No Survivors

A fishing vessel meets a mysterious end in the Bering Sea.

Lessons Learned from Casualty Investigations

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Everyone loves a mystery—the suspense, the puzzle, the excitement—all leading to the final reveal. Everyone, that is, except the Coast Guard when faced with the sudden disappearance of the *Arctic Rose*.

The death toll was high and there were precious few facts to analyze. Somewhere in the cold depths of the Bering Sea lay the clues that would lead to several theories concerning what happened to the ill-fated fishing vessel and its crew of 15. Through interviews and underwater explorations, the Coast Guard and its Marine Board of Investigation were able to piece together enough facts to come up with several scenarios that may account for the final moments of the vessel.

The Final Deployment

The vessel departed Dutch Harbor in Unalaska, Alaska, on March 22, 2001, after taking on 10,580 gallons of fuel and an unknown quantity of water. Six days later, it left Unalaska with a crew of 15 and made several trawls in the Slime Banks area of the Bering Sea, known for producing small amounts of yellow fin sole. On the last day of March, the vessel did not offload cargo but took on 3,591 gallons of fuel and another unknown amount of water at the last port of call—St. Paul, Alaska. After leaving St. Paul, the vessel sailed 36 hours to the Zemchug Canyon Bering Sea fishing grounds to participate in the flathead sole B season, which opened on April 1.

The April 1 flathead season lasted for three weeks and yielded sole containing valuable roe, which is marked for consumption in Asia and brings higher profits. As flathead sole are bottom-dwellers and remain on the sea floor during the day, the best time to catch them using trawling gear is during daylight hours.

Two trawl sets were made during the day on April 1. The first yielded very little marketable fish, but the second, completed around 8:00 or 9:00 p.m., produced a 50 percent flathead sole catch. The captain intended to remain in the vicinity to resume fishing in the morning and set the vessel for jogging at minimal speed in order to hold its position.

The vessel *Alaskan Rose*, owned and operated by the same company, was fishing within 10 to 15 miles of the *Arctic Rose* and the captains had spoken late in the evening of April 1. The captain of the latter vessel had expressed his irritation at the garbage that had been left in the processing space, clogging the chopper sump pump.

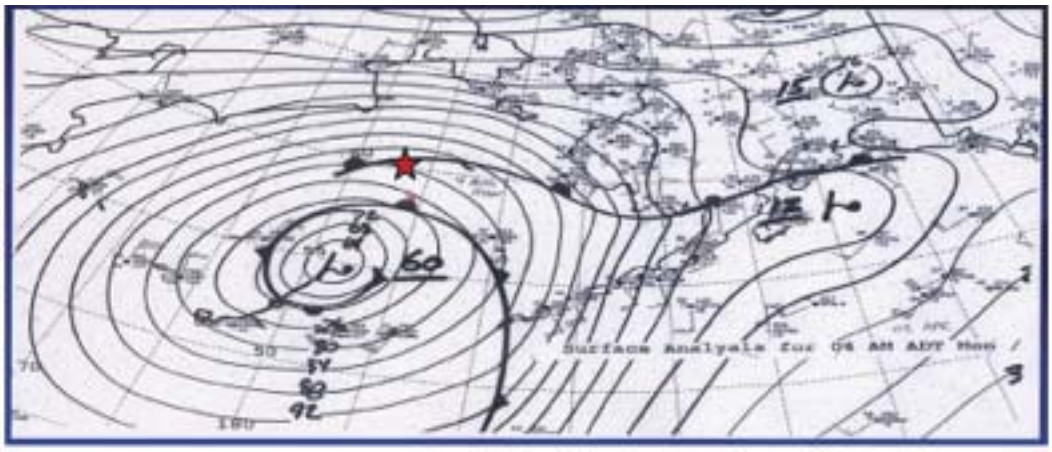
In a discussion of the day's events between the *Arctic Rose* captain and the other vessel's mate around 10:30 p.m., the captain did not report any mechanical problems or other concerns, and the problems with the sump pump had been resolved. The mate later testified that he last saw the *Arctic Rose* on radar around 11:59 p.m.

