sup> and a large reel, with its axis athwartships, to hold fishing nets. The vessel had four freeing ports which could be closed by steel plates, in both the port and the starboard bulwarks on the main deck. Freeing ports are openings in the bulwark to allow water to drain from the deck. The bulwark around the after deck was about 32 inches high, and each freeing port was about 12 inches wide and 4 inches high.

<sup>9/</sup> A ring or open-ended cylinder attached to the hull enclosing the propeller. Its longitudinal sections are so shaped as to permit a smaller diameter propeller for the same power and efficiency.

<sup>10/</sup> A transverse frame from which the clam dredge is towed while underway.

An opening in the bulwark for the stern ramp could be closed by a steel door which swung forward when the ramp was not in use. The owner stated that the freeing ports and the steel door for the stern ramp normally would be in the closed position while fishing for scallops.

Below the living spaces was the engineroom and aft of the engineroom was located the main fish hold. Aft of the fish hold was a stern ramp with a steering gear space below.

Electrical power was provided by two 30-kW diesel generators. Emergency power was provided by two banks of 32-volt, 270-amp batteries. The vessel was equipped with two direct-drive, 3-hp electrical bilge pumps; two direct-drive, electrical saltwater pumps; and two belt-driven, electrical freshwater pumps. Suctions for the bilge system were located at the after end of the engineroom and in a well at the forward end of the fish hold. The controls for the bilge drainage system for the fish hold were located in the engineroom. The shafting arrangement was unique in that the bearings and shaft were in a pipe on either side of a wet box which contained a coupling. The shafting extended forward to the engineroom bulkhead and aft through the skeg to the propeller. The pipe and wet box were open to the sea, and the stuffing box was on the engineroom after bulkhead where it could be adjusted easily. The wet box was about 4 feet long, 4 feet wide, and about 3 feet deep on the centerline. It had a bolted, gasketed cover.

The AMAZING GRACE was 1 of 10 fishing vessels owned and operated by the Daniels family of Wanchese, North Carolina, under the corporate name of Ironside Trawling Company. The Daniels family also owned and operated fish processing and packing facilities in Wanchese and in Hampton and Norfolk, Virginia. During the summer months, the Daniels family operated its fishing vessels out of New Bedford, Massachusetts.

The owner of the AMAZING GRACE stated that no plans for the vessel were received when the vessel was purchased, nor did the builder provide any information on the stability of the AMAZING GRACE. The owner stated that it was "a stable boat." The builder of the AMAZING GRACE was unable to provide the Safety Board with any plans for the vessel, but did make available a lines plan for a similar vessel which was 3 feet shorter in length. (A lines plan shows the shape of the hull and is used in stability calculations.)

Equipment.--The bridge was equipped with two radars, two LORAN-C receivers, a position plotter, an automatic pilot, a magnetic compass, a fathometer, a single-sideband radio with a range of about 5,000 nautical miles, three VHF-FM radiotelephones with about a 20-nautical mile range, and a citizens band radio with about a 15-nautical mile range. There was neither a gyrocompass nor a radio direction finder. Emergency batteries for the radios were located in the engineroom about 3 feet below the overhead near the forward bulkhead.

As of October 2, 1979, the date of the vessel's last condition survey by a marine surveyor, the AMAZING GRACE was equipped with 7 portable dry chemical and CO<sub>2</sub> extinguishers, 12 lifepreservers, 2 liferings (one with a water light), 6 flares, and 2 six-person liferafts. The vessel had no EPIRB, nor was one required. Additional emergency equipment may have been aboard the vessel. Several persons stated that it was common practice for most crewmembers to bring aboard their own exposure suits. The two six-person liferafts were mounted in gimballed cylindrical cradles secured with hydrostatic release systems and were located on either side of the aft pilothouse deck. Both liferafts were "Givens Buoy Rafts" and carried serial Nos. 618A and 633A.

The liferafts aboard the AMAZING GRACE were not USCG-approved, although this type of liferaft was approved by the USCG subsequent to the date of purchase of the AMAZING GRACE liferafts. The manufacturer stated that the principal differences between the liferafts aboard the AMAZING GRACE and the USCG-approved liferafts were the required floor area per person and the amount of provisions. The USCG probably would have certificated the AMAZING GRACE liferafts for only five persons. The USCG-approved liferafts require 40 ounces of water per person, while the AMAZING GRACE's liferafts had only 10 ounces of water per person.

Maintenance.--The liferafts were last serviced on May 21, 1982, when each should have been inspected, tested, recertified, and repacked with three hand-held red flares in addition to its survival equipment package. The vessel last was drydocked on November 26, 1982. Invoices showed that between December 1983 and September 1984, four pumps, including one bilge pump, were replaced. On July 2, 1984, six fire extinguishers were recharged. In early October 1984, the supply pipes and hoses on both the freshwater and bilge pumps were replaced. At that time it was found that a new freshwater pump had been connected incorrectly to the 110-volt electrical system; it was reconnected to the 220-volt system. The owner of the AMAZING GRACE testified that he boarded the vessel on November 2, 1984, and except for a leaking hydraulic winch, everything was working properly.

The Daniels family, as owners and managers of the company fleet, have an excellent reputation for their treatment of captains and their maintenance and equipment practices. A former captain for the company testified, "they have six of the nicest steel hulls in the ocean . . . the boats [are] in real good shape all the time."

Another former company employee, a previous captain of the AMAZING GRACE, stated during initial interviews that, "Kenny Daniels never cut me short on no gear, no equipment, nothing . . . I worked with the best boats." At the public hearing, this captain testified, "I was never denied anything for the crew's welfare that I asked for."

Operations.--The captain of the ATLANTIC PRIDE, who trained his brother, the captain of the AMAZING GRACE, as a mate, stated that he normally kept the fish hold covered when fishing for scallops. The hatchcover would be opened only for a short time about 1 hour after the end of a 6-hour work shift -- 0100, 0700, 1300, and 1900 -- to stow the scallops caught during each work shift. He said the hatchcover also might be opened to obtain fresh vegetables stowed in the fish hold.

During storms, fishing vessels often shut down their engines and drift with the weather to conserve fuel. A former captain of the AMAZING GRACE stated that it is common practice when drifting to have the fishing vessel's rudder hard to starboard so that the seas are coming from the starboard quarter and not broadside.

Accidents.--USCG records indicate that the AMAZING GRACE had had four previous accidents. On March 15, 1981, the vessel grounded in Oregon Inlet, North Carolina; the vessel was refloated with no significant structural damage. On August 18, 1981, its engine stopped off Massachusetts due to water in the fuel. On March 19, 1982, the vessel grounded in Pamlico Sound, North Carolina, without significant damage. On December 22, 1983, the AMAZING GRACE grounded in Oregon Inlet without significant damage.

### Meteorological Information

At 0700 on November 13, there was a low-pressure area over Maine with an associated cold front extending east and then south, passing about 500 miles off the Maryland coast. This low, coupled with a large high-pressure area over the Mississippi Valley, was causing a northwesterly air flow in the vicinity of the last reported position of the AMAZING GRACE.

By 0700 on November 14, the low had moved northeastward to Nova Scotia, Canada, and the high had moved to the southeastern United States. Northwesterly winds continued over the Atlantic Ocean off the Maryland coast. During the night of November 14-15, the winds diminished, as the high moved off the southeastern United States coast, becoming light and southerly by 0700 on November 15.

At 0700 on November 16, a cold front was located along the eastern Appalachian Mountains moving toward the Atlantic coast. This front passed the last reported position of the AMAZING GRACE between 1300 and 1900 on November 16, and by 0700 on November 17, the Maryland coastal waters were under the influence of an easterly-moving high over eastern Kentucky.

At 0700 on November 18, the high had moved over the Virginia-Maryland coast. The winds had become light, and there was increasing cloudiness over the area. Based upon coastal reports, rain caused by a frontal system over the Carolinas began in the area off the Maryland coast during the night of November 18-19.

On November 19, a complex frontal system over the Carolinas became organized into a cold front which moved off the southeastern United States coast ahead of a large high moving southeast out of central Canada. By 0700 on November 20, the winds increased out of the northwest, and skies over the last reported position of the AMAZING GRACE cleared. By 0700 on November 21, the high moved over the Great Lakes and was influencing virtually all of the eastern United States. Conditions over the last reported position were characterized by scattered to clear skies and northerly winds.

Based upon the pilot chart of the North Atlantic Ocean for November 1984, published by the U.S. Defense Mapping Agency, the last reported position of the AMAZING GRACE was on the eastern edge of the southerly moving coastal Arctic Current where it begins to swing to the east and then north to join the western edge of the Gulf Stream. Current speeds in this area are on the order of 0.6 knot.

A hindcast by the Safety Board showed that on the morning of November 14, the winds were from the northwest at 31 knots with 10-foot-high waves. The average air temperature for November 14, 15, and 16 was about 50° F, and the average sea temperature was about 50° F. During the night the wind speed and wave heights decreased as the winds backed around to the southwest. On November 15, the winds were from the southwest at 25 knots with 12-foot waves. (Appendix C contains details of the meteorological conditions from November 13 to November 16.)

The last reported position of the AMAZING GRACE was approximately 60 nautical miles northwest of the North Wall 11/ according to the Gulf Stream chart prepared by the

11/ The North Wall is the irregular, constantly changing, northern boundary of the Gulf Stream, where the sea surface temperature can change dramatically, as much as 22° F over 2 nautical miles.

U.S. Naval Eastern Oceanography Center, Norfolk, Virginia. Within 50 nautical miles of the North Wall on the cold water side (northwest side), winds frequently are 15 knots greater and seas 5 feet higher than would be expected for the same conditions at greater distances away from the North Wall. An analysis by the Canadian Forces Meteorology and Oceanography Center, Halifax, Nova Scotia, placed the North Wall about 90 nautical miles southeast of the AMAZING GRACE at the time of the last reported position.

### Wreckage

As of the date of this report, the AMAZING GRACE has not been found. However, a Givens Buoy Raft with serial No. 633A, was recovered from the North Atlantic Ocean by the CLIFFORD MAERSK on November 21, 1984. According to the CLIFFORD MAERSK's crew, the liferaft was found with the two main chambers fully inflated. The three canopy chambers were deflated partially. Both the sea anchor and heaving line were deployed fully, and there were no provisions aboard. The blade of the line-cutting knife was extended, and the knife was found stowed in its canopy storage packet on the liferaft. After photographing the liferaft, the crew destroyed the liferaft by cutting it into small pieces and throwing the pieces overboard.

### Medical and Pathological Information

As of the date of this report, no one aboard the AMAZING GRACE has been found. According to information listed in U.S. Coast Guard regulations (33 CFR 181.705), a person in 50° F water could be expected to survive from 1 to 6 hours. A person wearing an exposure suit could be expected to survive from 21 to 37 hours. <sup>12/</sup> A person in a liferaft could survive for an indefinite amount of time.

### Tests and Research

Loading.--The Safety Board performed a weight study to determine the loading of the AMAZING GRACE on the morning of November 14, 1984. The weight study was based on witness testimony, structural plans for a similar vessel, estimated fuel and water consumption, and estimated amount of scallops onboard. The results of the weight study were as follows:

Displacement	150.9 long tons
Vertical center of gravity (KG)	10.5 feet above keel
Longitudinal center of gravity	4.0 feet aft of amidships

The Safety Board also calculated five other hypothetical weight conditions based on the information above and on the reported information that (1) the AMAZING GRACE had taken some water over the bow, (2) the crewmembers were removing the steel plates from the freeing ports to drain the water from the after deck, and (3) the captain was going to pump out the fish hold or possibly the engineroom. The six conditions considered in these hypothetical conditions were:

1. the estimated loading condition on the morning of November 14, 1984
2. 1 foot of water on the after deck
3. 1 foot of water over the wet box in the fish hold

<sup>12/</sup> On Scene, the National Maritime SAR Review, 1/1985.

4. 1 foot of water on the after deck and over the wet box in the fish hold
5. 1 foot of water in the engineroom
6. 1 foot of water in the engineroom and on the after deck

Because the depth of water in the various spaces, if any, and on deck from the wave coming over the bow was unknown, a 1-foot depth of water was assumed for calculation purposes to show the effect of water on the vessel's stability. Depths of water from a few inches to a few feet would not have yielded significantly different results.

