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Lessons Learned

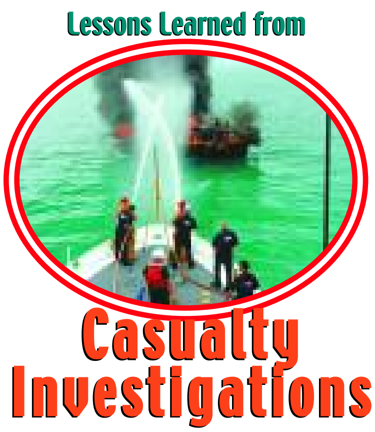
from U.S. Coast Guard Casualty Investigations

PROCEEDINGS

Summer 2006

Vol. 63, Number 2

On the cover, top: A charter vessel aground in the surf on Clatsop Spit, Ore., near the mouth of the Columbia River. Center: A commercial fishing vessel aground near Kodiak, Alaska. Bottom: A bulk carrier burns off Coos Bay, Ore. USCG Photos.



Casualty Investigations

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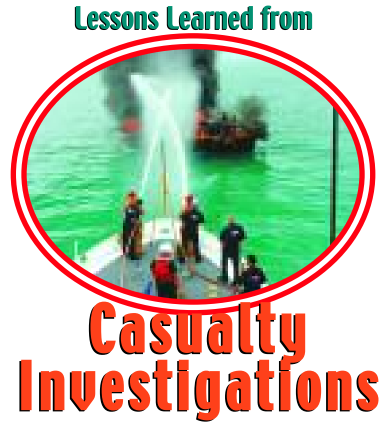

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Assistant Commandant's Perspective

by RDML C. E. Bone
Assistant Commandant for Prevention

To serve the public and protect the U.S. Maritime Transportation System from accidents or intentional sabotage, the U.S. Coast Guard is determined to prevent marine causalities and strengthen the ability to prepare, protect, and respond to a wide variety of marine incidents involving vessels as well as marine facilities both onshore and offshore.

We all share common goals of safe, environmentally sound, and secure use of our ports and waterways. Ships and their systems are built to meet comprehensive standards of safety and pollution prevention, and undergo considerable oversight during construction by interested parties and governmental authorities. Waterways have rules of operation, controls, and restrictions to limit the risks. Likewise mariners are trained, tested, and licensed to operate within the scope of their abilities. Yet maritime accidents, more commonly referred to as marine casualties, continue to occur throughout U.S. and internationals waterways every day. The term "marine casualty" for vessels and the mariners who operate them, includes any event or any occurrence involving a vessel that results in damage by or to the vessel, its apparel, gear, or cargo, or injury or loss of life of any person. This includes, among other things, collisions, strandings, groundings, founderings, heavy weather damage, fires, explosions, failure of gear and equipment, and any other damage that might affect or impair the seaworthiness of the vessel.

The U.S. Coast Guard investigates marine causalities to promote maritime safety and security and to protect the marine environment. Similar to other transportation sectors such as air, rail, or highway, there is a constant need to assess the qualitative and quantitative analysis of the probability of risk. We identify hazard initiators and risk reduction options, as well as methods of reducing and evaluating the consequences of risk. Ultimately the goal of the U.S. Coast Guard is to protect the public through prevention of future incidents by revealing the linkage of compounding factors that causes an accident or casualty.

The ability to prevent marine casualties has been developed through over a century of case experience and with decades of extensive coordination with partner organizations such as the International Maritime Organization, the National Transportation Safety Board, and the Occupational Health and Safety Administration. The effort to prevent marine casualties is coordinated through a breadth of industry organizations; national, regional, and local committees; and state partners. The U.S. Coast Guard has developed extensive experience with risk assessment for marine causalities. As part of its mission to prevent and mitigate marine accidents, the U.S. Coast Guard investigates the causes of marine casualties and analyzes investigation data in an effort to identify measures that will improve marine safety. It is estimated that 80 percent of marine casualties have human error or human factor-related causes. Therefore, particular attention is made to analyze the entire chain of events, operating environment, and decisions made to include operations, maintenance, management, and governmental oversight that led up to the casualty. We must remain rigorous, open, and deliberate in our investigative process, engaging the breadth of governmental and private sector expertise if we are to be successful in identifying the causal factors and preventing future marine casualty events.

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Champion's Point of View

by CAPT Michael B. Karr
Chief, U.S. Coast Guard Office of Vessel Activities

During the U.S. Coast Guard's long history, assuring safety in the marine environment has been our most traditional mission; and the personnel of the Coast Guard are very proud of this heritage. Much of our effort is directed at prevention. We perform regular vessel inspection and regulation enforcement activities in an ongoing effort to secure the marine environment and assure vessel safety.

Despite these efforts, however, maritime casualties do occur, and the Coast Guard stands ready to respond to these incidents. A marine casualty incident can last for weeks as an ongoing event, beginning with intense and risky search and rescue operations, fire-fighting, or damage control, and transitioning to waterway closures, marine traffic control issues, salvage efforts, and pollution response.

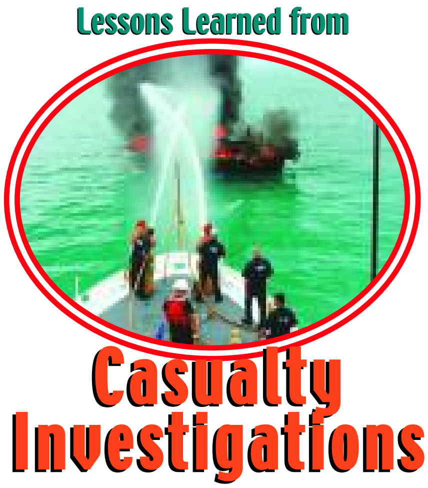
In this edition of *Proceedings*, we will take a close look at nearly a dozen recent marine casualties. We will explore how each of these incidents occurred, including any environmental, vessel design, or human error factor that contributed to each event. We will outline the U.S. Coast Guard Marine Casualty Investigations that followed; and describe in detail the lessons learned through the investigation of these incidents, and any changes in maritime regulations that occurred as a result of those investigations.

I believe that reading the experiences of others can reduce marine casualties, especially if the reader can identify with those experiences. In my case, I keep many instances of maritime lessons learned on my mind. In particular, I can readily identify with the marine safety regulatory agency leadership in place during the sinking of the *General Slocum* in 1904, and do not want to repeat its mistakes. The lessons learned from the *General Slocum* serve to motivate me to prevent those organizational failures from happening again, today.[1]

It is important to note that lives were lost in some of the marine casualties we present in this edition. These were tragedies not only for those whose lives were lost, but also for the family and crewmembers who remain. Out of respect for all these people, the reports presented here mention no names of any person involved in any of the incidents.

Some of these incidents were catalysts for major changes in maritime regulations. Some occurred because those involved ignored these regulations. It is our intention to publicize the lessons learned from each of these incidents to educate the maritime community. In so doing, we hope to prevent similar incidents in the future.

[1] For more information on the General Slocum investigation see the *Proceedings* October – December 2003 issue and the "Report of the United States Commission of Investigation Upon the Disaster to the Steamer *General Slocum*" at http://www.uscg.mil/hq/g-m/moa/reportindexcas2.htm



Gambling with Safety

Allision of a towing vessel.

by Ms. Jennifer Kiefer
Special Correspondent to *Proceedings*

Gambling is always a risky venture, but that's usually part of its appeal. On the evening of April 4, 1998, however, the gamblers aboard the *Admiral*'s President Casino in St. Louis, Mo., unwillingly encountered a game of chance with their lives. While more than 2,000 people were enjoying the casino's entertainments, just a short distance away, the M/V *Anne Holly* allided with a bridge, which set adrift most of its 14 barges. The strong current carried some of those barges back toward the casino, a permanently moored vessel, ultimately parting nine of its 10 mooring lines and swinging it out into the river. The gambling inside the casino suddenly took a dramatic turn outside.