Vessel Versus Nature

The forecast from the National Weather Service (NWS) for 5:00 a.m. April 1 through 5:00 a.m. April 2 called for a gale warning, with seas building to 16-24 feet by the morning of April 2. The forecast covers a large area and can lead to ambiguous weather projections because of the lack of data buoys and weather stations in the Bering Sea region. The NWS generates forecasts that are conservative in nature in order to compensate for this lack of information and often call for more severe weather than actually occurs. Because of the cautious nature of the forecasts, fishermen tend to discount them.

A hindcast, which tested the forecast against the actual occurrence of the weather in the vicinity of the sunken vessel, was generated based on weather reports from the Coast Guard and other commercial sources operating in the region. The analysis showed that a significant

weather event called a "triple point" occurred at the vessel's last known position. This is an area of a frontal system where a cold, warm, and occluded front join together, and is usually associated with severe weather. It is likely, based on the triple point, that the vessel experienced these three distinct weather patterns in a short period of time.



National Weather Service surface analysis for 4 a.m. on April 2, 2001. The red star indicates the approximate position of the Arctic Rose. Graphic courtesy of the National Weather Service.

It is also possible that conditions were further complicated by another phenomenon known as micro-weather, characterized by localized severe weather that can be experienced in one area, but not by other vessels nearby. Micro-weather would also produce confusing seas that would make it difficult for watchstanders to predict wave patterns and height. The hindcast from the NWS shows that the weather at the time of the casualty was worse than had been forecast.

A Call for Help

The command center of Coast Guard District 17, Juneau, Alaska, received an Emergency Position Indicating Radio Beacon (EPIRB) notification via telex at 3:35 a.m. on April 2. Having identified the EPIRB as belonging to the *Arctic Rose*, the watch supervisor called the Seattle, Wash., representative for the vessel's owner and requested that he contact the vessel to determine whether the alert was a false alarm. The representative called back to inform the command center that he had been unable to reach the vessel by either phone or e-mail, so the command center issued an Urgent Marine Information Broadcast (UMIB) to alert all vessels to be on the lookout for the fishing boat and/or any survivors.

After being informed that the *Alaskan Rose* was in the vicinity, Coast Guard Communications Station Kodiak unsuccessfully attempted to contact that vessel. Air Station Kodiak launched a C-130 at 4:00 a.m. to begin the search for the missing vessel while the C-130 and Communications Station Kodiak continued to try to contact it, without success.

Shortly before the C-130's arrival on scene at 7:30 a.m., contact with the *Alaskan Rose* was made via VHF radio. The mate informed the crew of the C-130 that he had not heard a "mayday" or other call for assistance from their sister vessel and altered his own vessel's course to intercept the EPIRB after immediately waking the captain to inform him of the situation. As they traveled the 11 miles south to the EPIRB position, the mate continued—unsuccessfully—to try to hail the other vessel on VHF radio.

Captain Recovered

Approximately one hour after receiving the Coast Guard transmission, the *Alaskan Rose* entered a debris field and the crew spotted someone wearing an immersion suit in the water. They recognized him as the

Photograph of the *Arctic Rose* taken during the remote operated vehicle expedition. U.S. Coast Guard graphic.

captain of their sister ship and attempted to hail him, but he was unresponsive.

The mate donned an immersion suit, attached himself to a safety line, and entered the water to rescue the captain, but the tether was too short and he was unable to reach the man in the water. Unhooking his safety line, the mate swam the distance to the captain and pulled him back to the vessel. The crew threw a ring buoy to the mate and hoisted him and the captain aboard, where they began to administer CPR to the unresponsive man.

A Vessel with a Story

The *Arctic Rose* was a stern trawling fishing vessel with an extensive history that came to an abrupt end on April 1, 2001. Originally constructed in 1988 in Biloxi, Miss., the vessel operated as the shrimp boat *Sea Power*. As there were no plans available, it is unknown what construction methods were used and whether the vessel was constructed within the recognized standards.