Stability.--The USCG Marine Technical and Hazardous Materials Division in Washington, D.C., calculated the intact stability of the AMAZING GRACE on the morning of November 14, 1984. <sup>13/</sup> The stability calculations were based on the calculated loading conditions and on the lines plan provided by the builder for a similar vessel with 3 feet of midbody added at amidships. Table 1 summarizes the vessel's GM <sup>14/</sup> for each assumed loading condition, and figure 4 shows the vessel's righting movement curves for conditions 1, 2, 3, and 4. Conditions 5 and 6 were similar to conditions 3 and 4, respectively. The results of the calculations show that except for condition 2, the overall stability of the AMAZING GRACE is improved by the assumed flooding over its stability in condition 1. The USCG also calculated the stability of the vessel under the six hypothetical loading conditions listed previously assuming a variation in vertical center of gravity of 0.5 foot above and below the calculated values.

Table 1.-- Stability of the AMAZING GRACE

<u>Condition</u>	<u>Displacement (long tons)</u>	<u>KG (feet)</u>	<u>GM (feet)</u>
1	150.9	10.50	1.85
2	174.0	10.76	1.43
3	185.7	9.38	2.67
4	209.0	9.73	2.32
5	169.1	9.74	2.45
6	192.2	10.07	1.98

The calculated intact stability condition of the AMAZING GRACE on the morning of November 14 was compared to the stability criteria for fishing vessels over 79 feet in length contained in USCG Navigation and Vessel Inspection Circular (NVIC) No. 3-76. (On June 3, 1985, NVIC No. 3-76 was superseded by NVIC No. 5-85.) These criteria have been endorsed by the International Maritime Organization (IMO) and are contained in the 1977 Torremolinos Convention on the safety of fishing vessels. <sup>15/</sup> The righting arm stability criteria contained in NVIC No. 3-76 states that the area under the righting arm curve should not be less than 10.34 foot-degrees up to a 30° angle of heel and not less than

<sup>13/</sup> "Stability Calculations for the F/V AMAZING GRACE, O.N. 591163, March 1985."

<sup>14/</sup> GM is an acronym of the distance between a vessel's vertical center of gravity (KG) and its transverse metacentre (M). GM is a measure of a vessel's ability to right itself after being affected by an overturning moment. The higher the GM is for a given vessel, the more righting moment the vessel has.

<sup>15/</sup> Since the criteria were originally adopted by the IMO in 1968, it has been found that for vessels in the 79-foot to 100-foot length range, there may be a need for more stringent criteria.

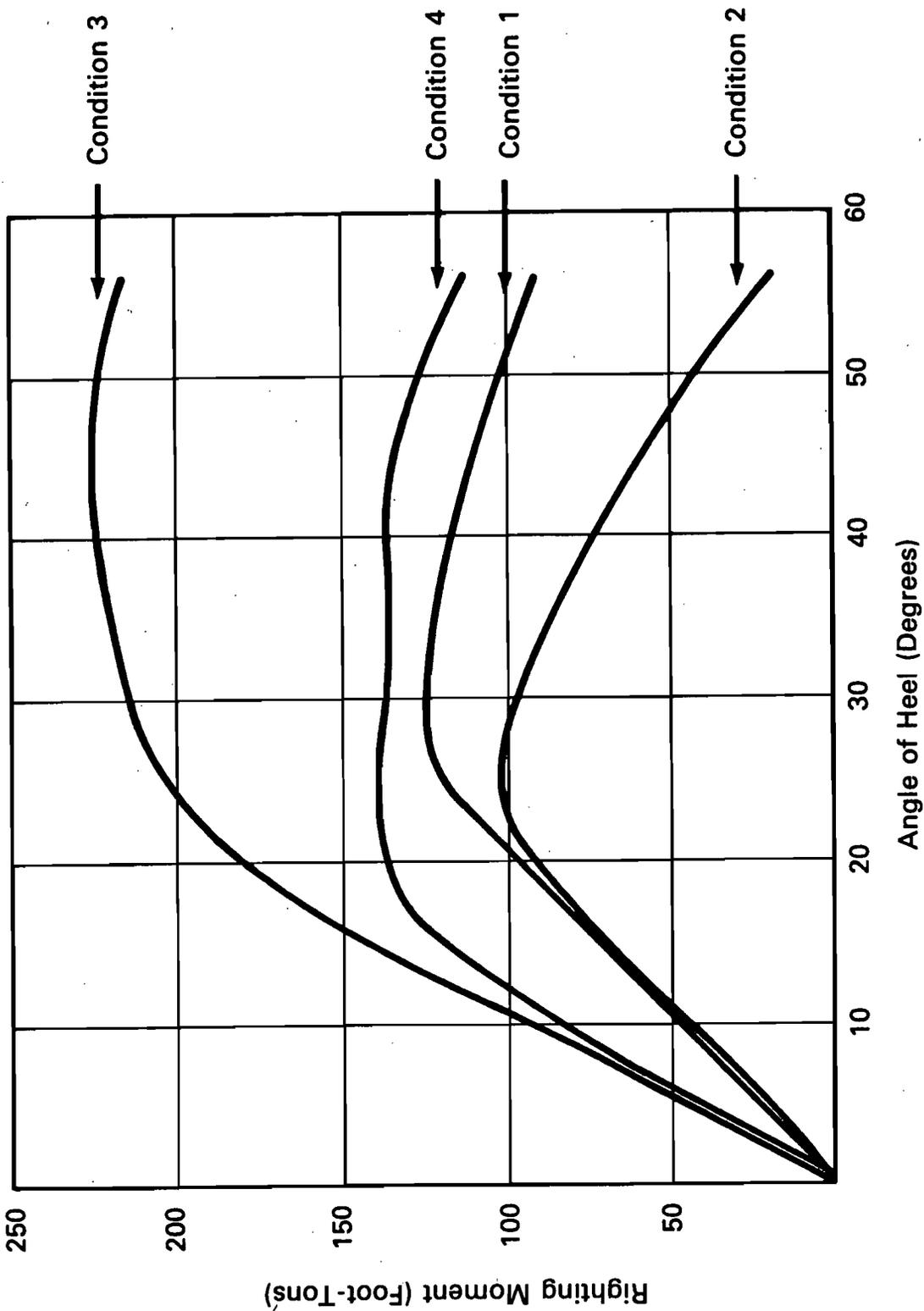


Figure 4.--AMAZING GRACE righting moments determined by the USCG.

16.92 foot-degrees up to a 40° angle of heel or the angle of flooding if this angle is less than 40°. In condition 1, the AMAZING GRACE had an area under the righting arm of 13.56 foot-degrees up to a 30° angle of heel. The angle of flooding (30°) was assumed to be at the door on the port side of the main deck leading into the crew's quarters. Therefore, the AMAZING GRACE did not meet the criterion for 16.92 foot-degrees up to the angle of flooding. The criteria required an additional 5.64 foot-degrees under the AMAZING GRACE's righting arm curve between 30° and the flooding angle which was not satisfied. The criteria state that the righting arm should be at least 0.66 foot at an angle of heel equal to or greater than 30°, that the maximum righting arm should occur at an angle of heel greater than 25°, and that the GM should not be less than 1.15 feet. The vessel met this part of the criteria with a righting arm of 0.812 foot at 30°, the maximum righting arm being at 30°, and a GM of 1.85 feet. NVIC No. 3-76 also contains a GM stability criteria which would require the AMAZING GRACE to have a minimum GM of 1.31 feet. The AMAZING GRACE was not required to meet these criteria, and the USCG stated that although these criteria are the best available, they do not provide fully for a dynamic situation when a vessel takes water over the bow and has water trapped on the after deck.

The results of the USCG sensitivity analysis to determine the effect variations in KG would have on the stability of the AMAZING GRACE show variations of 20 percent to 35 percent in GM with a 0.5-foot change in KG. A 0.5-foot change in KG also increases or decreases the area under the righting arm curve up to a 30° angle of heel by about 25 percent.

The effect of a steady beam wind of 31 knots, assuming still water conditions, would result in a static angle of heel of about 2° for condition 1.

Clam Dredge Overturning Moment.--Based on the stability calculations performed by the USCG, the Safety Board performed calculations to determine the overturning moment that one of the AMAZING GRACE's clam dredges could exert on the vessel if the clam dredge was snagged on the ocean bottom. The calculations assumed that the vessel was perpendicular to the dredge's wire cable and that the wire cable was pulled by the AMAZING GRACE's winches until the cable parted. The calculations show that for loading conditions 1 through 6, the overturning moment of the clam dredge as calculated exceeded the AMAZING GRACE's righting moment by a ratio of 2 to 1 or greater.

#### Other Information

Fishing Vessel Crew Training.--There are no Federal or State requirements specifying the qualifications or training of the crews of commercial fishing vessels of less than 200 gross tons. The typical fishing vessel captain has had no formal training in vessel safety and has learned navigation, radio procedures, first aid, and the use of lifesaving equipment from on-the-job training or by attending fishing industry expositions. Most fishing captains do not know all the factors that affect the stability of their vessels.

The USCG has stated that because of the high loss rate of fishing vessels and crewmembers, it is undertaking a program to develop voluntary standards to reduce the number of commercial fishing vessel accidents by not less than 10 percent by 1991. The USCG intends to publish voluntary vessel standards and safety guides for the training of fishing vessel crews, but the USCG does not intend to seek legislation to require any mandatory training. The USCG also intends to encourage educational institutions and industry personnel to develop fishing vessel safety courses. The USCG also has an ongoing program to provide safety information to fishermen.

The National Marine Fisheries Service, through its Sea Grant programs for universities, also has encouraged improvements in the safe operation of fishing vessels. There are currently six fishing vessel safety centers sponsored through the Office of Sea Grant in Rhode Island, Florida, Texas, Washington, Alaska, and Hawaii. However, the Sea Grant programs provide only short-term grants from the Federal government and do not represent any long-term commitment by either the Federal government or the States; nor does the program prescribe consistent goals to be met by all centers.

Through the Virginia Sea Grant program, Wells Scallop Company of Seaford, Virginia, has developed training films for fishermen, and the Virginia Institute of Marine Sciences in Gloucester, Virginia, held a seminar on fishing vessel safety in March 1985. The North Carolina Sea Grant program currently does not have any active safety programs but has held safety seminars in past years. The Massachusetts Sea Grant Program sponsors numerous courses at the Massachusetts Maritime Academy including courses on fishing vessel safety. However, the number of fishermen attending any of these seminars and courses is small. Since there has been little demand for such courses, there are no major centers in the private sector providing safety training for fishermen. At present, most marine insurance companies impose no requirements regarding the experience or training of fishing vessel crews.

Radio Procedures.--Although fishing vessels like the AMAZING GRACE may be out fishing from 2 to 3 weeks, fishing vessel captains normally do not have any scheduled communications with shore. Some captains are reluctant to broadcast their position and the amount of their catch in order to prevent their competition from finding their fishing area. Other captains do not want to let other fishing vessels know when they are returning to port because the time of their arrival at the processing facility will affect the price offered for their catch. Even when fishing vessels are working in a group, the captains may not communicate for a number of days. Some fishing vessel owners have established a code system so their captains can communicate ashore without giving away their position, amount of catch, or estimated time of arrival.

EPIRB.--There are three types of emergency position indicating radio beacons (EPIRB's) approved by the Federal Communications Commission (FCC) for use as emergency transmitters on recreational and commercial vessels: Class A, Class B, and Class C. Class A EPIRB's transmit a distress signal on the frequencies 121.5 MHz and 243 MHz. Commercial and private aircraft monitor 121.5 MHz, and military aircraft monitor 243 MHz. Class A EPIRB's, which must be capable of floating free of a sinking vessel and activating automatically, are required equipment on most commercial vessels subject to USCG inspection. Class B EPIRB's, which also transmit a distress signal on the frequencies 121.5 MHz and 243 MHz, although waterproof, are not required to float free of a sinking vessel or to activate automatically. Class B EPIRB's normally are used as optional equipment on recreational boats. Class C EPIRB's transmit a distress signal on the frequencies 156.75 MHz (Channel 15) and 156.8 MHz (Channel 16). Channel 16 is the calling and distress frequency for ship VHF radiotelephone stations. All USCG shore stations and most other shore stations with VHF-FM radiotelephone equipment monitor the frequencies 156.75 MHz and 156.8 MHz. However, since the range of a Class C EPIRB is limited, Class C EPIRB's normally are used in coastwise or Great Lakes operations. Class C EPIRB's, although waterproof, are not required to float free of a sinking vessel or to activate automatically. Class C EPIRB's are required by the USCG on Great Lakes vessels that are not required to have Class A EPIRB's and are used also as optional equipment on recreational boats. The cost of an EPIRB ranges from \$200 to \$300.