The potential for a major maritime casualty loomed large, but thanks to a number of quick-thinking people and a lot of luck, nobody aboard either vessel was seriously hurt and the damaged barges were quickly recovered. But what makes this accident so noteworthy—besides its brush with catastrophe—is how it set the stage for a number of valuable maritime safety improvements.

Incident Overview

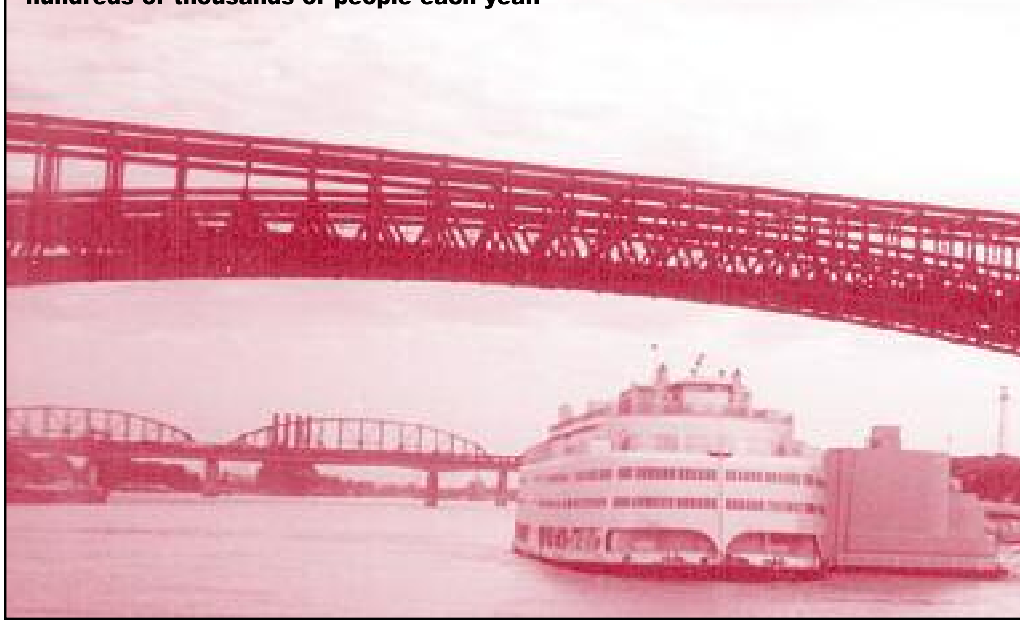
To understand the value of the safety improvements requires first examining the accident in greater detail.

Waterway/Transit Hazards

In some ways the accident almost seemed inevitable, as the waterway on which it took place is well known for its difficulties. With four bridges (Poplar, MacArthur, Eads, and Martin Luther King) located within a narrow 1.2 mile navigable channel, St. Louis Harbor on the Upper Mississippi River requires an experienced pilot. Specifically the Eads Bridge—where the allision began—has long been recognized as one of the most difficult navigation areas on the Western Rivers. Clearing the bridge's diminishing vertical clearance requires steady steering and concentrated accuracy.

In addition to the four bridges that are always of concern to pilots, the water itself presented an unusual challenge the night of the allision. High river conditions had been noted at the St. Louis River level gage for several days. On the evening of April 4, the river

Just north of the St. Louis Gateway Arch on the Mississippi River, the 380-foot-long *Admiral* is a permanently moored vessel that plays host to hundreds of thousands of people each year.



current was running about six mph at a river gage of approximately 31.5 feet; in St. Louis the flood stage is 30.0 feet. This high river gage significantly increased the hazards to all vessels navigating through St. Louis Harbor, prompting the Coast Guard to issue a safety zone that included a "daylight operation only" restriction on southbound tows over 600 feet. As the *Anne Holly* was traveling northbound, it was not affected by the safety zone and thus the transit occurred during the more challenging night hours.

The Allision

The captain was a very skilled pilot with more than 38 years of maritime experience. Shortly after 5 p.m. on April 4, he relieved the pilot on watch, watched over the completion of the tow's barge configuration, and confirmed with the engine room that all propulsion and engine room equipment was operating satisfactorily. Both the tow and its crew were prepared for the transit. About 6:30 p.m., the vessel got underway from the fleeting area, heading upstream, pushing 12 loaded and two empty barges secured to each other with extra rigging because of the severe river conditions. The complete tow, including the 154-foot-long towboat, was 1,149 feet long and 105 feet wide.

Shortly after getting underway, however, the captain requested towing vessel assistance through the four bridges to ensure safe transit. Unfortunately there was only one vessel working at the time and its operator replied that he was unable to meet the request. According to testimony included in the Coast Guard Investigation Report afterward, the captain responded that he "seemed to be moving OK and would keep going" without an assist vessel. This ended up being a mistake.

The *Anne Holly* successfully passed under both the MacArthur and Poplar Street Bridges, and began the tricky approach to the Eads Bridge. The only passage possible under the bridge, with the tow's height and the increased flood stage, was directly under the center span. This approach required a course change and repositioning of the tow alignment. It is this steering maneuver that caused the allision and its domino effect.

As the forward barges passed under the bridge's center span, the captain began steering to port to ensure the pilot house would pass under the center span and to properly align the tow for passage under the next bridge. Partway under the bridge the vessel stalled, its forward movement essentially halted by the opposing river current. With the headway stopped, the current caused the tow to drift sideways toward the Missouri shore, pushing the tow's port side barges into a bridge support and breaking its tow coupling. A number of the barges broke away from the tow and started drifting back south. With only a few barges still attached to the tow, the captain quickly radioed for assistance and attempted to hail the nearby *Admiral*.

Just north of the St. Louis Gateway Arch on the Mississippi River, the 380-foot-long *Admiral* is a permanently moored vessel that plays host to hundreds of thousands of people each year. That particular evening more than 2,000 staff and guests were wrapped up in the clinking of coins, the whirring of slot machines, and the excited shouts of winners. With the *Anne Holly*'s attempt at contacting the *Admiral* unsuccessful, everyone on the vessel remained temporarily oblivious to the disaster unfolding so closely.

Shortly thereafter though, one or more barges allided with the *Admiral*'s bow and another struck an entrance ramp, breaking the walkway loose from its moorings. Several people on the ramp were quickly evacuated off, all of them successfully reaching the Missouri bank seconds before the ramp sank. With eight of its 10 mooring lines now parted, the *Admiral* began to rotate clockwise downriver away from the Missouri bank.

Watching the casino vessel swing out into the river was the captain of a towing vessel and the master on watch of a nearby gaming vessel. Both men quickly broadcast urgent messages to the *Anne Holly*, informing it of the path of lost barges. Upon hearing the messages, the captain quickly released the remaining barges, turned the tow around, and raced downriver placing the bow against the *Admiral* as its next-to-last mooring line parted. The vessel actually transited about 500 feet downriver, but the combined efforts of the *Anne Holly* and the last remaining mooring wire successfully held the vessel near the Missouri bank.