In the early 1990s, the vessel was relocated to New Bedford, Mass., and was modified to dredge for scallops. Again, there is a lack of plans for the modification, though pictures taken by a marine surveyor reveal plug welds installed in the heavy doubler plates on the port and starboard sides and the stern. It is thought that this adjustment was likely installed in order to protect the sideshell from the scallop dredge banging against those areas of the hull.

The *Sea Power* was purchased in 1991 and again modified, this time to work in the head-and-gut (H&G) and freeze industry in Pascagoula, Miss. Several modifications were made to the vessel at this time:

- A shelter deck, housing fish processing equipment and extending aft from the house on the main deck, now covered about two-thirds of the aft working deck.
- A gantry and net reel, for trawl operations, was added at the stern.
- The live fish hold was transformed into a cargo hold, which was outfitted with a refrigeration system and insulated with spray-on urethane foam.
- A concrete deck was poured to level the deck and to serve as insulation from the shaft alley running through the cargo hold.

The changes were reviewed by a naval architect who conducted an inclining experiment on Dec. 11, 1991, following the completion of the majority of the work. A stability book, which incorporated the processing space as a part of the vessel's watertight envelope and requiring it to be weathertight when the vessel was underway, was issued to the owner.

The vessel was renamed *Tenacity* and continued to operate as an H&G processor. The vessel had experienced constant engine, equipment, and shaft and trawl problems as the *Tenacity*, which contributed to the owner filing for bankruptcy in 1996. The vessel was removed from service and remained in lay-up status for more than two years at Fisherman's Terminal in Seattle, Wash.

The *Tenacity* was purchased in March of 1999 and rechristened the *Arctic Rose* on June 25, 1999. Under the new owner, the vessel underwent additional modifications:

- The existing gantry was removed and a new, larger, "A"-frame gantry was installed.
- A Cummings generator was installed in the engine room.
- Six-inch pipe guards were installed on the upper deck in order to center the trawl net.
- A refurbished propeller and intermediate shaft were machined and installed.
- The processing space was overhauled and all old equipment (except for two plate freezers) was removed.
- Tsurimi and Vaughn sump pumps were installed on the port and starboard sides of the processing area.
- The deck of the processing area was installed with new fiberglass grating and steel framing (at a minimum of five inches off the deck).
- The by-catch chute was raised to four feet above the deck and fitted with a manual guillotine closure, and the waste overboard chute was raised to five feet off the deck and outfitted with a flopper door.
- The refrigeration system was overhauled.
- New stainless steel equipment was installed, including: a packing table with scales, wash tanks with incline conveyor, bleeding bins, bleeding bin conveyor with incline conveyor, sorting belt with incline conveyor, break tank gutting belt heading machine, dump box with incline conveyor and hydraulic sliding hatch, and bleeding bins with three hydraulic doors.
- The port and starboard refrigerant accumulator tanks and the related piping were removed from the weather deck, and the accumulator tank was removed from the auxiliary machinery space.
- Two 8-foot by 4-foot low side receivers and associated control panels and piping were installed in the auxiliary machinery area.
- In order to accommodate a new pan plate freezer that was installed in the processing space, another pan plate freezer was moved several feet to the starboard side and the piping was modified.

The captain was fully clothed, wearing boots, and his immersion suit was filled with water. The crew made several cuts in the suit to administer emergency medical treatment, thereby eliminating any chance of determining the means by which the water had entered the suit. The captain's body was later taken by the Dutch Harbor police department and turned over to the Alaska State medical examiner in Anchorage for autopsy, which showed no use of drugs or alcohol and revealed the cause of death to be salt water drowning.

A Desperate Search

For the next 36 hours, the crew of the rescue vessel searched for survivors. Several miles south of the debris field, they came across an inflatable life raft belonging to the vanished fishing boat; it was right-side-up and empty. After several failed attempts to recover the life raft and with the weather beginning to worsen, causing a hazard to their lives, the C-130 commander directed the vessel's crew to destroy the life raft. Holes were sliced into the flotation chambers and the raft sank into the depths.