On May 1, 1985, the FCC adopted regulations implementing the rules governing radio equipment contained in the second set of amendments to the International Convention for the Safety of Life at Sea, 1974 (SOLAS 74). The regulations include specifications for a Class S EPIRB to be used in survival craft. Class S EPIRB's are to be similar to Class B EPIRB's. The SOLAS amendments are scheduled to enter into force on July 1, 1986.

On April 24, 1980, as a result of its investigation of the sinking of the fishing vessel LOBSTA-1 16/ about 50 nautical miles southeast of Point Judith, Rhode Island, the National Transportation Safety Board issued Safety Recommendation M-80-23 to the USCG:

Seek authority to require the carriage of emergency position indicating radio beacons (EPIRB) on documented U.S. fishing vessels and, in the interim period, pursue all available means to encourage their use.

On December 23, 1980, the USCG stated:

The Coast Guard concurs with this recommendation. We believe that increased use of EPIRBs is desirable from a search and rescue (SAR) point of view. On 21 November 1978 we issued Commandant Notice 2370 on the use of EPIRBs by fishing vessels. This notice explicitly directed Coast Guard District Commanders to use such means as are practicable within their districts to encourage fishing vessels (those going more than twenty miles offshore) to carry EPIRBs. This notice has since been reissued as Commandant instruction 2370.2 dated 27 August 1980 in order to insure a continued effort in this regard.

At present time there is an international experimental program underway involving the use of a low-orbiting satellite system to detect and locate both aircraft electronic [sic] locator transmitters (ELT) and marine EPIRBs operating on 121.5/243 MHz. The first launch is scheduled for 1982. This experiment will also test a new class of EPIRB designed to operate on 406 MHz, a frequency set aside by the World Administrative Radio Conference (WARC) for maritime satellite SAR purposes. It is hoped that this EPIRB will be capable of being received by geosynchronous as well as low orbiting satellites. Existing ELTs and EPIRBs do not have sufficient power to be received by geosynchronous satellites. Undoubtedly a 406 MHz satellite EPIRB system will offer many advantages for alerting and locating maritime distress cases, e.g., area coverage will be far more extensive and there will be no gaps in coverage. In addition, the Intergovernmental Maritime Consultative Organization (IMCO) is currently urging the International Maritime Satellite Organization (INMARSAT) to include an EPIRB capability in its geostationary satellite network.

16/ Marine Accident Report--"Fishing Vessel M/V LOBSTA-1 Capsizing and Sinking in the Atlantic Ocean, Point Judith, Rhode Island, September 23, 1978" (NTSB-MAR-80-6).

The Coast Guard intends to seek legislative authority to require the satellite EPIRB system on U.S. vessels, including fishing vessels. The Coast Guard does not intend to seek legislative authority to require the present EPIRB system on fishing vessels since the satellite system could be ready for implementation in the four or five year period that would be needed to obtain the enabling legislation and get the final regulations into effect. The satellite EPIRB system is expected to render the present system obsolete, so there would be no reason to pursue its mandatory carriage on fishing vessels. By seeking legislative authority now for the satellite system while it is still under development, the Coast Guard will be prepared to implement the system with a minimum of delay as soon as it is operational.

On February 22, 1982, the USCG stated:

The Coast Guard continues to concur [with Safety Recommendation M-80-23]. When an acceptable operational satellite system comes into being, we will seek legislation to provide us with the necessary authority to require satellite EPIRBs on U.S. vessels. We will notify the Safety Board when this becomes a part of our legislative program.

On August 3, 1982, the Safety Board classified Safety Recommendation M-80-23 as "Open--Acceptable Action."

The international satellite system project, COSPAS-SARSAT, which began in 1982 is now in its demonstration and operational phase, with four polar orbiting satellites that monitor two frequencies, 121.5 MHz and 406 MHz. COSPAS is managed by the Soviet Union, and SARSAT (Search and Rescue Satellite-Aided Tracking) is the contribution of the United States, France, Great Britain, and others. According to available information, the system has provided alert and location data in 112 marine and aviation distress incidents worldwide involving 333 persons and resulting in the rescue of 289 survivors. Among these distress incidents were 12 involving fishing vessels from which 67 persons were rescued. In each marine incident, rescuers were alerted to the distress by an EPIRB from the vessel transmitting on the 121.5 MHz and 243 MHz frequencies. In each aviation incident, rescuers were alerted by an emergency locator transmitter (ELT), a device similar to an EPIRB, which transmits on the 121.5 MHz and 243 MHz frequencies and is carried onboard most aircraft as a result of Public Law 91-596.

On February 7, 1984, as a result of its investigation of the sinking about 10 nautical miles offshore of the charter fishing boat JOAN LA RIE III, 17/ the Safety Board issued Safety Recommendation M-84-13 to the USCG:

Amend 46 CFR Subpart 180.40 to eliminate the present exception from the requirement to carry an Emergency Position Indicating Radiobeacon (EPIRB) on coastwise vessels carrying passengers for hire that carry radiotelephone communication equipment that complies with Federal Communications Commission requirements.

17/Marine Accident Report--"Sinking of the Charter Fishing Boat JOAN LA RIE III, Off Manasquan Inlet, New Jersey, October 24, 1982" (NTSB/MAR-84/02).

On May 15, 1984, the USCG stated:

This recommendation is concurred with in part. An EPIRB should be required on these vessels, but it should be a Class C and not a Class A EPIRB. Elimination of the present exception to the regulations would result in a requirement to carry a Class A EPIRB which operates on aircraft frequencies that are routinely monitored only on long over-water flights. In addition, these frequencies are generally not monitored by civilian aircraft over coastal areas. Major airports guard the Class A EPIRB frequency but this only covers the limited number of coastal areas near those airports. The Search and Rescue Satellite System (SARSAT) is also being used to alert rescue centers to Class A EPIRB signals, but it still takes several hours to validate a SARSAT alert. If the JOAN LA RIE III had been carrying a Class A EPIRB and was activated, the signal could have been used as a locating beacon, but it would have been of limited or no value in providing a timely initial alert of the casualty.

On the other hand, Class C EPIRBs operate on channel 15 and 16 in the VHF-FM marine frequencies which are monitored by almost all vessels and shore stations with VHF-FM radiotelephone equipment. All Coast Guard air and surface units are equipped with direction-finding equipment compatible with Class C EPIRB signals. However, only larger cutters are equipped with direction finders compatible with the transmitted signal of a Class A EPIRB. This means that the initial alert of a marine casualty would not depend on the presence of a vessel in the vicinity and a Class C EPIRB would instantly alert the Coast Guard. Since the number of shore facilities equipped with direction finders for Class C EPIRBs is growing, the probability of success for the timely location of a vessel in distress is much better if equipped with a Class C EPIRB rather than a Class A EPIRB.

The Coast Guard is preparing a final rule that would require Class C EPIRBs on small passenger vessels on the Great Lakes and will prepare a notice of proposed rulemaking that would extend the requirement to cover coastwise vessels.

Since the loss of the AMAZING GRACE, the Daniels family and other fishing companies in the Hampton Roads area have provided their vessels with Class A EPIRB's. The owner of the AMAZING GRACE testified that he was not aware of the existence of EPIRB's until the loss of the AMAZING GRACE.

Fishing Vessel Losses.--A 1984 study by the USCG <sup>18/</sup> showed that, between 1970 and 1982, an average of 185 U.S.-documented commercial fishing vessels were lost each year; an average of 70 fishing vessels were lost because of capsizing, flooding, or foundering. <sup>19/</sup> The same study showed that there were an average of 43 lives lost each

<sup>18/</sup> "Analysis of U.S. Commercial Fishing Vessel Losses 1970-1982," T.E. Hart and F. Perrini, May 5, 1984.

<sup>19/</sup> Capsizing is the overturning of a vessel due to insufficient stability, flooding is the accidental filling of one or more compartments with water, and foundering is the sinking of a vessel as the result of waves overwhelming it.

year due to the total loss of vessels and that an average of 30 lives are lost each year due to the capsizing or foundering of vessels. USCG statistics for 1983 show that of the 250 vessels lost, 102 were lost as the result of capsizing, flooding, or foundering, and resulted in 111 deaths. The above data do not include State-registered fishing vessels.

USCG statistics show that the death rate for commercial fishermen is seven times the national average for all industry groups (twice that for miners). For the 10-year period from 1970 to 1980, the accident-related deaths for fishermen averaged 103 per year. An article in the 1981 USCG Proceedings of the Marine Safety Council states, "the number of deaths relative to the number of vessels seems to be rising."

The 1984 study by the USCG states that many of the accidents "could have been prevented or the severity of the incident diminished had a few precautions been taken. . . . Generally, causes can fall into three broad categories: human failure, vessel related, or environmental." The report goes on to state:

Among the various causes noted in reviewing casualties, human failure stands out. These failures include:

- a. Poor watchkeeping practices.
- b. Navigational errors and rules of the road violations.
- c. Lack of understanding of the various forces acting on the vessel, especially as concerns the [sic] stability; i.e., failure to load and operate the vessel according to its stability chart, modification of the vessel without consideration of possible change in stability characteristics, operation of the vessel in weather conditions which overwhelm the vessel, etc.

Furthermore, the human factor often plays a role in those casualties where the direct cause was failure of some vessel component.

CASP Computer Program.--The computer-assisted search planning (CASP) program incorporates three mathematical models to predict the drift of an object. The first model incorporates prevailing ocean currents in the Northern Hemisphere such as the Gulf Stream. The data for this model are based on historic studies of the currents during the 1970's. During the search for the AMAZING GRACE, the USCG manually entered satellite photographic information of the position of the Gulf Stream which was obtained from the U.S. Naval Eastern Oceanography Center in Norfolk, Virginia. The second model addresses the effect of wind. This information also was obtained from the Naval Eastern Oceanography office. The third model addresses wind-driven currents. The wind-driven currents are derived from the wind information. The CASP program was developed based on actual case studies and has been verified through the recreation of known drift patterns. CASP also permits the manual input of drift information from datum marker buoys.

The USCG has conducted the majority of the world's research into the drift patterns of objects and has a continuing research program to improve its drift predictions. During the summer of 1983, the USCG conducted some tests, which included a Givens liferaft, in wind conditions from 3 to 12 knots and in maximum wave heights of 3 feet. The resulting information eventually will be incorporated in a new mathematical model being developed by the Florida Atlantic University and may lead to some changes in the CASP Program.

During the search for the AMAZING GRACE, the manufacturer of the Givens liferafts that were aboard the AMAZING GRACE contacted the USCG Research and Development Center in New London, Connecticut, and requested that the research center give RCC New York the latest information available on the drift patterns of a Givens liferaft. RCC New York was informed by the research center that the preliminary results indicated that a Givens liferaft drifted slower than assumed in the USCG Search and Rescue Manual for liferafts with drogues. RCC New York incorporated this information into its search planning.

The manufacturer of the liferafts testified that based on the last reported position of the AMAZING GRACE, the position where the liferaft was found, and his knowledge of the search, the USCG was 250 percent in error while searching for the liferafts. He stated that he calculated the 250 percent by dividing the number of days from the time the USCG was notified of the loss of the AMAZING GRACE until the liferaft was picked up by the number of days that the formulas in the USCG Search and Rescue Manual predicted a liferaft would take to drift that distance. The USCG search planner for the AMAZING GRACE stated that the straight-line drift rate of the recovered liferaft was within the predicted drift rates calculated by CASP.

The manufacturer of the liferafts stated that the USCG was in the wrong area because the USCG used conventional liferaft drift rates to identify search areas. The USCG calculations were generated by its CASP computer program, which bases its calculation on lightly ballasted liferafts with and without drogue, a person in the water, and a vessel adrift. As of the date of this report, the manufacturer has not produced any further information to support his claims or data which could be used to modify the CASP program.