The *Admiral* had evaded disaster. But with the entrance now facing the river, the passengers had to cross from the *Admiral* to the *Anne Holly*, where they were then transferred to two excursion vessels and subsequently to shore. There were a number of reported injuries from passengers, but fortunately none of them were considered serious. The casino vessel itself retained significant damage to the bow and all three entrance ramp walkways were separated; its initial estimated cost was over $10 million. Thirteen of the *Anne Holly*'s barges were recovered within an hour of the incident, while one barge sank; the initial estimate of structural damage to the barges was over $400,000. Fortunately there was no structural damage to the Eads Bridge.

Cause

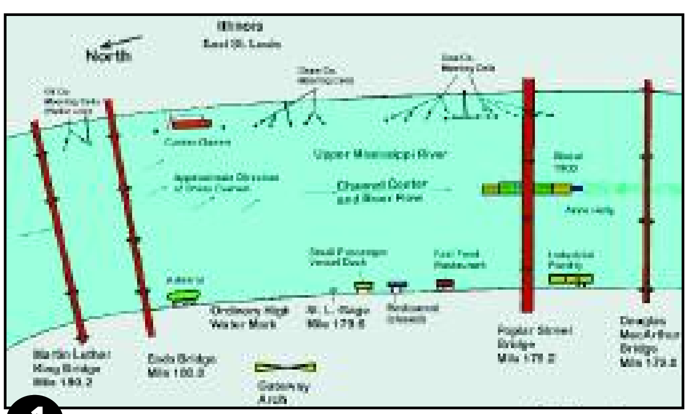
The Coast Guard and National Transportation Safety Board (NTSB) Investigation Reports, while conducted independently, both attributed the cause of the allision and subsequent breakup of the tow to poor decision-making on the part of the *Anne Holly*'s captain. They both specifically cited his failure to properly account for the prevailing currents, which led him to oversteer. According to the findings of the Coast Guard Report, "as the lead barges in the unit responded to the steering maneuver, the main downriver current acted with the increasing intensity on the unit's starboard side. Meanwhile, the cross current at the Eads Bridge, flowing in a direction opposite to that expected by [the captain], intensified the rate of turn beyond that anticipated." The high river conditions and subsequent limited vertical clearance under the Eads Bridge during a nighttime transit were also listed as potential contributing factors.

The captain acknowledged in his testimony to the NTSB that nighttime transits in the St. Louis Harbor are definitely more difficult than daytime transits. During the NTSB investigation, he commented that "The biggest difference in daytime you can see your current, you can see your setting. At nighttime the only thing you have to rely on is your radar and your searchlight. Which the radar doesn't pick up current. It doesn't pick it up, and your searchlight you can't see it… But on the Eads Bridge in particular you have no way of, you know, other than common knowledge, of what the current is going to do."

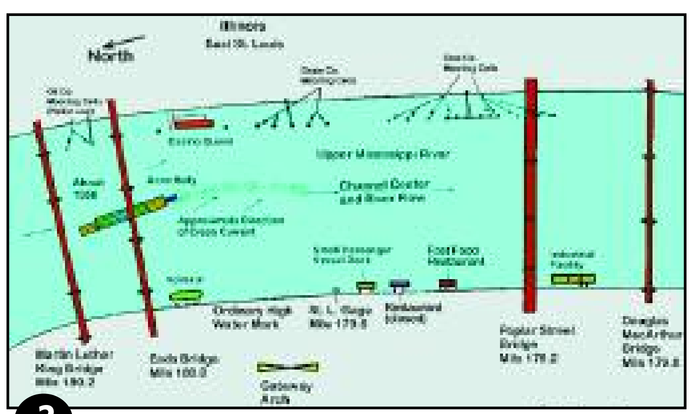
To the captain's credit, testimony included in the Coast Guard Report stated that no evidence was found to suggest that alcohol or drugs contributed to the accident, and there was "no actionable misconduct, inattention to duty or willful violation of the law." The report also acknowledged that the captain properly considered the navigation markers in determining the vessel's position for passage under the bridges and that his actions after the casualty "were commendable, and likely played a large role in minimizing injury or loss of life and further damage to property." Regardless of his efforts both before and after the allision, there was still enough evidence to charge him with negligence under Title 46 of the US Code of Federal Regulations Part 5. The captain pleaded no contest in September 1998 and all valid licenses and documents issued to him by the Coast Guard were suspended for two months, remitted on six months probation.

Could the Accident Have Been Prevented?

Ironically, this accident was not the first time the *Admiral* had been struck. In 1994, shortly after the



1 **The *Anne Holly* crosses under both the MacArthur and Poplar Street Bridges.**



2 **The vessel approaches the Eads Bridge.**

allision of the M/V *Robert Y. Love* with the *Admiral*, the Coast Guard Captain of the Port (COTP) at Marine Safety Office St. Louis wrote a letter to the Corps of Engineers St. Louis District, requesting "a review of the *Admiral*'s permit, to determine if additional conditions are necessary to assure public safety." When the Corps of Engineers updated the permit, personnel informed the owner that engineers had "deemed it necessary that the *Admiral* must emplace a protection cell to provide protection from ice flow, debris, and breakaway tows." Accordingly, a professional engineering consulting firm was hired to perform a risk assessment in 1995. The resulting assessment noted that although breakaway upriver tows had struck the vessel three times in the same mooring position, a protection cell might actually redirect barges toward the vessel. The Coast Guard COTP later agreed that a protection cell "would not significantly improve the public's safety. This conclusion is particularly valid given the probability of a change in the vessel's location in the near future."

Unfortunately the casino's location did not change prior to the April 1998 accident, nor were protection cells added. Validly arguable on both sides, whether or not such cells would have made a difference with the *Anne Holly* remains unknown. Since the allision though, the *Admiral* has been moved 1,000 feet and now resides—buffered by protection cells—just north of the last of St. Louis Harbor's four bridges.

Actions Taken

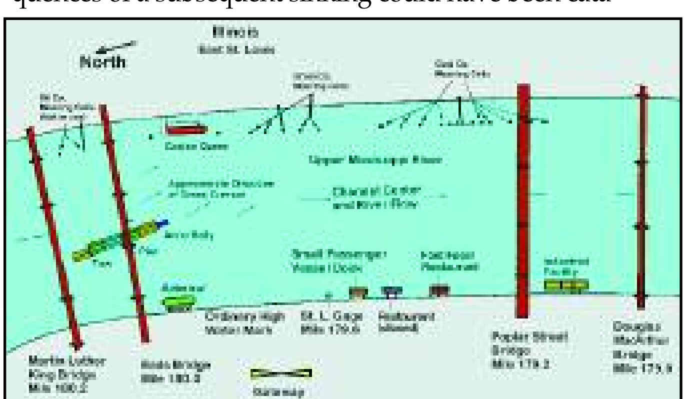
The many questions of "What if…" undoubtedly made the *Anne Holly* /*Admiral* allision a noteworthy accident. What if the allision had been more severe? What if the drifting barges had been heavier or larger? What if the *Admiral* had parted its last remaining mooring line and been forced southbound toward the Poplar Street Bridge, which did not have the vertical clearance for the *Admiral*? The questions are daunting. With more than 2,000 people on board, the consequences of a subsequent sinking could have been catastrophic. Those questions—and the fear of their answers—served as the impetus for a number of safety improvements for permanently moored vessels.