Two crewmembers later testified that, during the rescue efforts, they spotted a person in the water. One man testified he had seen someone wearing a white shirt and dark pants, while the other saw a dark shirt or jacket and dark pants. Based on the descriptions, which revealed they had seen two different individuals, the families were able to identify one of the men, though both bodies had slipped beneath the waves before they could be retrieved.

As there was nothing for them to recover on the surface, the Coast Guard conducted two expeditions using a remote operated vehicle (ROV) to collect data for the marine board's investigation. The marine board began the first operation in mid-July. The expedition contracted a Klein 500 sonar and a Phantom HD2 ROV. The sonar located a large contact during its third pass over the search area. Several additional passes were used to determine the size of the debris field and the position of the vessel.

ROVs Provide Eyes Under Water

Early in the morning on July 18, 2001, the ROV, equipped with a video camera, was lowered to the area where the vessel had been found. The sunken vessel was seen sitting upright under 73 1/3 fathoms (well over 400 feet) of water approximately 200 miles northwest of St. Paul, Alaska.

As the ROV maneuvered up the port side of the hull, the name of the vessel was once again seen by human eyes. The multicolored polypropylene lines that were used to mend the trawl net had unraveled from the vessel and the lines were sucked into the propellors, entangling the remote operated vehicle. Efforts to free it caused the umbilical cord to part, and the ROV was lost.

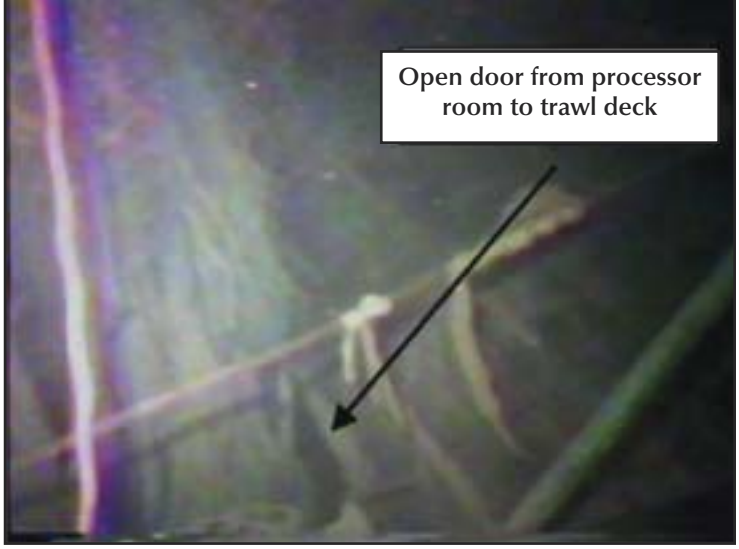
The second expedition began in the middle of August with a more powerful ROV. As the vehicle surveyed the wreck, examining the hull above and below the waterline as well as the port side of the pilothouse and the aft deck area, it found the following:

- The hull of the vessel was intact.
- The pilothouse was undamaged and all visible windows were intact.
- The rudder was hard to port.
- The trawl doors were missing and the trawl net was on the reel with the cod end in the dump box.
- The starboard overboard chute was partially open.
- Wires were spooled on the trawl winches and trawl gear, wires, and mud lines had shifted to starboard.
- Plow marks aft, where the vessel's kort nozzle made its initial impact, indicate that the vessel landed on the sea floor, stern first.
- There was no evidence of explosion or fire.
- The vessel was not fishing at the time the casualty occurred.

Vessel Stability

An inclining experiment was performed on March 31, 1999, to calculate the lightship displacement and center of gravity for the vessel and to create operating limits for the vessel. The test was conducted by a representative of a naval architecture and marine engineering firm with only two weight movements rather than the standard of three weight movements recommended by the American Society of Testing and Materials. The naval architect conducting the experiment explained that it was normal practice for uninspected fishing vessels to be treated differently than inspected vessels.