Although testimony by a USCG researcher indicated that a Givens liferaft "drifts slower than what the SAR manual said" for the conditions tested, in referring to USCG research with respect to liferaft drift in general, the researcher said, "no definite conclusions or anything else that would be useful came out of it." He further agreed that the search area would be much smaller if CASP were programmed for a slower drift rate for a Givens-type liferaft. A smaller search area would use USCG and other resources more efficiently during SAR efforts.

USCG Message Handling.—The following message from the CLIFFORD MAERSK concerning the recovered liferaft from the AMAZING GRACE was misdirected by RCA to AMVER in New York:

RCA NOV 21 1252  
AMVER NYK

TO: US Coast Guard  
FM: MASTER CLIFFORD MAERSK OXZH  
11.21.84 1545 UTC

AT 1415 UTC IN POS 38 DEG 03,5 MIN NORTH 71 DEG 27,8 MIN  
WEST PASSED ORANGE COLOURED HALF BLOWN INFLATABLE  
RUBBER LIFERAFT. STOPPED TO INVESTIGATE AND FOUND RAFT HAS  
BEEN USED BUT EMPTY. RAFT MARKED: LIFERAFT 4-6 PERS.MDF.FEB.  
1978 SERIAL NO. 633A, GIVENS, RESQRAFT. LICENSED  
BY NASA, PAT. NO. 3.736.607.  
1520 UTC CONTINUED VOY. TOWARDS BALTIMORE WHERE ETA 0700/22ND  
BT

The message should have been transmitted to the USCG Communications Center in New York, which is part of the USCG Operations Center. The RCA computer had two separate listings, one for Coast Guard, New York, and another for AMVER. However, both listings had AMVER's telex number associated with them. This error has since been corrected by RCA, and the computer programs of other communications companies participating in the AMVER network have been or will be reviewed.

According to an AMVER officer, the AMVER computer system that receives messages is not always capable of distinguishing between messages intended for AMVER and those intended for the USCG Communications Center. If the words "Coast Guard" do not appear in the address, the message may not be routed to the USCG Communications Center. To complicate matters further, the AMVER officer said, "because many commercial vessels, especially foreign commercial vessels, know the Coast Guard primarily through AMVER, they will send us [AMVER] messages which are of an operational nature, even medical evacuation or search and rescue messages." Therefore, although the corrected computer programs of companies participating in AMVER have reduced the number of misrouted messages, AMVER most likely will continue to receive messages intended for operational centers.

When a message arrives at AMVER, it undergoes several manual and automated processes. Usually a watchstander, or "operator," scans the message shortly after its arrival for keywords such as "medical" or "search and rescue." If nothing in the message attracts the attention of the operator, he will process the message routinely. In this case, the operator who initially handled the message from the CLIFFORD MAERSK concerning the liferaft was a trainee. He did not recognize it as being other than routine. The operator's instructor did not scan the incoming message.

Routine messages are next processed through two computers. The end product is a white paper printout that the operator uses to update the AMVER data base for vessel locations. The copy is first scanned for keywords that would indicate the need for "more expeditious" handling of the message. It was at this point that someone determined that it was not a regular, routine AMVER message designed to update the data base, but contained non-AMVER information and should have been forwarded to the USCG Operations Center.

Messages received from RCA and other companies in the network are treated as "military routine" by AMVER. When AMVER forwarded the liferaft message to the USCG Operations Center (via the USCG Communications Center), the message automatically was upgraded by AMVER to a "priority" status. If AMVER personnel had recognized the message to be of immediate importance, they would have informed the USCG Operations Center by telephone. The liferaft message was not handled in this manner because AMVER operators did not know "that it related to an ongoing search and rescue case."

USCG Communications Center personnel did not recognize the message was related to an active SAR case either. According to the Chief of the USCG Operations Center, the USCG Communications Center did not call the USCG Operations Center. Although the USCG Operations Center received the message designated "priority," higher priority messages that evening may have been voluminous due to message traffic associated with the termination of the search for the AMAZING GRACE. The Operations Center watchstanders, both fully qualified, did not recall seeing the liferaft message, although it is likely that they handled it. The Chief of the Operations Center testified: "I don't know how and they don't know how the message got from the pneumatic tube through the watch

without them seeing it. They both agreed after the fact, had they seen the message and read the word 'Givens' that they certainly would have known that this had something to do with the AMAZING GRACE case." The message was placed in the "discard file" rather than the file for the AMAZING GRACE. It was not until the next morning when the relief team reviewed the message traffic from the previous watch that the importance of the message was recognized.

Since the AMAZING GRACE accident, the USCG has reviewed AMVER's procedures for handling messages, and the following changes have been implemented: (a) the watch supervisor rather than a watchstander is now responsible for handling messages received over the teletype machine from commercial sources; (b) an internal memorandum known as an "ALLOP," which is seen and acknowledged by all watchstanders, has been issued pending a change to the permanent operating procedures. The ALLOP provides that all non-AMVER messages will be handled in a timely manner by the watch supervisor, including an immediate telephone call to the Operations Center in the case of SAR-related messages; and, (c) there is a followup with commercial communications carriers for every misrouted message.

Probability of Detection.--One of the primary criteria the USCG uses to evaluate search effectiveness when deciding whether or not to continue a search is probability of detection (POD). According to the USCG officer-in-charge, he recommended suspension of the search based "on the probability of detection, the areas searched, and the professional experience of we individuals in the Coast Guard who are involved."

Probability of detection, according to the USCG National Search and Rescue Manual (SAR Manual), is "the probability that the search object will be detected under given conditions if it is in the area searched." 20/ The manual offers the following guidance on the use of POD:

Although [POD] is usually expressed as a percentage, keep in mind that it is really stating the odds of success or failure for detecting the search target. . . . Suppose the SMC [SAR Mission Coordinator] calculated the detection probability to be 90%. He would expect that the search target would be detected nine times out of ten, on the average. And conversely, he would expect one failure for every nine successes. Thus occasional failures to detect survivors is understandable and consistent with high values of calculated probabilities for successful detection.

The SAR Mission Coordinator for the AMAZING GRACE, in explaining why the liferaft was not found, given that the computer predicted the correct areas to search and that high POD's were achieved, stated:

. . . the aircraft overflow the raft at some period in time, once, twice, three times. We don't know how many times it did. We do have a lot of case studies that we find people in; they are successfully rescued and they tell us, "sure, we saw your aircraft but they didn't see us." It is going to happen even in high probability areas and it is going to happen on good search days. It is just a human factor involved in search.

20/ National Search and Rescue Manual, United States Coast Guard COMDTINST M16130-2, 1 July 1973.

A USCG report published in 1981 analyzed the results of seven visual detection experiments conducted between 1978 and 1981. <sup>21/</sup> The report identified 25 parameters that have a potential influence on visual search effectiveness. Many of these parameters concern characteristics of the target, environmental conditions, and search vehicles. Seven were designated "interdependent human factors": fatigue; stress (due to noise, glare, vibration, etc.); visual acuity and perception; training level; motivational level; position of lookouts; physical/psychological stress.

The research report demonstrated that fatigue, expressed as a function of "time on task," had a definite influence on observer performance. Some observers spend a total of 2 to 3 hours at search positions while other observers serve (off and on) for periods of 10 hours or more. USCG policy is to rotate an observer to a new position every 30 minutes, and to provide relief at "periodic intervals," usually after 1 hour, whenever feasible. Policies governing Air Force and Navy participants in the AMAZING GRACE search were assumed by the USCG to be similar to those of the USCG. The USCG SAR Manual states the following about fatigue and airborne observers:

A flight of long duration will always cause scanner fatigue. . . . If conditions are favorable and the scanners are trained, good visual efficiency can be maintained for 2 to 3 hours. After this length of time, it drops rapidly. Changing positions at intervals of 30 minutes to an hour will help postpone fatigue. . . . Even with shifts of position and reliefs, fatigue on long flights is inevitable and can only be postponed.

A followup research study reported the results of three visual detection experiments which were conducted by the USCG specifically to study the following human factors: experience level, time on watch, amount of sleep, and lookout position. <sup>22/</sup> Time on watch again was found to have a "marked influence" on observers for some types of search units; the report recommended that "this should be used to modify the procedures employed for assignment of lookouts." The report also recommended:

Future studies should be dedicated to the collection of human factors data. Such tests would allow direct comparisons to be made between SRU's [SAR units], target types, and individual lookouts. . . . If real progress is to be made in understanding and ultimately modeling the human factors that influence the SAR problem, experiments dedicated to these ends must be undertaken. Training for effective lookout procedures may have to wait until the human factors that affect it are more sharply defined.

## ANALYSIS

### The Accident

The AMAZING GRACE has not been found as of the date of this report, and the last known radio message from the vessel about 0720 on November 14, 1984, did not indicate that the vessel was in distress, although the message stated that the AMAZING GRACE

<sup>21/</sup> Edwards, N. C., Jr., et. al., "Factors Affecting Coast Guard SAR Unit Visual Detection Performance," United States Coast Guard Report No. CG-D-09-82, Interim Report, August, 1981.

<sup>22/</sup> Remondini, D. I., et. al., "A Pilot Study of Human Factors in SAR," United States Coast Guard Report No. CG-D-19-82, Interim Report, May 1982.

had taken a wave over its bow and there was water on its after deck. The only recovered trace of the AMAZING GRACE was one of its two liferafts. The liferaft was recovered about 7 days after the accident about 100 nautical miles from the last reported position of the AMAZING GRACE with no survivors or bodies aboard.

The loss of the AMAZING GRACE without any distress message being received or any survivors or bodies being found indicates a sudden and rapid sinking of the vessel. The AMAZING GRACE was well equipped with three VHF-FM radiotelephones, one single-sideband radio, and one citizens band radio. There were several other fishing vessels within range of its VHF-FM radiotelephones, including the ATLANTIC PRIDE, whose captain was the brother of the captain of the AMAZING GRACE. The crew of the ATLANTIC PRIDE had communicated twice with the AMAZING GRACE on the morning of November 14. The single-sideband radio had an almost unlimited range. Although atmospheric conditions can sometimes interfere with radio transmissions, the proximity of other fishing vessels and the clear weather condition on November 14 would have provided favorable conditions for the reception of a distress message. The failure of the captain of the ATLANTIC PRIDE to contact the AMAZING GRACE in spite of repeated attempts on November 14 indicates that the AMAZING GRACE probably sank shortly after the 0720 conversation on November 14.

The AMAZING GRACE was equipped with two six-person inflatable liferafts and probably six flares. Particularly if the vessel sank slowly, the crew should have been able to abandon the AMAZING GRACE in the liferafts. Both the USCG and other fishing vessels searched the area of the last reported position of the AMAZING GRACE on November 15 without success. An extensive search for survivors continued until November 30 without success. If any crew had successfully abandoned the AMAZING GRACE in a liferaft, they should have been found by November 30. The Safety Board concludes that the AMAZING GRACE sank before any crewmembers were able to send a distress message or to use distress flares. Although the ATLANTIC PRIDE was close to the position of the AMAZING GRACE, the crew of the ATLANTIC PRIDE did not see any flares on the night of November 14 and 15. Three flares were sighted by the CAPT LIS two nights later about 22 nautical miles to the northwest of the last reported position of the AMAZING GRACE. It is unlikely that a liferaft would have drifted to the northwest under the prevailing currents, and a search of the area did not locate the vessel, any liferafts, or debris. The three flares that the CAPT LIS reported probably did not come from the crew of the AMAZING GRACE.

The Safety Board considered a number of possible explanations for the loss of the AMAZING GRACE including an explosion, a fire, a structural failure, a scuttling, <sup>23/</sup> or a capsizing. Because of its low vapor pressure, a leak of diesel oil into either the engineroom or the fish hold would not have produced an explosive atmosphere, and there were no other known substances aboard that could have produced an explosive atmosphere. Furthermore, there is no evidence to support a finding that an explosion was the cause of the accident, and the recovered liferaft showed no signs of an explosion. If a fire occurred aboard the AMAZING GRACE, there should have been sufficient time to send a distress message and to abandon the vessel; also, the other fishing vessels in the area did not report having seen smoke. A structural failure might have resulted in rapid flooding, but there still should have been enough time to send a distress message and abandon the vessel. Furthermore, the evidence available to the Safety Board indicates that the relatively new AMAZING GRACE was well maintained, and there was no history of any structural failures on the vessel.