Permanently Moored Vessel Quality Action Team

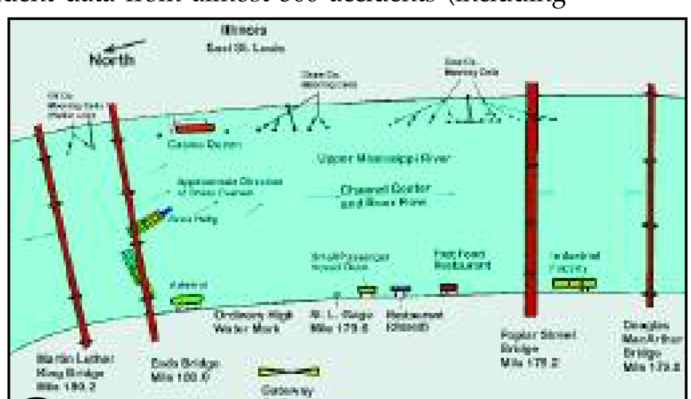
As with all Coast Guard casualty investigations, the objective of this investigation was to determine the cause of the accident and support recommendations to improve safety and help eliminate future similar accidents. To more thoroughly review the investigation's recommendations, and because of a number of other recent accidents involving permanently moored vessels, the Coast Guard convened a Quality Action Team (QAT). The goals of the team were to identify risks involving permanently moored vessels, establish more formal means of Coast Guard involvement in their siting and mooring, and develop measures for reducing their risk of accidents. The QAT's report was issued in December 1999 and addressed many of the recommendations from the *Anne Holly* investigation.

The QAT found that barge breakaways, collisions, and high water were the main causes of permanently moored vessels parting their moorings. The team also found that 68 percent of the accidents occurred at high-risk locations. The QAT report concluded that site selection was the most effective way of managing permanently moored vessel risk. Where site selection options were limited, the next option suggested in the report was site modifications such as the installation of protection cells (like the ones discussed with the *Admiral*).

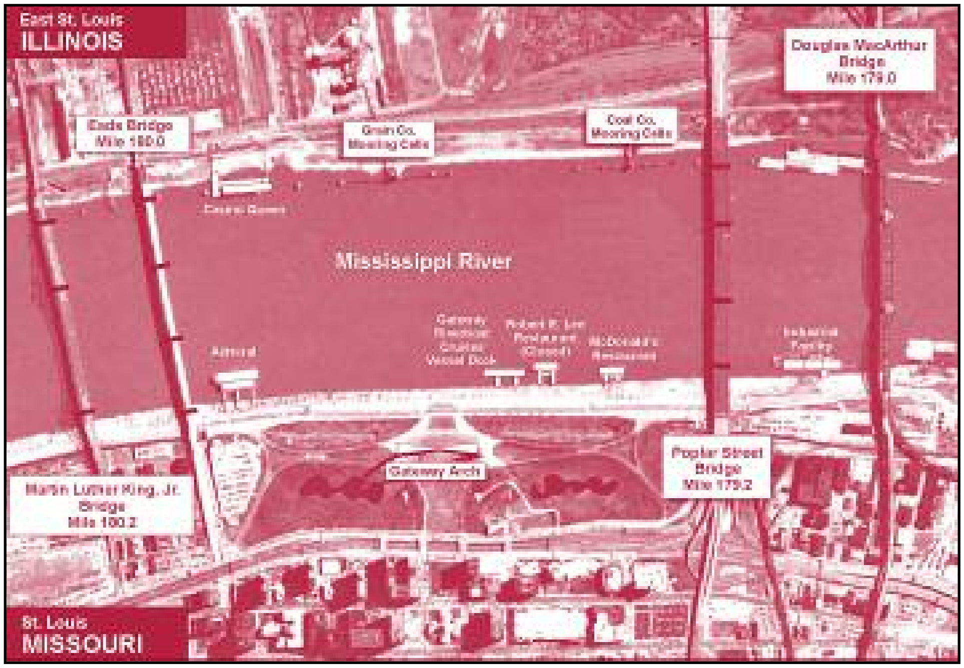
The members of the QAT also developed a Permanently Moored Passenger Vessel Initial Risk Assessment for Coast Guard field units to better quantify risks. The methodology that created the assessment relied on expert opinion, experience, and local knowledge from Coast Guard field units. To confirm the assessment's validity, the QAT examined accident data from almost 300 accidents (including



3 The only passage possible under the bridge with the increased flood stage is directly under the center span.



4 Partway under the bridge the vessel stalls, and the current causes the tow to drift sideways, pushing barges into a bridge support and breaking the tow coupling.



This area has long been recognized as one of the most difficult navigation areas on the Western Rivers.

groundings, collisions, allisions, and breakaways) that occurred between 1992 and 1997 within one-half mile upstream of permanently moored vessels. That accident data generally validated the methodology, and those accident statistics were used to establish acceptable risk scores.

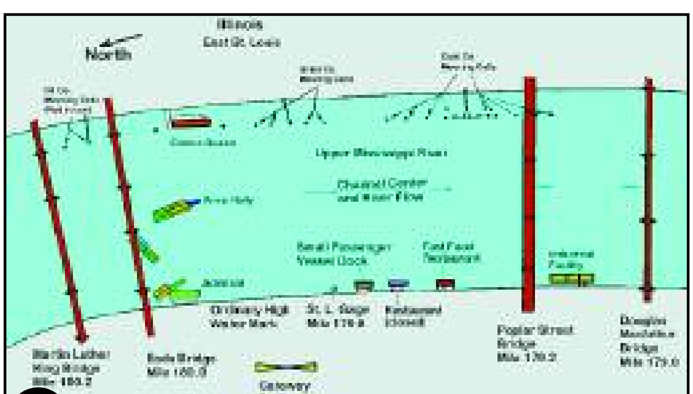
The information and recommendations listed within the QAT were then used as the base for changes in Coast Guard policies applicable to permanently moored vessels. These policy changes, including the Risk Assessment, were included in the 2000 update of the Coast Guard's *Marine Safety Manual* (MSM).

Update of the *Marine Safety Manual*

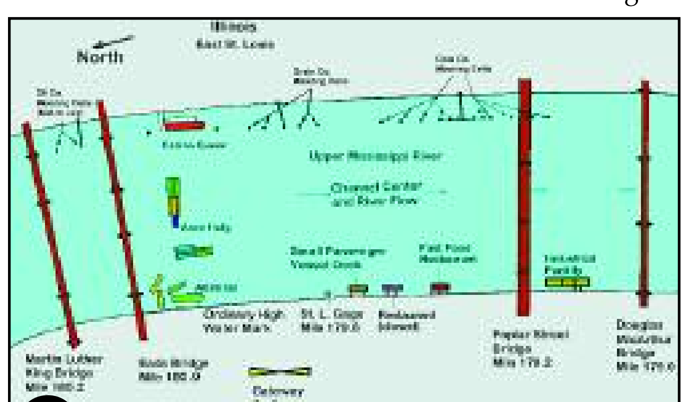
Volume II, Section B, Chapter 4 of the Coast Guard's *Marine Safety Manual* addresses permanently moored vessels. It is here that a large number of the recommendations from both the *Anne Holly* investigation and the QAT have been fully addressed. As mentioned above, the Permanently Moored Passenger Vessel Initial Risk Assessment is included. The assessment's six categories—location, traffic, response, anticipated environmental factors, severe and sudden environmental factors, and passenger exposure—all help determine the safety of the vessel.