An independent review of the marine consultant files indicated that a third weight movement would not have changed the outcome or altered the conditions of the stability letter. Between July 9, 1999, when the operating instructions were issued, and April 2, 2002, there were a number of weight additions, relocations, and removals performed on the vessel. These alterations were not tracked by a naval architect to evaluate the weight changes on the vessel's stability (see sidebar "A Vessel with a Story").



ROV photo of open weathertight door on aft bulkhead of processing space. U.S. Coast Guard graphic.

Contributing Regulatory Failures

At the time of the casualty, the vessel was not in compliance with the operating instructions. The second ROV survey revealed that the aft starboard door in the processing space was open and the guillotine closure for the starboard discharge chute was more than half open. Both conditions prevented the processing space from being weathertight.

As the vessel used water in sorting and processing fish, it was required to have an interlock installed to prevent flooding of the processing space. Testimony from several witnesses indicated they had seen processing water left on, or the pumps in the processing space clogged with debris, which allowed the space to flood. It is possible that, based on this testimony, the interlock system was either non-existent or not functional.

Testimony from an engineer indicated that the double-bottom fuel tank had been used as a day tank and was refilled at the beginning of each day. When the vessel sank, there were between 9,500 and 12,000 gallons of fuel aboard, and 53,000 lbs. of product, stores, and ballast in the fish hold.

The maximum allowable deck load, according to the stability book, was 3,000 lbs. Though independent calculations later found the vessel met the intact stability criteria, the master of the vessel was able to evaluate whether his vessel met the minimum stability criteria only through use of the operating instructions. The average commercial fisherman is often unfamiliar with stability information because it is provided in several different forms (as there is no set industry standard) and is often difficult to read or interpret. Instead, they often determine vessel stability based on "feel." Therefore, the stability information on this particular vessel was left open to several interpretations.

Unraveling a Mystery

Because there were no survivors to recount the vessel's last hours or surface evidence to reveal what happened, the marine board requested the assistance of the Coast Guard's Marine Safety Center (MSC) to conduct an independent analysis to determine the most likely cause of the trawler's sinking. The MSC evaluated more than a dozen different scenarios that could have led to the loss of the fishing vessel and determined one to be the most likely.

They used the best estimate of the loading condition of the vessel at the time of the casualty as the baseline for all stability calculations. It is believed, based on the loading conditions as they were recreated using the analysis of data gathered during the investigation, that the vessel met the righting arm characteristic criteria and severe wind and roll criteria in NVIC 5-86, provided that the processing space was completely weathertight, as was required by the vessel's stability letter.

The Society of Naval Architects and Marine Engineers worked with the MSC to develop a progressive flooding analysis spreadsheet as a forensic analysis tool. Based on quasi-static time steps through various progressive flooding scenarios into as many as six interior compartments where large free surface "sloshing" effects[1] would negatively affect the vessel's stability, it was determined that the loss of the vessel was most likely caused by progressive flooding from the aft deck, into the processing space, through the door in the aft bulkhead.

The analysis suggested the vessel likely flooded rapidly forward through the open door in the bulkhead of the processing space, with the water then flooding into the galley and engine room through non-watertight doors. It is likely that the vessel lost all positive stability between one minute forty seconds and two minutes forty seconds, and sank in as few as four minutes six seconds after the progressive flooding began.

Several factors likely contributed to the accident: improper vessel operations and a failure to adhere to regulations, a lack of safety training for crewmembers who spent little time on the vessel prior to the last voyage, and a failure of emergency systems.

Vessel Operations

The vessel was engaged in head-and-gut (H&G) operations, in which the processors remove the head, either by

hand or by guillotine, and the entrails before flash-freezing the fish. After the fish are frozen, they are bagged and placed in the cargo hold until they are offloaded. As H&G does not meet the regulatory definition of processing, the vessel was exempted from the processing vessel regulations found in 46 CFR, Part 28, Subpart F.