23/ Scuttling is to deliberately sink a vessel.

The possibility that the crew scuttled the AMAZING GRACE might explain the lack of a distress message, and the crew might have been caught aboard before they could abandon the vessel. However, there is no evidence to support this possibility, and it is unlikely that all of the crew would have been caught aboard. The AMAZING GRACE was a relatively new vessel and was considered a good vessel by former captains. Consequently, scuttling of the vessel was not considered a reasonable possibility.

Calculations performed after the accident showed that it was possible to capsize the AMAZING GRACE by continuing to pull on one of its clam dredge's wire cables if the clam dredge was snagged on the ocean bottom. The captain of the ATLANTIC PRIDE said that at the time of the last radio conversation, the AMAZING GRACE was not fishing; if so, its clam dredges probably were on deck. However, the captain of the ATLANTIC PRIDE began fishing soon after this conversation, and it is possible that the captain of the AMAZING GRACE also began fishing as the weather improved. Therefore, it is possible that the AMAZING GRACE may have capsized due to one of its clam dredges being snagged on the ocean bottom.

If the AMAZING GRACE had lost power or was drifting to conserve fuel, the vessel might have taken a large wave on its after deck and capsized. The seas on the morning of November 14 were about 10 feet high from the northwest. The AMAZING GRACE was jogging into the wind and waves, and with the weather continuing to improve, it is unlikely that the captain of the AMAZING GRACE would have continued to drift or would have begun drifting. It is more likely that he would have attempted to begin fishing.

The AMAZING GRACE might have capsized and sunk due to the water on the after deck reported at 0720 on November 14. The stability calculations show that the AMAZING GRACE's stability was below recognized international standards at the time of its loss, even without any water from the wave taken over the bow. It is reasonable to assume that the door on the port side of the main deck was either open or not fully closed because the crew was working on the after deck and it was a clear day with the temperature around 50° F. With water trapped on the after deck, the stability of the AMAZING GRACE would have been reduced, and rolling could have increased until the vessel capsized suddenly in the rough seas and high wind. Capsizing due to water trapped on deck, while the captain was below to pump out the fish hold, is the most reasonable explanation for the sudden loss of the AMAZING GRACE.

The freeing ports and the door on the stern ramp were kept closed on the AMAZING GRACE to keep water off the after deck and to prevent scallops from washing overboard during fishing operations. However, an accumulation of water on deck plus the dynamic effects of the water could reduce significantly the stability of a vessel and cause it to capsize. The practice aboard fishing vessels like the AMAZING GRACE of keeping freeing ports closed can be a safety hazard. The large openings for the freeing ports were designed to get rid of water rapidly. Wire mesh over freeing ports could solve the problem of scallops washing overboard, but solid plates should not be permitted. The same sea conditions that can cause excessive water on deck through the open freeing ports normally will be the same conditions that may cause an occasional wave to come over the top of the bulwarks or over the bow of a vessel, as in the case of the AMAZING GRACE. Fishing vessel owners should not permit freeing ports to be closed during adverse weather.

Although some water might have leaked into the fish hold through a loose deck fitting, it is unlikely that any water would have entered the fish hold through the hatch because it had a 2-foot coaming and the hatch normally was kept closed. Likewise, only a

small amount of water, if any, could have entered the engineroom through the two gooseneck-type vents on the pilothouse deck from the wave that was taken over the bow, because the vents face aft and the openings are 2 feet above the deck. Furthermore, the stability calculations showed that water in the fish hold or engineroom would have improved the stability of the AMAZING GRACE. Although the captain of the AMAZING GRACE stated in his last radio conversation that he was going to pump out the fish hold, he did not indicate that any unusual amounts of water had accumulated in the fish hold. Due to melting ice used to preserve the scallops, water accumulates in the fish hold routinely and must be pumped out periodically. Therefore, it is unlikely that water in the engineroom or in the fish hold caused a sudden loss of the vessel.

The AMAZING GRACE had two direct-drive bilge pumps. On November 14, the ATLANTIC PRIDE was to deliver some spare belts for the freshwater pumps on the AMAZING GRACE. Invoices show that the owners had replaced one of the two bilge pumps over the past year. In early October 1984, the supply pipes and hoses on the bilge pumps were replaced. The owner testified that on November 2 all the pumps were working properly. Therefore, the Safety Board believes that the bilge pumps on the AMAZING GRACE were operating properly on November 14.

The Safety Board considered the possibility that the AMAZING GRACE might have been affected by the Gulf Stream at the time of its capsizing, which would have resulted in higher wind speeds and greater wave heights than normally would be expected. However, since the last reported position of the AMAZING GRACE was about 60 to 90 miles northwest of the North Wall of the Gulf Stream, the Board believes that the AMAZING GRACE probably was not affected by the Gulf Stream.

As a result of its investigation of the capsizing of the 82-foot-long fishing vessel PATTI-B in 1978, 24/ the Safety Board on June 25, 1979, issued Safety Recommendation M-79-69 to the USCG:

Conduct a design study to determine if current published intact stability criteria are adequate for vessels similar in design to the PATTI-B.

On December 16, 1980, the USCG replied that "... there is no fully satisfactory stability standard... for small vessels like the PATTI-B..." The USCG has "encouraged research into the seakeeping characteristics of small vessels on the international level, but is no longer able to continue small vessel research due to limited funds and other priorities." The Safety Board classified Safety Recommendation M-79-69 as "Closed--Acceptable Alternate Action," but urged the USCG to reevaluate its position with regard to such research.

In the USCG stability calculation report on the AMAZING GRACE, the USCG again reiterated that there are no fully satisfactory stability standards for small fishing vessels like the PATTI-B and the AMAZING GRACE. The USCG has announced that, because of the high rate of loss of fishing vessels and crewmembers, it intends to embark on a program to reduce the number of commercial fishing vessel casualties by not less than 10 percent by 1991 through the formulation of voluntary standards including stability standards. A 1984 study by the USCG shows that about 38 percent of the total losses of fishing vessels are the result of flooding, foundering, or capsizing. If the USCG is going to

24/ Marine Accident Report--"Grounding and Capsizing of the Clam Dredge PATTI-B, Ocean City Inlet, Ocean City, Maryland, May 9, 1978" (NTSB-MAR-79-9).

reduce the number of fishing vessel accidents, the USCG needs to develop adequate stability criteria for small fishing vessels. The USCG should reconsider its priorities and resume its research on the seakeeping capabilities of small vessels.

Since research on seakeeping of small vessels is a long-term project, the fishing industry should adopt as an interim measure the stability criteria contained in NVIC No. 5-85, which have international recognition. Owners of fishing vessels should require builders to provide them with the stability characteristics of the vessel and guidance on how to load the vessel to meet the stability criteria contained in NVIC No. 5-85. The owner of the AMAZING GRACE was not provided with any stability information by the builder or any plans with which stability calculations could have been performed; however, stability information could have been developed from the actual vessel. The Safety Board believes that with the high loss rate of fishing vessels due to flooding, foundering, and capsizing, fishing vessel owners should determine the stability characteristics of their vessels and provide guidance to their captains on the proper loading of the vessels. The USCG has developed a number of simplified loading diagrams for inspected vessels that could be adopted for fishing vessels.

### Search and Rescue

The search for the AMAZING GRACE and its crew was one of the most extensive searches, in terms of time and area searched, ever conducted by the USCG. During a 16-day period, the USCG searched over 192,000 nautical square miles of ocean and harbors along the east coast of the United States from Cape Hatteras, North Carolina, to Montauk, New York. When the USCG first was notified on the morning of November 15 by the CAROLINA PRINCESS that radio contact had been lost with the AMAZING GRACE, there was no definite indication that the AMAZING GRACE was in distress. Even so, the USCG sent that day two helicopters, an airplane, and two cutters to search the last reported position of the AMAZING GRACE while USCG personnel ashore began a search of harbors of safe refuge.

Through a series of errors involving USCG Station Cape May and RCC New York, RCC New York incorrectly placed the last reported position of the AMAZING GRACE about 10 nautical miles due west of the position that the CAROLINA PRINCESS had reported to USCG Station Cape May. However, this error did not affect substantially the search because the initial search areas covered both the correct and incorrect last reported position; the position of the AMAZING GRACE on November 15 was not known precisely because over 24 hours had elapsed from the time the AMAZING GRACE reported its position until the CAROLINA PRINCESS made its report to the USCG, and the initial error had little effect on the determination of the search areas for subsequent days.

From November 15 to November 20, the seas were running at least 7 feet high each day making the detection of small objects in the water difficult. Although the USCG estimated its probability of detecting the 86-foot-long AMAZING GRACE was approaching 100 percent and the probability of detecting the 10-foot-diameter Givens liferafts had exceeded 90 percent, the probability of detecting an individual in the water was significantly less. In the 50° F water, the expected time of survival for an individual without an exposure suit was less than 6 hours. An exposure suit would have extended the survival time by several hours, but by November 20 any crewmembers in the water probably would have died. It was almost certain by November 20 that the AMAZING GRACE was no longer afloat, and the USCG had checked all harbors of safe refuge

without success. The USCG also had exceeded its norm of 78 percent probability of detecting a liferaft. Thus, the recommendation to suspend the active search made by the USCG Chief of Search and Rescue on November 20 and the decision to search one more day on November 21 was reasonable.

It cannot be determined why the USCG was unable to detect the liferaft recovered on November 21 by the CLIFFORD MAERSK, but there are a number of possibilities. A 90-percent probability of detection means that 1 out of 10 times the object will not be detected. The liferaft may not have been in the search pattern on a given day because it may have moved out of or was not yet in the search area. The liferaft may have been caught in the AMAZING GRACE's rigging as it sank and surfaced several days after an area already had been searched. The latter reason would explain the manufacturer's estimate that the liferaft should have reached its recovered position sooner since the liferaft would not have begun drifting for several days after the vessel sunk. It would also explain why the USCG had not detected the liferaft. Moreover, the USCG did not search the entire area between the last reported position of the AMAZING GRACE and the recovered position of the liferaft between November 18 to November 21. The USCG had been concentrating its efforts after November 17 on areas farther to the east and did not complete a search pattern to the northeast of the liferaft recovery position because an aircraft ran low on fuel. Assuming the liferaft surfaced on November 17 or later, the liferaft would not have been in the USCG search area from November 17 to November 21, because the USCG search assumed the liferaft had been drifting from the last reported position of the AMAZING GRACE from November 14 to November 17.

After determining on November 22 that the liferaft recovered by the CLIFFORD MAERSK probably came from the AMAZING GRACE, the USCG immediately resumed the search on the afternoon of November 22. Because of the hope for survivors, the USCG also requested the aid of USAF reconnaissance aircraft on November 23. The two objects detected by the USAF reconnaissance flights as possible liferafts on November 25 and November 27 probably were the two 14-foot boats recovered by the USCG which were not related to the accident. The search conditions on November 23 through November 25 were ideal for searching, and the USCG determined that the probability of detecting a liferaft in the search area was approaching 100 percent. If there had been a second liferaft in the general area where the one liferaft was recovered, the USCG search probably would have detected it. The only reason the USCG continued searching was the renewed hope provided by the reconnaissance photographs, but the objects detected were not liferafts. The search conducted by the USCG was exhaustive and extensive, and the decision to terminate the search on November 30 was justified.

#### U.S. Coast Guard Message Processing

The message that a Givens liferaft had been recovered did not reach the USCG Operations Center until about 10 hours after it was sent. Even after the message was received, it was 10 hours before the USCG Operations Center realized that the message might be related to the search for the AMAZING GRACE. The delay in recognizing the significance of the liferaft message appears to have stemmed from two primary causes: the volume of message traffic and the methods used to screen messages so that they receive appropriate attention.

The USCG AMVER Center processes between 750 and 1,000 messages daily; the USCG Operations Center receives an average of 1,500 messages daily. Procedures at both organizations provide that each message will be scanned or reviewed twice. In the case of

AMVER, the misrouting of the message was not recognized at the initial screening, but it was recognized at the second review some 5 or 6 hours later. AMVER personnel forwarded the message that had been misrouted to them without being aware, nor should they have been aware, of the significance of the message. The message did not attract attention at the Operations Center until a second screening by the relief watch. The Communications Center personnel, in passing on the message, also did not notice the significance of the message. In view of the large number of messages, the redundancy designed into the procedures which led to the correct identification of the message appears justified.