According to the MSM, the risk assessment is to be conducted prior to a vessel being placed in permanently moored vessel status. Essentially, the initial assessment is designed to determine whether a vessel appears safe or warrants a formal risk assessment. The six categories can each receive a risk score (or value) from one to five, with one being poor and five being outstanding. If the total score is 13 or less, the COTP then involves the vessel owner/operator and they review the areas of high risk and attempt to lower them. This review is followed by another scoring and if the score remains 13 or less, the COTP should require the owner/operator to present a formal risk assessment. Because the QAT showed that a vessel's site location is most important in managing risk, this same review holds true if the location category alone receives a score of two or less.

Another of the recommendations from both the *Anne Holly* investigation and the QAT was the need for clarification of the term "vessel" to assist Coast Guard COTP responsibilities shared by overlapping regulatory jurisdictions. Obligingly, the MSM now notes that "a vessel taken out of transportation and permanently moored falls somewhere between a statutory definition of a vessel and a building or land structure and is deemed to be 'substantially a land structure.'" The MSM continues with the listing of



5 **A number of the barges break away and drift back south.**



6 **One or more barges allide with the *Admiral*'s bow and strike an entrance ramp, breaking the walkway loose from its moorings.**

criteria needed for determining how a vessel meets "substantially a land structure" status.

To receive a permit for a permanently moored vessel, requests are submitted, not to the Coast Guard, but to the Army Corps of Engineers. The reason is outlined in Section 10 of the River and Harbor Act of 1899, which states that it is the Corps of Engineers who is deemed responsible for issuing permits for structures on navigable waterways. And according to the Coast Guard's MSM, "a floating fuel dock … restaurant, museum, etc., is not a 'vessel' for inspection purposes if it is permanently moored and thus taken out of navigation." As the Coast Guard is responsible for ensuring maritime safety of people and vessels—both on and near the water—this shared responsibility between the two groups can be confusing. This confusion over authority and responsibility was listed under many areas of recommendation in both the *Anne Holly* investigation and the QAT.

Coast Guard/Corps of Engineers Memorandum of Agreement

Because a vessel switches from the Coast Guard's authority to the Corps of Engineers when it receives permanently moored vessel status, one of the concerns voiced during the investigation was the feeling that the Coast Guard should be more involved and seek a formal role in guaranteeing safety on "substantial land structures." While the responsibility for issuing permits remains with the Corps of Engineers, a Memorandum of Agreement (MOA) between the Coast Guard and Corps of Engineers was signed in June 2000 establishing a formal process "through which the Coast Guard provides input during the evaluation process for issuing permits, including permanently moored vessels and facilities on safety standards, emergency equipment, and other safety conditions."

To facilitate this transition and help guarantee that a vessel is ready to change status, COTPs evaluate each vessel's mooring arrangements beforehand. Once they have determined that the vessel meets the risk criteria, the Corps of Engineers provides a site permit and the Coast Guard then transfers responsibility for future safety regulation of the vessel to local authorities. As mentioned in both the MSM and the MOA, the Coast Guard continues to remain involved with the permanently moored vessel, reevaluating the vessel's risks every two years (and when pertinent local conditions change), using the aforementioned risk assessment.

Conclusion

The allision of the *Anne Holly* with the Eads Bridge and the subsequent ramming of its barges into the *Admiral* was an unfortunate accident that fortunately yielded valuable maritime safety improvements. The creation of the risk assessment, along with clarification of permanently moored vessels and the Coast Guard's role with them, has created a more quantified means of assessing risk and establishing safer measures. This results in higher levels of safety for all.

Sources Used:

- National Transportation Safety Board *Marine Accident Report: Ramming of the Eads Bridge by Barges in Tow of the M/V* Anne Holly *with Subsequent Ramming and Near Breakaway of the President Casino on the* Admiral*, St. Louis Harbor, Missouri, April 4, 1998.* Marine Accident Report NTSB/MAR-00/01. (Report Number PB2000-916401)
- U.S. Coast Guard *Investigation into the Circumstances Surrounding the Allision of the M/V* Anne Holly *with the Eads Bridge, and Subsequent Allision with the* Admiral *Casino, in St. Louis Harbor, Missouri, on 04 April 1998, with Multiple Injuries and No Loss of Life.* (Marine Casualty Report MC98004086)
- U.S. Coast Guard *Marine Safety Manual* Volumes II and X.
- U.S. Coast Guard *Permanently Moored Vessel QAT: A Site Selection and Risk Mitigation Model: Final Report, December 7, 1999.*
- U.S. Coast Guard *Permanently Moored Vessel QAT: A Site Selection and Risk Mitigation Model: Final Report, December 7, 1999.*

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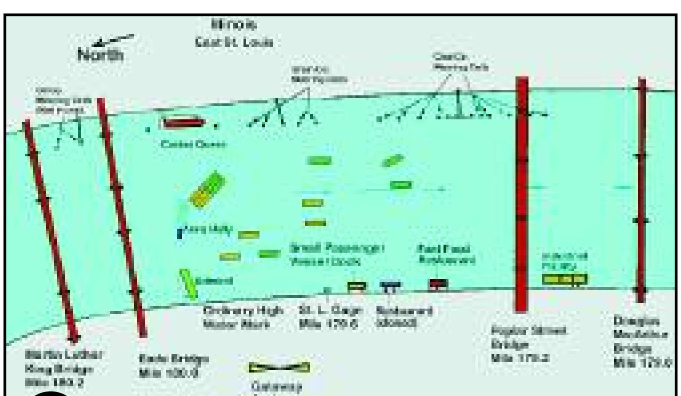

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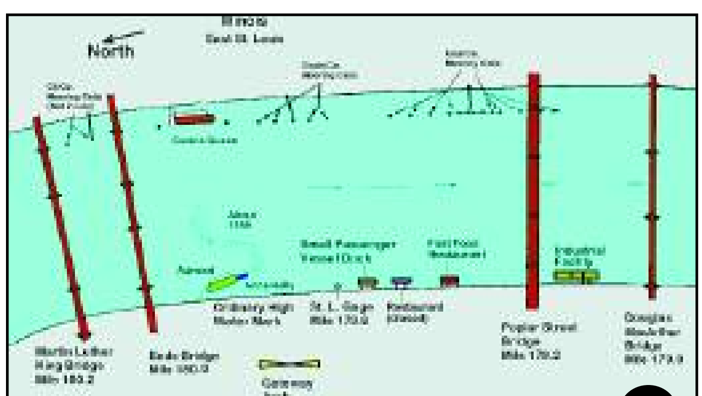

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The captain releases the remaining barges, turns the towboat around, and places the bow against the *Admiral* as the casino's next-to-last mooring line parts. Photos courtesy NTSB.

Lessons Learned from

Casualty Investigations

Sunk Within Seconds

The disappearance of a Great Lakes fishing vessel.

by Ms. Betty Lynn Sprinkle
Special Correspondent to *Proceedings*

On December 11, 1998, the fishing vessel *Linda E*, with her three crew members, set out of Port Washington, Wis., to retrieve and set gill nets. The winds were out of the southwest at approximately six knots, the sea was calm, visibility was seven miles and the air temperature was 31 degrees F. The nets they were retrieving were about nine miles southeast of the port. Ordinarily, the vessel would have returned to port between 1:00 and 3:00 p.m. the same day. At 8:00 p.m. the Coast Guard was notified that the vessel was overdue.