However, testimony from former crewmembers revealed the vessel did engage in processing by removing tails and fins, and therefore was subject to those regulations pertaining to fish processing vessels. The regulations require a class society or other qualified organization to conduct a vessel examination. A vessel cannot arbitrarily change its status from "non-processing" to "processing."

Testimony from former crewmembers revealed that when the vessel was ready to go to sea, last-minute hires were often required to fill vacancies. This policy was apparently prevalent aboard this vessel, since experienced processors were able to assess the production capabilities of the vessel by analyzing the size of the cargo hold and number of plate freezers and came to the conclusion that they would not make much money aboard the vessel. Former employees testified that crewmembers were often hired off the street or dock. In the case of the vessel's last voyage, three crewmembers were not documented for work in the United States (working under aliases), and 10 of the 15 crewmembers had been working aboard the vessel for less than three months.

Safety Observations Indicate Problems Aboard

Processors are not required to have basic safety training prior to accepting a position within the fishing industry. However, a safety orientation conducted by the master or other qualified individual is required to be provided when the processor reports aboard the vessel. As a vessel greater than 60 feet but less than 125 feet, it was required to have part-time National Marine Fisheries Service (NMFS)-certified observer coverage for 30 percent of its time fishing in each calendar year.

The last observer departed the vessel on March 21, 2001, and filed a brief that cited safety concerns ranging from occupational and workplace safety to vessel safety. The observer testified that acceptable abandonship drills were conducted on a weekly basis and stated that the vessel orientation was the best she had received as an observer. However, former crewmembers testified that the only safety training they had received was a brief introduction to the equipment and a short presentation on using the immersion suits.

Emergency Systems

Two ring buoys were mounted on the port and starboard weather deck bulkheads and the 20-person inflatable life raft was located on the roof of the pilothouse, forward of the mast, while signal flares were kept on the bridge in a watertight container. A wooden box on the port side held 17 immersion suits, each of which was equipped with whistles, waterlights, and retroflective tape. The vessel's EPIRB was mounted on the starboard side of the vessel, outside the weather deck. There it deployed at the time of the incident and emitted a signal that was received by satellite, which then forwarded the signal to the land station and sent it via phone line to the command center in Juneau, Alaska.

The vessel used an internationally utilized, semi-automated satellite service designed to distribute maritime safety information (MSI) to all types of vessels. Broadcasts are made over the INMARSAT-C system of geostationary satellites free of charge. The service is part of the Global Maritime Distress and Safety System (GMDSS) that provides for automatic distress alerting when a radio operator is unable to send an SOS or MAYDAY alert and also requires vessels to receive MSI broadcasts. The system also provides repeated distress alerts and an emergency source of power.

Two types of INMARSAT-C systems are sold for use aboard vessels: A GMDSS version and a non-GMDSS or "fisheries" version. While the two are very similar and provide comparable features, the fisheries version allows messages and safety broadcasts to be received and stored internally without notifying the operators that a message has been received. Both the *Arctic Rose* and *Alaskan Rose* had the non-GMDSS system installed in the pilothouse.

Technological Hiccup Waylays Distress Signal

On April 2 at 4:29 a.m., the District 17 command center in Juneau relayed the casualty vessel's distress information with a priority parameter of "distress" and a service parameter of "navigational warning."

However, a configuration in the system caused the message to default to a less urgent priority based on the service parameter, which is used to determine the system's response based on the settings and location of the vessel. There was no documentation that would indicate that the priority of messages would be determined by the service parameter, and users were not made aware that the system could default a message to a lower priority. This discrepancy was addressed in November 2001.

continued on page 86

Based on the findings of the ROV expeditions and witness testimony, the Marine Board of Investigations made several recommendations. Unless noted, the Coast Guard concurred with the recommendation and took action to implement.

Regulatory

- The Coast Guard should develop regulations requiring that all weathertight and watertight doors that are required to be closed, by the vessel's stability book, be alarmed and equipped with an audible and visual system in the pilothouse, indicating the position of the doors.[1]
- Vessels equipped with a processing space, or a space used in the sorting of fish in which water is used, should be fitted with high water alarms that sound in both the processing space and the pilothouse.
- The Coast Guard should re-evaluate the regulatory definition of processing vessels as it applies to fishing vessels and ensure that it includes head-and-gut operations.