Two methods are used to help watchstanders select important messages in the large volume of traffic: an amorphous group of "keywords" and a formal message classification system (routine, priority, and immediate). One problem in message screening arises from the varying sources of messages. There is no formal convention for the maritime public to use in formatting messages when it wants to inform the USCG about emergencies. Over the years, however, a common practice has emerged of putting the words "medico" or "search and rescue" in the top line of the message. The word "liferaft" was not a keyword in the AMVER list.

Commercial vessels send messages to the USCG typically through commercial radio stations. There are 197 commercial radio stations that voluntarily participate in the AMVER network. Messages are not screened at these stations before being forwarded to the USCG. Even if AMVER had a formal keyword list, it could not enforce its use by either the vessels themselves or the commercial stations. Mariners and radio station personnel could be requested to use a keyword list and a message format, but AMVER and other USCG organizations could not rely on their compliance. Disseminating this information to the marine industry still would be beneficial, however.

Although individuals and agencies outside the USCG could not be relied upon to use keywords in their messages, significant benefits could be derived from the internal use of keywords by the USCG. A keyword list need not and should not be very long. A short list (a dozen words or so) would be relatively easy for personnel to recall and apply to numerous emergency situations. The first USCG organization to receive a given message still would be required to screen the message for keywords and assign a keyword if one would be appropriate. The USCG message format should be amended to position keywords in a prominent location at the top of the message. This procedure would assist any party to whom and through whom the message is routed. Messages containing keywords could be discriminated easily for special attention.

It might be argued that the existing system for assigning priorities to messages (routine, priority, and immediate) was a sufficient screening procedure. However, sometimes there are too many nonroutine messages. On November 21 and 22, the number of immediate messages was voluminous, according to the USCG Operations Center. Messages for which a keyword is necessary should not be too numerous, if the established keyword list is not too long and is used with discrimination.

A development under study at AMVER should reduce the amount of message traffic which has to be reviewed by watchstanders. An "artificial intelligence" software program for the computer has been designed to process and update routine position reports. The objective is to have AMVER personnel see only message traffic that is not position reports so that every message that a watchstander receives will get special attention. If successful, the program will reduce the number of messages reviewed by watchstanders by

at least 90 percent. There is a concern that the software would mistake some emergency or search and rescue messages as position reports. There are numerous hardware and programming obstacles to be surmounted, but experimental testing is underway, and USCG personnel involved in the project state that an optimistic estimate for implementation is the end of 1985.

### Probability of Detection

At times, the search for the AMAZING GRACE and survivors achieved probabilities of detection (POD's) of over 90 percent. The SAR Chief in New York explained that a POD of 78 percent usually is considered "about the best you can do on a search." On November 21, the search was suspended for the first time, "based on the cumulative POD in excess of 90 percent." This was on the same day that the CLIFFORD MAERSK recovered the liferaft from the AMAZING GRACE.

To a great extent the success of USCG search efforts is based upon the ability of human observers to detect the presence of relatively small objects located on the water. Parameters affecting the performance of observers vary tremendously, e.g., the sea conditions as they affect the contrast of the search object, the lighting conditions, etc. Vessels and aircraft serve merely as platforms for the observers. The human factors involved in search operations also need to be accounted for adequately to arrive at the level of confidence to be placed in POD as a major decisionmaking tool. This concern has been expressed in at least two USCG research studies in 1981 and 1982 on the subject. In spite of acknowledging that fatigue and other human factors influence observer performance, the SAR Manual makes no attempt to quantify their effect on POD. The scanning performance of all categories of observers involved in a search is treated as being homogeneous.

The 1981 research study states: "Of the 25 variables listed . . . only five are used at present [none of the interdependent human factors] and the magnitude of their influence is uncertain. Thus, World War II visual search techniques, which have been updated once from sighting report data collected 24 years ago, are utilized in SAR planning." The report recommended that the CASP program used by search planners be updated to incorporate the study's findings on human performance and other factors. It further recommended that the CASP method "replace the present SAR manual search planning method and POD predictions."

Since the 1982 report, the USCG has not conducted further studies of this subject. The Coast Guard is considering the adoption of a new visual detection model (called the Wagner Model) which makes some allowances for time on task: "There are two categories -- low and high. For surface searchers the cutoff is 2 hours; for aircraft the cutoff is 1 hour." <sup>25/</sup> However, fatigue is only one of many human factors which should be considered, and the developer of the Wagner Model admits "some key search parameters such as searcher type (for example, cutter or helicopter) are not built into the model." Nevertheless, the Wagner Model, if proved valid, could be a significant and overdue advancement to update SAR procedures. The findings of research disclose that the human factors involved in search operations are not being accounted for adequately. There is evidence that search planners have unjustified confidence in POD as a decisionmaking aid. The USCG should continue to support research efforts in human factors and incorporate the findings of these studies into SAR mission planning.

<sup>25/</sup> Weisinger, J.R., "Analytical Techniques to Estimate Lateral Range Functions for Visual Detection," prepared for the United States Coast Guard by Daniel H. Wagner, Associates, Report No. 1-84, January 1984.

### CASP Computer Program

Although the CASP computer program involves approximations, it is an effective tool for planning search and rescue operations, and it is being refined constantly. The USCG has done extensive research into ocean drift patterns, and the latest information is continually being incorporated into the program. One of the first operations conducted by the USCG was to deploy a datum marker buoy near the last reported position of the AMAZING GRACE. Information from the datum marker buoy was used daily to predict the drift of the AMAZING GRACE or one of its liferafts. Gulf Stream information also was used. The drift characteristics of the liferafts aboard the AMAZING GRACE fell within the drift prediction of the CASP computer program. Therefore, the USCG's prediction of the drift of the liferafts aboard the AMAZING GRACE was reasonably accurate at the time of the search. However, the CASP program should be improved in the future by including the drift characteristics of a heavily ballasted liferaft.

A comparison was made between the U.S. Navy and Canadian Forces Gulf Stream analyses for the area off the east-central and northeast Atlantic Coast of the United States. The analyses were essentially the same. The U.S. Navy Gulf Stream analysis also was compared with the Canadian Forces sea surface temperature chart for this area. Although the charts present different oceanographic information, the basic features were the same. Thus, the oceanographic information on the Gulf Stream used by the USCG during the search for the AMAZING GRACE was well validated.

### Emergency Position Indicating Radio Beacon

The AMAZING GRACE probably sank sometime on the morning of November 14 before any crewmember could transmit a distress signal. The USCG was not notified that the AMAZING GRACE possibly had a problem until the morning of November 15. If the vessel had been equipped with an EPIRB, its sinking might have been detected earlier, and the search effort could have been confined to a smaller area. The last reported position of the AMAZING GRACE was near major aircraft routes where aircraft could have picked up an EPIRB signal; moreover, a properly operating EPIRB probably would have been detected by satellite and reported to the USCG within 6 hours. Fishing vessels are not required to carry EPIRB's, and the owner of the AMAZING GRACE did not equip the boat with an EPIRB. In 1980 the Safety Board issued Safety Recommendation M-80-23 which recommended that the USCG seek legislative authority to require EPIRB's on fishing vessels. The USCG replied that since it would take 4 or 5 years to obtain and implement such legislation, the USCG would not seek legislation until there was a satellite EPIRB system.

Before the COSPAS-SARSAT satellite EPIRB system design is made final, the participating countries must decide which frequency is the best to use, determine the extent of possible system use beyond the marine and aviation modes, and adopt user identifications. Until these issues are resolved, which may take much longer than the current target date of 1996, U.S. fishing vessels should avail themselves of the safety offered by the existing satellite detection system, which has been proven successful in detecting signals emitted by EPIRB's on the 121.5 MHz and 243 MHz frequencies.

In the 5 years since the Safety Board made Safety Recommendation M-80-23, about 1,000 fishing vessels and more than 200 lives have been lost in accidents. Although the USCG actively has promoted voluntary installation of EPIRB's on fishing vessels, most fishing vessels still do not carry them. The cost of providing the approximately 33,000

documented U.S. fishing vessels with EPIRB's is estimated at less than \$10 million. The search for the AMAZING GRACE alone cost about \$12 million. Because the date for implementation of a full satellite system is still indefinite, and many issues are yet to be resolved, the Safety Board believes that there is no justification for the USCG to delay requiring EPIRB's on U.S. fishing vessels. The USCG has indicated that legislative authority is necessary to require EPIRB's; if this is the case, the Safety Board believes that the USCG should seek the appropriate legislative authority immediately so that regulations requiring U.S. fishing vessels to be equipped with current EPRIB's can be promulgated without further delay. On June 26, 1985, the Safety Board sent the USCG a letter reiterating its concern that the USCG has not implemented Safety Recommendation M-80-23.

### Crew Lists

The Safety Board was unable to determine precisely who was aboard the AMAZING GRACE. The captain of the ATLANTIC PRIDE identified his brother and the mate on the AMAZING GRACE from radio conversations, but as of the date of this report the Safety Board has not found anyone who saw the AMAZING GRACE leave Hampton. The owner had no positive record of who was aboard.

As a result of its investigation of the sinking of the USCG-certificated charter fishing boat JOAN LA RIE III, 26/ the Safety Board on February 7, 1984, issued Safety Recommendation M-84-14 to the USCG:

Require that operators of charter fishing boats making an offshore trip or voyage prepare a crew and passenger list and deposit the list, or copy thereof, at a suitable location ashore before departure.

On May 15, 1984, the USCG replied that it intends to revise the USCG regulations for small passenger vessels to require that operators deposit a crew and passenger list ashore before departure. The Safety Board has classified Safety Recommendation M-84-14 as "Open--Acceptable Action." The Safety Board believes also that commercial fishing vessel owners should require their captains to deposit a crew list ashore before departure.

### Radio Procedures

A simple method to minimize the loss of life on commercial fishing vessels operating offshore for extended periods of time would be to require such vessels to establish scheduled radio communications with designated shore facilities or other fishing vessels. For business purposes, most commercial fishing vessels are equipped with radio equipment that is capable of communicating with shore facilities and of contacting another fishing vessel if they are not capable of communicating directly with shore stations. Fishing vessel captains often do not communicate with shore facilities for days or weeks. If the fishing vessel has an accident and is unable to send a distress message, days may elapse before anyone is aware of a problem. The captain of the ATLANTIC PRIDE did not become concerned for 24 hours after the probable time of the accident, even though he had not been able to contact the AMAZING GRACE during that time, because shutting down radio communications is not unusual.

26/ Marine Accident Report--"Sinking of the Charter Fishing Boat JOAN LA RIE III Off Manasquan Inlet, New Jersey, October 24, 1982" (NTSB/MAR-84/02).

The arguments that fishing captains do not want to disclose their position or other information to other fishermen can be overcome through the use of codes or other means. Also, if scheduled radio communications become commonplace, the failure to meet a scheduled communications check would alert shore facilities or other fishing vessels immediately of a potential problem. If fishing vessel captains were required to report their position regularly, rescue units would know where to begin looking to render assistance. Owners, insurance companies, and the USCG should all encourage scheduled communications by fishing vessel captains.

### Fishing Vessel Crew Training

The crew of the AMAZING GRACE was typical of most fishing vessels. The captain had no formal training in vessel safety. He had learned to be a fishing vessel captain by serving as a deckhand and mate under other fishing vessel captains who probably had little formal knowledge of stability, firefighting, or the use of the lifesaving equipment. Likewise, his crew probably would have had little knowledge of these subjects. There is little incentive for a fishing vessel captain to seek training since the evaluation for a good fishing vessel captain is based on how many fish he catches. Taking time off from fishing to attend courses, seminars, or expositions results in less fish caught and loss of income.

The large number of fishing vessel losses with the accompanying large loss of life each year indicates a need for higher safety standards. The USCG has recognized the problem and hopes to achieve an improvement in safety over the next 6 years through voluntary programs for fishermen. Voluntary participation in the past has not been successful, and there is no reason to believe that voluntary education programs for fishermen will be any more successful in the future. The Safety Board believes that the only remedy for the high loss rate of fishing vessels and the loss of lives is a licensing program, similar to that required of operators of uninspected towing vessels, which includes a mandatory safety training program. Currently employed fishing vessel captains should be required to attend basic training courses in safety, and future captains should be required to attend and pass these courses before becoming fishing vessel captains. These courses would become available in the private sector if there was a mandatory education program. Failure by fishing vessel captains to comply with basic safety procedures should be subject to USCG investigation and penalties if necessary.