The Mystery

The Coast Guard immediately initiated a search that ultimately covered 3,000 square miles of the middle to lower western side of Lake Michigan. Searchers found no sign of the vessel, pollution, or debris. While the Coast Guard suspended its search approximately 48 hours later, local commercial salvors continued to look for the vessel.

The last contact with the vessel was at 9:45 the morning of the 11th. A representative of the owners of the vessel talked to a crew member on a cell phone. The vessel carried VHF radio, cellular telephone, radar, magnetic compass, autopilot, personal floatation devices, a ring buoy, buoyant apparatus, and exposure suits. Typical of Great Lakes commercial fishing boats, the vessel was fully enclosed with no watertight subdivisions. A main deck ran the length of the 42-ft-long vessel and a raised platform was at the wheelhouse. The steel hull was completely enclosed with a weather-tight steel superstructure. The superstructure was fitted with portholes along the port and starboard side of the main superstructure and in all directions in the wheelhouse. The portholes were the only means of seeing out of the wheelhouse. Four sliding metal doors, one aft, one amidships on the port side, and two forward were opened for the crew to work the gill nets. The forward doors were used to retrieve nets and the stern door was used to set nets.

The Investigation

On December 13, the Coast Guard began the investigation into the disappearance of the vessel. The Coast Guard looked at 26 commercial vessels that may have been in that portion of Lake Michigan on December 11 between 9:00 a.m. and 3:00 p.m. Investigators interviewed the crews of several vessels.

The investigators talked to family members, close friends and others familiar with the *Linda E*, to gather information on repair and maintenance history of the vessel. The Coast Guard also gathered information and conducted a stability test onboard a similarly constructed fishing vessel. This data was used to conduct a computer analysis to determine strength and stability characteristics of the lost vessel. The U.S. Coast Guard Marine Safety Center (MSC) determined that, based upon the most likely loading condition of the vessel at the time of its disappearance, the vessel met the stability criteria and severe wind and rolling criteria. The tests performed by the MSC determined that, even if the vessel had its bilges flooded, and an accumulation of ice upon its superstructure, the vessel still had substantial positive stability. The weather conditions on December 11 did not contribute to ice accumulation, and no vessel in the area reported icing on that day.

Because fishing vessels like the *Linda E* have no longitudinal watertight subdivisions, any breach of the watertight envelope would allow the vessel to sink. Calculations by MSC indicated that flooding through an opening the size of the sliding doors would cause the vessel to sink within seconds, while flooding through an opening of 2.5 inches in diameter, such as that from a failed fitting, would take over an hour to sink the vessel.

An integrated tug, M/V *Michigan*, and barge, *Great Lakes* transited the waters off Port Washington between 11:30 a.m. and 12:05 p.m. on December 11, 1998. Of the 26 vessels investigated, this integrated tug and barge (ITB) combination was the only one in this area around this time. This ITB is 454 feet long and 60 feet wide. The barge was in a ballasted condition with drafts of 13 feet forward, 14 feet aft. When interviewed, the M/V *Michigan* crewmembers stated they did not see the *Linda E*, debris, or any other vessels in the area during their transit.

The mate relieved the master of the tug of the navigation watch at 11:30 a.m. The master stated he did not observe any vessel contacts on radar or visually while transiting the waters off Port Washington. The mate said the master passed no contacts to him. The radar on the *Michigan* was usually set for a six or 12 nautical mile range and neither the mate nor the master could recall what range the radar was set for during their watch.

When the *Michigan* is in the notch with the barge *Great Lakes* in ballast, the visibility of the operator in the pilothouse is restricted for some distance just forward of the barge. Even in this condition, the *Michigan/Great Lakes* met the visibility requirements of Title 33 CFR 164.15.

The portholes on the *Linda E* afforded limited visibility. There were blind spots, most notably the area caused by the exhaust stack forward and to the starboard of the wheelhouse.

Initial Conclusions

The *Linda E* sank off Port Washington. Three crewmen were missing at sea and presumed dead. The lack of a distress call and fact that no survival equipment was located indicated that the vessel sank quickly. Weather and sea state did not appear to be factors in this casualty.

Based on information gained at the last contact with the crew and the stability analyses performed, it was not likely that the vessel was overloaded or suffered from inadequate intact stability.

Had the *Linda E* carried an Electronic Position Indicating Radio Beacon (EPIRB), the Coast Guard might have been able to begin its search earlier and to condense the search area. Failure to maintain a continuous live watch at the main steering station increased the likelihood of collision.

There was no evidence that fatigue, drugs or alcohol contributed to this casualty. There was no evidence to support misconduct, negligence, inattention to duty, or willful violation of law or regulation on the part of any licensed or certificated persons. As a result of the preliminary investigation, it was recommended that the Commander, Ninth Coast Guard District examine the exemption policies for carriage of EPRIBs on all commercial fishing vessels operating on the Great Lakes. It was further recommended that MSO Milwaukee publish the results of this investigation as a safety advisory to all commercial vessels operating in Lake Michigan.

Discovery of the *Linda E*

For 18 months local commercial salvors' efforts to locate the *Linda E* were monitored by the Marine Safety Office Milwaukee. Despite hundreds of hours volunteered by these searchers, the location of the vessel remained unknown until the U.S. Navy Minesweeper *USS Defender* located it on June 18, 2000, when performing an underwater search.

Upon the discovery of the vessel, the Marine Safety Office Milwaukee reopened the investigation into the vessel's disappearance. The Captain of the Port Milwaukee placed a safety zone around the location of the *Linda E* to protect physical evidence at the wreck site. On June 21, 2000, the University of Michigan's remotely operated vehicle (ROV) was deployed from the U.S. Coast Guard Cutter *Acacia* to survey the wreck site. The ROV obtained video and still photography of the *Linda E* in its present condition. The ROV also collected paint samples from the vessel. These samples were sent to the Wisconsin State Crime Lab for comparison with samples collected previously from the barge *Great Lakes*.

The lack of a distress call and fact that no survival equipment was located indicated that the vessel sank quickly. Weather and sea state did not appear to be factors in this casualty.

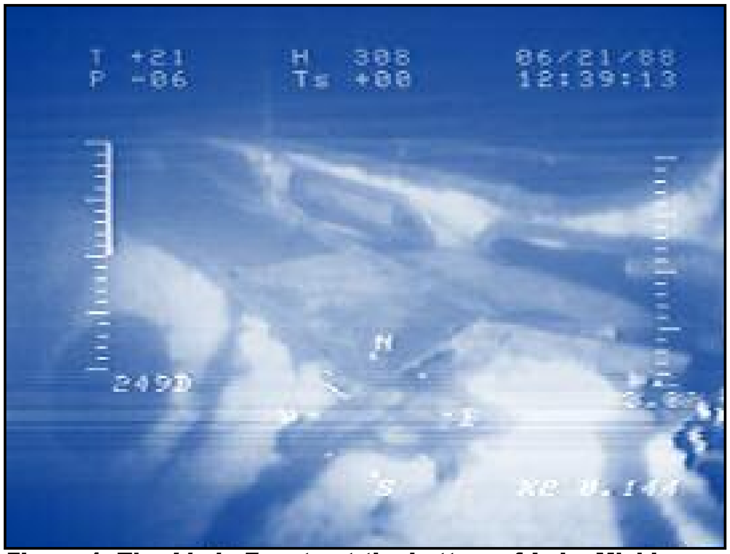


Figure 1: The *Linda E* rests at the bottom of Lake Michigan.