Vessel Operations

- The Coast Guard should modernize the policy addressing weight changes and the need for a new stability letter to reflect the changes in technology and update the requirements.
- The Coast Guard and commercial fishing industry should establish a non-regulatory program to encourage vessel owners to track weight changes and other alterations that may impact a vessel's stability.
- The Coast Guard should distribute guidance regarding fishing vessel construction standards to minimize the free flow of water.
- The Coast Guard should remove provisions allowing the use of above main deck space in the development of fishing vessel stability characteristics.[2]

Safety and Training

- The fishing industry and the Coast Guard should investigate the development of a minimal safety indoctrination program for first-time crew members, including processors, and provide a means to document training.[3]
- The Coast Guard should encourage the use of color graphic displays instead of complex numeric formats in stability books to ensure that they are easily understood by mariners.
- The Coast Guard and NMFS should develop a memorandum of understanding to encourage the exchange of safety information gathered by observers serving aboard fishing vessels. A similar MOU should be developed between the Coast Guard in D17 and the Alaska Department of Fish and Game.[4]
- The Coast Guard and the Society of Naval Architects and Marine Engineers should develop workshops on regional stability and damage control that focus on fishing vessels operating within their regions.
- The Coast Guard should circulate a policy to ensure the preservation of all evidence collected on the scene of a marine casualty and establish guidelines to improve the process of selecting members of a Marine Board of Investigations.

Communications

- All fishing vessels operating beyond the boundary line should be GMDSS compliant. The Coast Guard should partner with the Federal Communications Commission (FCC) to develop these regulations.
- The Coast Guard and the FCC should require fishing vessels equipped with a GMDSS system to have a properly trained operator.
- The Coast Guard should develop a long range automated information system that incorporates two-way communications for vessels equipped with a GMDSS satellite communications system, thus providing the Coast Guard with information on the location and identity of vessels operating in U.S. waters. This system could facilitate rescue coordination by providing the location and identity of vessels and two-way communications capability to direct resources to the scene of a vessel in distress.[5]

Endnotes:

As noted in the Marine Board of Investigation official report:

1. We concur with the intent of this recommendation. We believe that the fitting of watertight and weathertight doors, required to be closed by a vessel's stability booklet, with alarms and status indicators would improve fishing vessel safety by making masters and crews more aware of the status of their vessel's watertight integrity and alerting them to possible threats of flooding. However, we believe that the development and implementation of a voluntary compliance program rather than attempting to publish regulatory requirements is more appropriate and more likely to be completed faster and with better success. We will consult with the Commercial Fishing Industry Vessel Safety Advisory Committee and work with the industry on the development of appropriate voluntary standards and seek to include the results in an update to Navigation and Vessel Inspection Circular 5-86, Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels.
2. We concur with the intent of this recommendation. Incorporating the weathertight envelope in stability analyses provides an accurate measure of a vessel's stability so long as operational practices do not compromise the spaces' integrity. We believe removing the provisions that allow for the use of main deck spaces that are part of the weathertight envelope would be overly restrictive. However, there may be a need to amend the existing provisions to reduce the likelihood that the integrity of spaces above the main deck spaces that were used in stability analyses could be compromised due to operational practices or other factors. We will include this issue in our review of Navigation and Vessel Inspection Circular 5-86, Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels, and update its guidance as necessary.
3. We concur with the intent of this recommendation. Requirements for safety orientations to be given to each individual on board who has not received the instruction and has not participated in required drills, including first-time crew, already exist in 46 CFR 28.270(e).9 46 CFR 28.270(f) provides the minimum requirements for safety orientations. We are currently working on a regulatory project that will propose requirements for the documentation of training and drills.
4. We concur with the intent of this recommendation. We agree that the exchange of safety information obtained from observers would be extremely valuable in our efforts to improve the safety of fishing vessels; however, the development of a new memorandum of understanding (MOU) may not be necessary. As we continue discussions with the National Marine Fisheries Service (NMFS) on this issue, we will consider the possibility of expanding the existing MOU between the U.S. Coast Guard and NMFS, developing a new MOU as recommended, or other means to facilitate the information exchange.
5. We partially concur with this recommendation. Systems already exist with the capabilities described in the recommendation. We are currently working at the International Maritime Organization to select appropriate systems to be used internationally and to establish standards and requirements for the equipment on board vessels. Once the work at the IMO has been completed, we will evaluate the feasibility of adopting those requirements for U.S.-flagged fishing vessels.