### Contingency Plans

The Daniels family owned and operated 10 fishing vessels, including the AMAZING GRACE, and 3 fish-processing and -packing facilities in North Carolina and Virginia. The owners also operated fishing vessels out of New Bedford, Massachusetts. However, they had no contingency plan in case one of their vessels had an emergency such as a fire or flooding or a medical problem involving one of the crewmembers. The owners did not know what day the AMAZING GRACE departed Hampton, nor exactly who or how many persons were aboard. It took several days for them to determine that there were two liferafts and not just one aboard. It was fortunate that the approximate position of the AMAZING GRACE was known by the captain of the ATLANTIC PRIDE because the owners did not maintain regular radio communication with their vessels. In time of an emergency, complete and accurate information must be available to search and rescue authorities as quickly as possible. The owners of fishing fleets should develop contingency plans that include: (1) detailed information about each vessel, its communication equipment, and its crew; (2) procedures for contacting the USCG; (3) a list of other

individuals or organizations to be contacted; and (4) procedures for coordinating search and rescue efforts with the USCG. The better the information provided to search and rescue authorities, the more effective will be their ability to respond to an emergency.

The National Council of Fishing Vessel Safety and Insurance, which represents the major fishing fleets in the United States and marine insurance companies, should promote the development of contingency plans by owners and operators, safety education programs for fishermen, and scheduled reporting by fishermen to keep shoreside personnel informed of their movements. Similarly, the USCG should encourage the development of contingency plans for fishing vessels and develop standard formats which are compatible with USCG search and rescue procedures so that the USCG can obtain quickly the information it needs in time of an emergency. Such contingency plans would increase the probability of rescuing fishermen and at the same time reduce the effort of the USCG in obtaining vital information.

### Behavioral and Medical Factors

The work experience of the captain of the AMAZING GRACE, his ability to meet USCG licensing standards, and his professional reputation among several fishing boat captains indicate that he was a well-qualified captain. The captain's reported regular use of marijuana while ashore raised the possibility that marijuana use may have impaired the captain's judgment or ability to operate the vessel. He allegedly did not use or allow others to use illegal drugs aboard the boat. There is no evidence that the captain of the AMAZING GRACE used marijuana or any other drugs while aboard the boat.

Other aspects of his use of marijuana need to be considered, however. Given the frequency and amount of use--one cigarette daily when off-duty--the effects of chronic use upon his performance when he was not intoxicated must be considered. Unfortunately, research in this area is inconclusive. According to one research group that reviewed studies about the chronic effects of marijuana on human subjects, "The available studies of chronic behavioral effects lead to no clear conclusions . . . human studies have such methodological weaknesses that they cannot be interpreted." 27/

Research on the existence of withdrawal symptoms associated with marijuana and the effects on humans is more conclusive:

Studies of animals and human subjects given moderate to high doses of marijuana orally or by inhalation several times per day have demonstrated tolerance to many of the effects of marijuana. When such use of marijuana is stopped after several days, a withdrawal syndrome occurs. In human subjects, this resembles the typical mild withdrawal symptoms seen after prolonged sedative use (Jones and Benowitz, 1976 28/). Subjects show irritability, agitation, insomnia, and EEG [electroencephalogram] changes. These symptoms are self-limiting; they peak at 30 hours and disappear by 90 hours.

27/ Marijuana and Health. Report of a Study by a Committee of the Institute of Medicine, Division of Health Sciences Policy. National Academy Press, Washington, D.C., 1982, p. 121.

28/ Jones, R.T. and Benowitz, N. The 30-Day Trip -- Clinical Studies of Cannabis Tolerance and Dependence. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marijuana. New York: Raven Press, 1976.

There is no clinical evidence that physical dependence plays an important role in persistent use of marijuana. Withdrawal symptoms would not be expected in intermittent users; however, daily round-the-clock users of high-dose marijuana may be expected to show some symptoms of withdrawal soon after stopping regular use. 29/

The testimony indicates that the captain of the AMAZING GRACE was not a "round-the-clock user of high-dose marijuana." Therefore, it is unlikely that his performance was affected by withdrawal symptoms associated with marijuana. The captain of the AMAZING GRACE had no history of physical or mental problems. There had been no changes in his mood or personality. Statements by his employer and by other fishing vessel captains indicate that there were no work conflicts that adversely influenced the captain of the AMAZING GRACE.

He had returned from a week-long vacation before departing on the accident trip. He had been at sea for about 7 days before the accident, and his work schedule required him to be on duty at least 12 hours each day. This schedule provided the opportunity for adequate rest. During his last radio conversation, he did not express any sense of concern or that there was a problem.

In summary, the captain of the AMAZING GRACE seems to have been in good physical and mental health. There is no evidence that drug use or adverse medical factors contributed to the accident.

#### Lifesaving Equipment

The water survival equipment onboard many uninspected oceangoing vessels consists of liferafts, lifepreservers, and personal exposure suits. Only lifepreservers are mandatory. Depending on the environmental conditions, long-term water survival is unlikely without the protection provided by liferafts and exposure suits. The amount and type of survival equipment carried aboard the AMAZING GRACE probably was adequate, although the number of exposure suits is unknown and the amount of provisions in the Givens liferafts was less than required on USCG-approved liferafts. However, if each liferaft had been equipped with an EPIRB, search and rescue efforts would have been enhanced greatly; potentially shortening the length of time necessary for search and rescue.

The AMAZING GRACE was equipped with two Givens liferafts. Both liferafts reportedly were mounted on gimballed cylindrical cradles secured with hydrostatic release systems. The liferafts were located aft on the pilothouse deck. The gimballed cradles, which are unique to the Givens liferaft, are supposed to assure that the liferaft deploys even when the vessel capsizes.

The recovered liferaft sustained damage to its canopy causing it to deflate partially. It is possible that the damage to the canopy could have been inflicted by the vessel's superstructure as the liferaft was inflating, or as the result of one of the crewmembers jumping on top of the canopy from the capsized vessel rather than jumping into the cold water and risking hypothermia. The liferaft was found with no provisions aboard, the blade of the line-cutting knife extended, and both the sea anchor and heaving lines fully

29/ Marijuana and Health, op. cit., pp. 123-124.

deployed. Although these conditions indicate that the liferaft might have been occupied at one time, it also is possible that during servicing the provisions could have been omitted and the knife left extended or another type of knife was substituted which was not retractable. The sea anchor should have deployed automatically, and the heaving line could have deployed in the rough seas.

The tracking of the liferaft found by the CLIFFORD MAERSK to the AMAZING GRACE by the USCG took a number of hours, which in other cases directly could have affected the possibility of rescue. When a liferaft is found at sea, the USCG must call the manufacturer who in turn has to search its records to determine to whom the liferaft was sold. The vessel owner then must be contacted for verification. Further research is required if the purchaser of the liferaft was not the owner of the vessel. Delays in identifying the vessel using the liferaft may delay a decision by the USCG to initiate a search or affect continuation of one that already is in progress, and may affect decisions on how to deploy search planes and ships. One central office within the USCG responsible for maintaining an up-to-date computer list of vessels with liferafts onboard may be a solution. Some of the information necessary to establish a computer data file for liferafts presently is manually maintained in the USCG Merchant Vessel Inspection Division in Washington, D.C. However, the files normally are available only during working hours.

It was unfortunate that the crew of the CLIFFORD MAERSK destroyed the liferaft from the AMAZING GRACE since it was the only item recovered related to the fishing vessel and might have aided in this investigation. The examination of recovered lifesaving equipment and an evaluation of its effectiveness can aid in the development of better equipment. The USCG should develop guidance, possibly through AMVER, for the retention and examination of recovered lifesaving equipment for subsequent examination.

## CONCLUSIONS

### Findings

1. The AMAZING GRACE capsized and sank on the morning of November 14, 1984.
2. The captain and crew of the AMAZING GRACE are presumed dead.
3. The AMAZING GRACE did not sink due to an explosion, fire, structural failure, or scuttling.
4. The AMAZING GRACE may have capsized and sunk due to continuing to pull on one of its clam dredge's wire cables after the clam dredge was snagged on the ocean bottom.
5. Based on the report from the AMAZING GRACE that there was water on deck and that the freeing ports were closed, on the weather conditions, and on calculations performed after the accident, the AMAZING GRACE may have capsized suddenly and sunk as a result of water trapped on its after deck.
6. The practice of keeping the freeing ports on the AMAZING GRACE closed during fish-handling operations and during adverse weather significantly reduced the vessel's stability by trapping water on its after deck.

7. The owners of the AMAZING GRACE followed good maintenance practices.
8. The bilge pumps and other machinery on the AMAZING GRACE were in good working condition.
9. The AMAZING GRACE's intact stability was not governed by any regulation or standard but was below internationally accepted standards.
10. The captain of the AMAZING GRACE was experienced and, by industry practices, well qualified to serve as captain.
11. The search conducted by the U.S. Coast Guard for the AMAZING GRACE and any survivors was extensive and exhaustive, and the decision to terminate the search on November 30 was reasonable.
12. The present search and rescue computer program (CASP) used by the U.S. Coast Guard adequately predicts the drift of liferafts similar to the type carried aboard the AMAZING GRACE, but could be improved by including the drift of heavily ballasted liferafts as a separate item.
13. The misrouting of the message reporting the recovery of a liferaft from the AMAZING GRACE to the U.S. Coast Guard AMVER Center instead of the Operations Center was the result of an error in programming a computer at the RCA Communications Center in Piscataway, New Jersey.
14. Although RCA has corrected its computer program, many commercial vessels contact the U.S. Coast Guard primarily through AMVER, and AMVER probably will continue to receive messages intended for operational centers.
15. The delays by the AMVER and Operation Centers of the U.S. Coast Guard in recognizing the significance of the message reporting the recovery of a liferaft from the AMAZING GRACE resulted from the volume of message traffic each center receives and the methods used to screen messages.
16. Although the U.S. Coast Guard is developing computer software for AMVER which is intended to reduce the amount of manual message processing by at least 90 percent, there still exists the possibility that some emergency or search and rescue messages may not be recognized promptly.
17. Both the U.S. Coast Guard AMVER and Operations Centers could benefit from using a formal keyword list as a screening device for emergency messages.
18. Human factors as identified in recent USCG studies involved in search operations are not being accounted for adequately in the U.S. Coast Guard search planning methods.
19. The carrying of emergency position indicating radio beacons (EPIRB's) on commercial fishing vessels could reduce the time and cost of conducting search and rescue operations and could save lives.

20. The lifesaving equipment aboard the AMAZING GRACE was adequate, although U.S. Coast Guard-approved liferafts would have had more provisions for an extended survival time.
21. The destruction of the liferaft from the AMAZING GRACE prevented the analysis by the Safety Board of the only item recovered from the AMAZING GRACE.
22. The lack of a crew list for the AMAZING GRACE made it impossible to determine precisely the identities of the persons who were aboard the vessel when it sank.
23. The establishment of regular radio communications by fishing vessel captains with shoreside facilities or other fishing vessels would expedite the recognition of the possibility of a need for assistance and increase the probability of being rescued in time of an emergency.
24. Productivity was the leading factor in the selection of captains and the promotion of crewmembers by the owners of the AMAZING GRACE, and knowledge of safety practices was not a consideration.
25. The crews of many fishing vessels lack adequate training in basic safety subjects such as firefighting, stability, and the use of lifesaving equipment, and the U.S. Coast Guard's proposed voluntary education program probably will not improve the present situation significantly.
26. The development of contingency plans for emergencies at sea by the owners and operators of fishing vessels would facilitate more effective action by search and rescue authorities in time of an emergency and would increase the probability of saving lives.
27. Although the captain of the AMAZING GRACE used marijuana when off-duty, there is no evidence that he used this or any other drug aboard the vessel.
28. Given the frequency and amount of marijuana use by the captain of the AMAZING GRACE, it is unlikely that his performance was influenced by any chronic effects of marijuana.

#### Probable Cause

The National Transportation Safety Board is unable to determine the probable cause of the loss of the AMAZING GRACE.