Investigators analyzed the video and still photographs from the ROV to determine the cause of the casualty. Investigators developed a profile of the damage documented by the ROV and compared the geometry of several vessels with the *Linda E*'s damage profile. Comparing the information with photographs taken of the barge *Great Lakes* on December 22, 1998, investigators determined the location of white and black marks relative to the hull and to the vessel's December 11, 1998 waterline.

Clues Emerge

The *Linda E* was found at the bottom of Lake Michigan in 260 feet of water, upright, partially imbedded into the lake bottom with an approximate 20 degree heel to port (Figure 1). The vessel is 0.2 miles west of the northern gang of nets identified as being set by the crew. The closest point of land is the Wisconsin shoreline, seven miles to the west. The service door on the aft port side of the vessel was found open. A small tangle of fishing nets extended just outside this door. Two of the three stern doors on the vessel were found open. The door that slides open to the port side of the vessel was fully open. One of the two doors that slide open to the starboard side of the boat was fully open and the other was partially open. The spreader bar over which nets are normally set could be seen as could a small amount of nets through the stern door. All other doors on the vessel were closed (Figure 2).

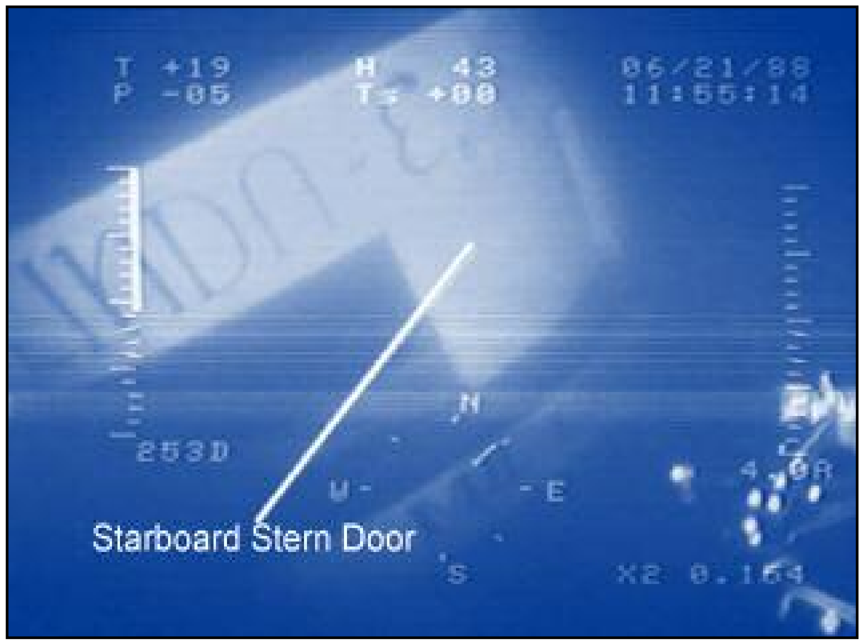


Figure 2: View of the starboard stern door.

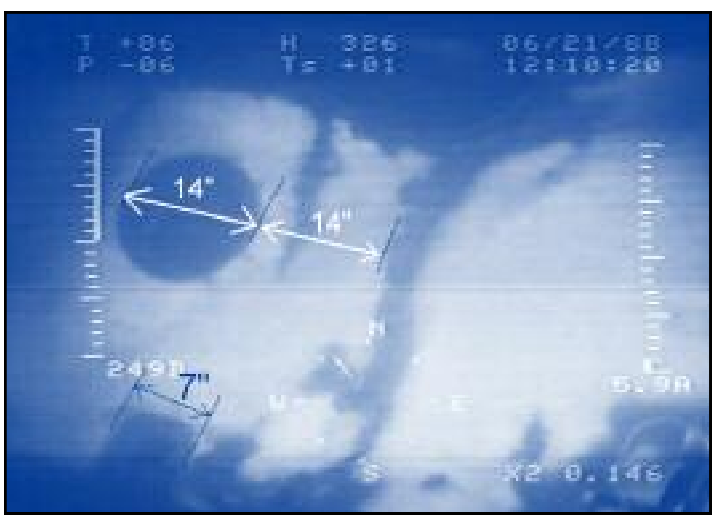


Figure 3: Damage to the vessel.

There was significant damage on the starboard quarter of the *Linda E*, along the side of the vessel from the forward end of the deckhouse aft, almost exclusively above the rub rail.

A wedge-shaped inset centered 14 inches forward of the aft, starboard portlight extended six feet vertically down from the top of the lower deckhouse to just below the rub rail (Figure 3). This inset was several feet wide near the upper deck and a few inches wide near the rub rail. The upper deck was crushed downward near the center of this inset. The deck was torn upward a few feet aft of the center of this inset.

The aft starboard portlight had several fractures but was not broken open. The lower deckhouse portlights on the starboard side were broken, their frames crushed. None of the other portlights on the vessel appeared to be damaged.

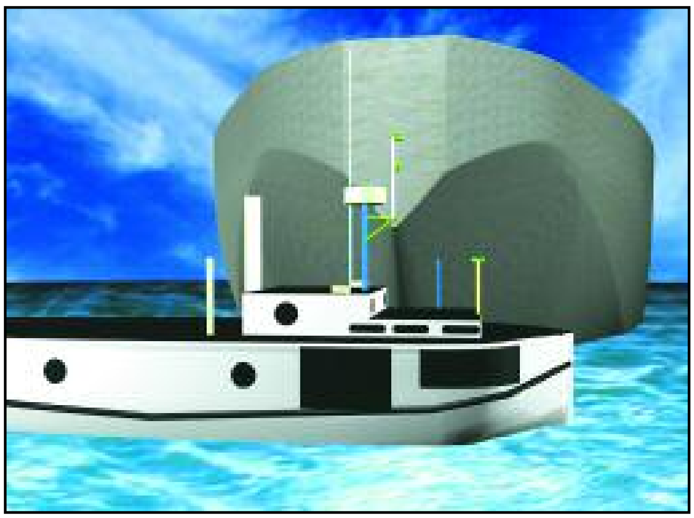
Appendages on the vessel were tilted in different directions. Those in front of the main inset bent forward and to port. Those behind the main inset are bent aft and to port. A number of appendages near the damaged area showed no visible signs of contact. There was no significant damage to the port side of the *Linda E*. Although the lake bottom obscured much of the bottom of the vessel, the visible portion of the hull beneath the rub rail showed little damage beyond a few superficial scratches. There appeared to be no significant damage to any other part of the vessel. There was no visible indication of fire on the vessel and no physical remains of the three missing crewmembers were found during the June 21, 2000 ROV dive.

Evidence to support this conclusion includes the fact that the ITB was the only vessel in the area where the *Linda E* disappeared that day. The bow of the *Great Lakes* had markings consistent with those that could have come from contact with the *Linda E*. The bow geometry of the barge is consistent with the damage found on the *Linda E* and no other vessels known to be off Port Washington and Milwaukee on December 11, 1998 have that kind of bow geometry.