Coast Guard Communications Station Kodiak maintains a live 24-hour watch to monitor all high-frequency (HF) communication and digital selective calling (DSC) distress and safety frequencies for the North Pacific region. Had the *Alaskan Rose* been equipped with a GMDSS DSC-equipped single sideband radio, the communications station may have been able to trigger an alarm on the vessel to initiate communications. DSC was designed to allow a receiver to scan the safety and distress channels despite any noise associated with HF.

The INMARSAT-C aboard the *Alaskan Rose* did not have an audible or visual alarm to notify the watchstander of an incoming urgent message; he would have had to go from the steering station to the INMARSAT-C unit to download the message. That evening, the vessel received several messages from Russia, but the distress message from its sister ship was not received until several hours after it had been sent by the D17 command center.

Recreating the Tragedy

The layout of the vessel increases the likelihood of the progressive flooding from the processing space. The door leading from the processing space to the aft deck was far outboard on the starboard side, which would have reduced the heel angle at which water would enter the processing space. The doors leading forward into the galley and engine room were also located on the starboard side. The angle to starboard caused by the inflow of water through the aft door combined with the free surface effect inside the processing space would cause the water to spill forward into the galley, into the engine room, and eventually into the fish hold.

Three likely causes of progressive flooding into the processing space were established using the analysis:

- a wash-up hose left on or the water supply from the plate freezers may have caused the processing space to flood internally,
- the processing space could have flooded by boarding seas flooding from the aft deck,
- the space could have flooded through the open aft door if the vessel had rolled to starboard by at least 23 degrees.

No matter the means by which the water entered the processing space, the subsequent stability would have been reduced and the flooding continued until the vessel sank. Had the processing space been weathertight, as required by the stability book, the vessel would not have sunk.

Since casualties are usually caused by a series of events rather than just one catastrophic event, the marine board believes it is likely that the vessel was in the process of turning or was jogging downwind with following seas when it capsized to starboard. The position of the rudder left hard to port suggests a natural human reaction to correct for a starboard list. However, this action would prolong or increase the list and allow sea water to initially enter the vessel through the open weathertight aft door. The vessel likely remained heeled to starboard until the rapid progressive flooding sank the vessel.

A Lesson for the Future

The tragedy that befell the vessel could have been prevented had the crew been properly trained to follow safety and stability guidelines and had all communications systems been working correctly. The families of the men lost at sea had the opportunity to review the findings of the marine board and so were able to learn as much as possible about the events that transpired.

Though the loss of life and property can never be considered in a positive light, it is the hope of many that the lessons learned from this misfortune will help save the lives of future vessel crews as they engage in the dangerous profession of fishing near the Arctic Circle.

Editor's Note:

All conclusions are based upon information taken from the Marine Board of Investigation Report "Investigation into the circumstances surrounding the sinking of the uninspected fishing vessel *Arctic Rose*, official number 931446, in the Bering Sea on April 2, 2001, with one person deceased and fourteen persons missing and presumed dead," signed Dec. 19, 2003.

Acknowledgments:

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Endnote:

1. The free-surface "sloshing" effect occurs when a tank is partially filled with liquid, and the movement of the liquid (in conjunction with the ship's rolls and pitches) slows the ship's return to vertical. This changes the center of mass and center of movement, and decreases stability. In heavy weather, this can increase the degree to which the ship rolls, and—in extreme cases—cause it to capsize.