#### **RECOMMENDATIONS**

As a result of its investigation of this accident, the National Transportation Safety Board reiterated Safety Recommendation M-80-23 made to the U.S. Coast Guard on April 24, 1980:

Seek authority to require the carriage of emergency position indicating radio beacons (EPIRB) on documented U.S. fishing vessels and, in the interim period, pursue all available means to encourage their use.

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

--to the U.S. Coast Guard:

Resume research into seakeeping characteristics of small vessels to develop stability standards for fishing vessels such as the AMAZING GRACE. (Class III, Longer Term Action) (M-85-67)

Seek legislative authority to require the licensing of captains of commercial fishing vessels, including a requirement that they demonstrate minimum qualifications in vessel safety including rules of the road, vessel stability, firefighting, watertight integrity, and the use of lifesaving equipment. (Class II, Priority Action) (M-85-68)

Promote the preparation of crew lists by the captains of commercial fishing vessels and the deposit of such lists at a suitable location ashore before departure. (Class II, Priority Action) (M-85-69)

Promote the development of contingency plans by the fishing industry to reduce delays in alerting U.S. Coast Guard search and rescue forces of the need for assistance. (Class II, Priority Action) (M-85-70)

Urge commercial fishing vessels to schedule frequent radio communications which include a report of their position with shore or other fishing vessels to reduce delays in initiating a response in case of an emergency in which the vessel is unable to communicate. (Class II, Priority Action) (M-85-71)

Modify the search and rescue computer program (CASP) to include the drift of a heavily ballasted liferaft similar to the liferafts carried aboard the AMAZING GRACE. (Class II, Priority Action) (M-85-72)

Develop a keyword list for use by U.S. Coast Guard personnel to facilitate screening of emergency messages received at U.S. Coast Guard AMVER and Operations Centers. (Class II, Priority Action) (M-85-73)

Incorporate human factors affecting search operations, as identified in recent U.S. Coast Guard studies, into search and rescue mission planning. (Class II, Priority Action) (M-85-74)

Develop guidelines for the retention of recovered lifesaving equipment for examination by accident investigators to evaluate its effectiveness. (Class II, Priority Action) (M-85-75)

--to Faith Evelyn, Inc.; Esther Joy, Inc.; Companion of Wanchese, Inc.; Trawler Dian Marine, Inc.; Ironside Trawling, Inc.; Michael Paul Daniels; Delores of Wanchese, Inc.; and Hiwal, Inc.:

Determine the stability characteristics of each of your fishing vessels, and provide guidance to your fishing vessel captains on the proper loading of the vessels. (Class II, Priority Action) (M-85-76)

Require that your fishing vessel captains keep all freeing ports open during adverse weather. (Class II, Priority Action) (M-85-77)

Provide your fishing vessel captains training in stability, watertight integrity, firefighting, and the use of lifesaving equipment, and train your crews in basic safety procedures at the beginning of each voyage. (Class II, Priority Action) (M-85-78)

Require your fishing vessel captains to deposit a crew list at a suitable location ashore before departure. (Class II, Priority Action) (M-85-79)

Develop a contingency plan for an emergency involving any of your fishing vessels which includes: (a) detailed information about each vessel, its communication equipment, and its crew; (b) procedures for contacting the U.S. Coast Guard and other authorities; (c) a list of other individuals or organizations to be contacted; and (d) procedures for coordinating search and rescue efforts with the U.S. Coast Guard. (Class II, Priority Action) (M-85-80)

Require your fishing vessel captains to make frequent scheduled radio communications, which include their position, with shore facilities or other fishing vessels in your fleet to reduce delays in initiating a response in case of an emergency in which the vessel is unable to communicate. (Class II, Priority Action) (M-85-81)

--to the National Council of Fishing Vessel Safety and Insurance:

Promote through your organization and your member organizations:

- (1) The carriage of emergency position indicating radio beacons (EPIRB's) on all commercial fishing vessels;
- (2) The training of fishing vessel captains and their crews, as appropriate, in basic safety such as stability, watertight integrity, firefighting, and the use of lifesaving equipment;
- (3) The deposit of crew lists by fishing vessel captains at a suitable location ashore before departure;
- (4) The scheduling of frequent radio communications by fishing vessel captains which includes their position to reduce delays in initiating a response in case of an emergency in which the vessel is unable to communicate;
- (5) The determination of the stability characteristics of fishing vessels by their owners and the provision of guidance to fishing vessel captains on proper loading;
- (6) The need to keep freeing ports open during adverse weather conditions; and

- (7) The development of contingency plans for emergencies by fishing vessel owners that include: (a) detailed information about each vessel, its communication equipment, and its crew; (b) procedures for contacting the U.S. Coast Guard and other authorities; (c) a list of other individuals or organizations to be contacted; and (d) procedures for coordinating search and rescue efforts with the U.S. Coast Guard.

(Class II, Priority Action) (M-85-82)

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JIM BURNETT  
Chairman

/s/ PATRICIA A. GOLDMAN  
Vice Chairman

/s/ G.H. PATRICK BURSLEY  
Member

**July 9, 1985**

**APPENDIX A**  
**INVESTIGATION AND HEARING**

**Investigation**

The National Transportation Safety Board was notified of the accident on November 20, 1984, when the U.S. Coast Guard had determined that the AMAZING GRACE was lost and the search for survivors was still underway. When it was determined that there were issues involving the planning and execution of the search for the AMAZING GRACE by the U.S. Coast Guard, the Chairman of the Safety Board and the Commandant of the U.S. Coast Guard agreed pursuant to the Memorandum of Understanding between the two agencies dated October 7, 1981, that it would be in the public interest for the Safety Board to conduct the investigation with Coast Guard participation. Safety Board investigators were dispatched to Hampton, Virginia, the home port of the vessel; Wanchese, North Carolina, the home offices of the owners; Bayou La Batre, Alabama, where the vessel was built; and New York, New York, the coordination center for the Coast Guard search and rescue operation. Investigative groups were established for survival factors, vehicle factors, and human performance.

**Hearing**

The Safety Board convened a 2-day public hearing as part of its investigation of this accident on December 19, 1984, at Portsmouth, Virginia. Parties to the hearing were Ironside Trawling Company, the owners of the AMAZING GRACE, and the U.S. Coast Guard. Additional testimony was taken at Norfolk, Virginia, on January 23, 1985. Testimony was taken from 9 witnesses, and 30 exhibits were accepted into the record.

**APPENDIX B**  
**PERSONNEL INFORMATION**

Captain Paul Robles

Captain Paul Robles, 26, became captain of the AMAZING GRACE in June 1984. His experience as a fisherman began in 1972 at the age of 14 when he went to work as a deckhand for his brother, Cecil Robles, catching shrimp in the Gulf of Mexico. In 1978, both brothers moved to Newport News, Virginia, from Aransas Pass, Texas, and worked for Duzich Trawlers, Inc. Initially, Paul Robles continued to serve as a deckhand on his brother's boat. During the next 3 years, Paul Robles progressed to the positions of mate and then captain of his own boat.

In 1981, Duzich Trawlers went out of business, and Captain Paul Robles returned to Texas. In December 1981, he obtained his USCG document as an ordinary seaman and worked as an engineer on an offshore supply vessel. In May 1982, he obtained his USCG license as an operator of mechanically propelled vessels less than 100 gross tons not more than 100 miles offshore between New Orleans, Louisiana, and Brownsville, Texas. After obtaining his USCG license, he served as the captain of an offshore supply vessel. In 1984, Captain Paul Robles moved back to Virginia and for a period of about 6 months worked as mate for his brother before becoming captain of the AMAZING GRACE.

Mate James Bowers

James Bowers, a cousin of Paul and Cecil Robles, served as mate on the AMAZING GRACE. Mate Bowers had worked as a deckhand in the shrimp industry off the Texas coast before coming to Virginia. He worked as a deckhand for Cecil Robles for a couple of months in 1984 before becoming mate on the AMAZING GRACE in June 1984.

Other Crewmembers

The investigation did not determine the identities or experience of the other crewmembers.

APPENDIX C

METEOROLOGICAL INFORMATION

The following are the surface conditions from November 13, 1984, to November 16, 1984, in the vicinity of the last reported position of the AMAZING GRACE. This information has been derived from surface weather maps prepared by the National Weather Service, a NOAA weather buoy located at 38.8° N latitude, 74.6° W longitude and, when available, onscene reports. The wind sea heights have been computed from the buoy winds. Swell has not been considered.

November 13, 0700

Sky:	Overcast
Visibility:	Not available
Wind:	320 degrees 19 knots gusting to 27 knots
Sea:	8 feet
Air Temperature:	42° F
Sea Temperature:	58° F
Pressure:	1013.8 millibars

November 13, 1300

Sky:	Broken to overcast
Visibility:	Not available
Wind:	360 degrees 23 knots gusting to 31 knots
Sea:	8 feet
Air Temperature:	42° F
Sea Temperature:	58° F
Pressure:	1012.4 millibars

November 13, 1900

Sky:	Scattered
Visibility:	Not available
Wind:	350 degrees 21 knots gusting to 27 knots
Sea:	8 feet
Air Temperature:	45° F
Sea Temperature:	57° F
Pressure:	1013.8 millibars

November 14, 0100

Sky:	Clear
Visibility:	Not available
Wind:	330 degrees 31 knots gusting to 41 knots
Sea:	10 feet
Air Temperature:	45° F
Sea Temperature:	57° F
Pressure:	1013.8 millibars

November 14, 0700

Sky: Clear  
Visibility: Not Available  
Wind: 330 degrees 31 knots gusting to 39 knots  
Sea: 10 feet  
Air Temperature: 43° F  
Sea Temperature: 57° F  
Pressure: 1018.9 millibars

November 14, 1300

Sky: Clear  
Visibility: Not available  
Wind: 320 degrees 31 knots gusting to 37 knots  
Sea: 9 feet  
Air Temperature: 49° F  
Sea Temperature: 56° F  
Pressure: 1018.7 millibars

November 14, 1900

Sky: Clear  
Visibility: Not available  
Wind: 340 degrees 23 knots gusting to 29 knots  
Sea: 8 feet  
Air Temperature: 52° F  
Sea Temperature: 56° F  
Pressure: 1024.3 millibars

November 15, 0100

Sky: Clear  
Visibility: Not available  
Wind: 340 degrees 12 knots gusting to 16 knots  
Sea: Less than 5 feet  
Air Temperature: 50° F  
Sea Temperature: 56° F  
Pressure: 1026.7 millibars

November 15, 0700

Sky: Scattered  
Visibility: Not available  
Wind: 200 degrees 2 knots gusting to 4 knots  
Sea: Less than 5 feet  
Air Temperature: 49° F  
Sea Temperature: 56° F  
Pressure: 1027.3 millibars

November 15, 1300

Sky: Broken to overcast  
Visibility: Not available  
Wind: 210 degrees 21 knots gusting to 25 knots  
Sea: 8 feet  
Air Temperature: 56° F  
Sea Temperature: 56° F  
Pressure: 1002.5 millibars

November 15, 1900

Sky: Clear  
Visibility: 5 nautical miles  
Wind: 210 degrees 25 knots gusting to 33 knots  
Sea: 12 feet  
Air Temperature: 57° F  
Sea Temperature: 56° F  
Pressure: 1018.2 millibars

November 16, 0100

Sky: Broken  
Visibility: 10 nautical miles  
Wind: 220 degrees 19 knots gusting to 25 knots  
Sea: 11 feet  
Air Temperature: 57° F  
Sea Temperature: 55° F  
Pressure: 1015.2 millibars

November 16, 0700

Sky: Scattered  
Visibility: 10 nautical miles  
Wind: 240 degrees 19 knots gusting to 23 knots  
Sea: 9 feet  
Air Temperature: 56° F  
Sea Temperature: 56° F  
Pressure: 1013.9 millibars

November 16, 1300

Sky: Scattered  
Visibility: 5 nautical miles  
Wind: 330 degrees 17 knots gusting to 21 knots  
Sea: 7 feet  
Air Temperature: 57° F  
Sea Temperature: 56° F  
Pressure: 1012.1 millibars

November 16, 1900

Sky: Scattered

Visibility: 10 nautical miles

Wind: 340 degrees 17 knots gusting to 21 knots

Sea: 7 feet

Air Temperature: 53° F

Sea Temperature: 56° F

Pressure: 1015.8 millibars