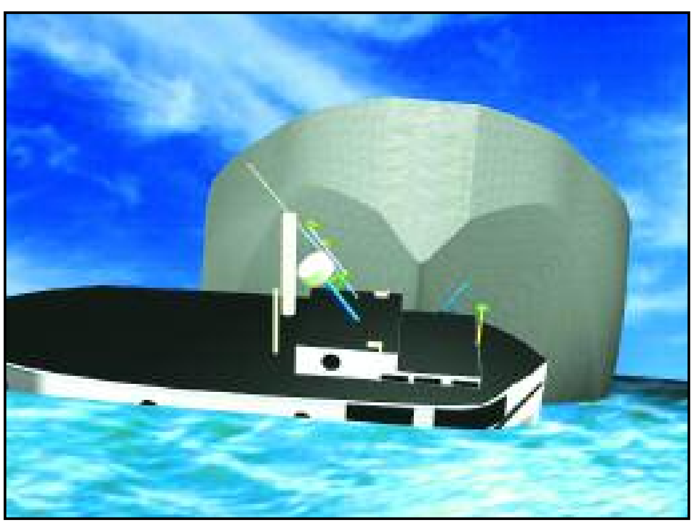
Contributing to the Casualty

Lack of visibility from both the ITB and the *Linda E* contributed to this collision and casualty. It is possible that the sun, just off the port bow of the ITB, was shining directly into the pilothouse and obscured the *Linda E*. Because of the length of the barge, once a small vessel such as the *Linda E* was close off the bow, the tug operator's view was obscured.

The evidence suggests that the *Linda E* collided with the *Michigan/Great Lakes* barge. The MSC's comparison of the *Linda E*'s damage profile and the bow geometry of the barge determined that the most likely angle of heel that the *Linda E* would have experienced, had they collided, to be approximately 51 degrees to port. With a 51 degree angle of heel, the entire port side of the *Linda E* would have been submerged. If both the port service door and part of the stern door were open, the MSC estimated that it would take about two seconds to exceed the *Linda E*'s buoyancy and flood the vessel. This would explain the lack of distress signals or attempts to abandon ship.



Figures 4 and 5: Graphic analysis, illustrating how the accident may have taken place. Courtesy Marine Safety Center.



The window arrangement of the downed vessel, with widely spaced portholes, was not conducive to a wide view of surrounding waters. Having no one on watch in the pilothouse because of a policy of setting the boat on autopilot also contributed to the lack of visibility. The investigation concluded that the casualty was a collision between the ITB *Michigan/Great Lakes* and commercial fishing vessel *Linda E*.

The apparent cause is the failure of the operators of the tug to detect the *Linda E* and a failure of the operators of the *Linda E* to detect the ITB or take sufficient action to avoid collision with it. The operators of both vessels had radar to help reduce the risk of collision. The investigators concluded that the radar on the *Michigan* was not monitored adequately or not used properly. The use of radar on the *Linda E* could not be determined.

Other contributing factors included the diverted attention of the ITB operator who was standing watch. The mate was performing a non-navigation activity that distracted his attention from activities essential to navigation—like looking out for other vessels.

Upon collision, the heel of the *Linda E* caused rapid downflooding through the submerged large door openings and overcame the vessel's reserve buoyancy, sinking the vessel within seconds.

The lack of watertight subdivision contributed to the rapid sinking, and prevented the crew from escaping. There was nothing to determine the vessel's operational status prior to the collision.

It is possible that the crew aboard the ITB neither felt, heard, nor observed the collision with the *Linda E* (Figures 4 and 5). Marks and damage to the barge suggested the collision was brief and light. Even if the collision were more severe, the resulting change in velocity of the barge would not have been detected by any crew members. Noise from generators and activity on the barge may have prevented hearing any sound of a collision and the *Linda E* most likely sank so quickly that it did not pass far enough aft to be seen by anyone on deck of the barge or in the pilothouse of the tug.

Lesson Learned/Recommendations

There was evidence the operators of the ITB failed to maintain a proper lookout to avoid a collision as required by Inland Navigation Rule 5. There was also evidence the operators failed to make proper use of the radar equipment to obtain early warning of risk of collision.

It is possible that the crew aboard the ITB neither felt, heard, nor observed the collision with the *Linda E.*

It could not be verified whether the *Linda E* crew maintained a lookout or used installed radar to avoid collision. However, the investigation did determine practices that indicated the crew may not have been standing a proper lookout prior to the collision. Location and investigation of the downed vessel did not alter any of the investigation's original conclusions concerning the effect of weather, sea state, fatigue, drugs, or alcohol on the outcome of this casualty.

Proper lookout procedures must not be influenced by distractions from normal watchstanding responsibilities, (such as updating charts or cleaning fish).

Final recommendations include:

- Promote the voluntary use of radars with anti-collision alarm features.
- Reiterate the inherent risks associated with operating a boat that has no watertight subdivision, including the difficulty of egress from a fast sinking fishing vessel.
- Re-emphasize to all Great Lakes fishing vessel operators the importance of properly displaying a fishing day shape.

The MSO Milwaukee published the contents of the supplemental report as a safety advisory to all commercial vessels operating in Lake Michigan. A copy of the report was provided to the state of Wisconsin and local agencies responsible for investigating boating accidents.

About the author: *Ms. Betty Lynn Sprinkle is a free-lance writer living in Alexandria, Va. In her 25 years of writing, she has covered such diverse topics as the construction industry, health care, higher education, and employment for national trade magazines, medical newsletters, university publications, and the* Washington Post.

Lessons Learned from Casualty Investigations

The Grounding of a Cruise Ship

A lesson in maritime management.

by Ms. Kriste Stromberg
Special Correspondent to *Proceedings*

It's a beautiful night in the Caribbean. You are taking a cruise on the ship, *Monarch of the Seas*. You've been dancing, eating, drinking, and having a wonderful time. You finally go to bed and rest for the next busy day of port calls and touring on Martinique. Suddenly, the ship shudders and shakes, and you are awakened by the captain's voice over the loudspeaker, stating that there has been an accident and to please move to the emergency stations.

How could this have happened? This is a modern vessel with many of the latest navigational aids. The officers and crew are all trained and certified. How could this beautiful vessel tear open its hull on a well-known coral reef on a clear night with a calm sea? Let's take a closer look at what actually happened very early on the morning of December 15, 1998.

The Incident

The ship was on its usual course from St. Thomas, U.S. Virgin Islands, to Martinique, when one of the passengers suffered a heart attack and required immediate shoreside medical treatment. The master deviated from his course to offload the passenger at Great Bay, St. Maarten, Netherlands, Antilles. This was safely accomplished at approximately 12:30 a.m., and the vessel prepared to depart once the doctor and nurse were back aboard the ship.

The doctor and nurse returned to the ship about 1:25

Figure 1: A shot of an interior stairway, showing water level. USCG photo.

a.m., and the master himself piloted the ship to pass to the east of the Proselyte Reef, not the usual departure route of the vessel. The master decided on this course based on his mariner's eye and the information from the officer of the watch (OOW) that the automatic radar plotting aid (ARPA) calculated the closest point of approach to the Proselyte Reef lighted buoy 3 cables off (0.3 nm), based on a course of 160 degrees true. The master felt that this would provide a safe passage around a known hazard and adequate clearance for a sailing vessel in the immediate area, and so he gave the orders to set sail for Martinique on this path.

About three minutes later, the master, not feeling well, left the bridge to retire to his stateroom. On the bridge were the staff captain, the OOW, and two quartermasters as the helmsman and the lookout. The master checked back in shortly after leaving to see if all was well. As almost a second thought and with a feeling that something was just not right, after he exited the bridge, the master immediately returned to ask if everything was okay. The OOW assured him it was, and the master left again.

Unfortunately, all was not well. Within another two to three minutes, the ship would tear a hole in its bottom on the sharp coral of Proselyte Reef. This occurred at about 1:30 a.m. The officer of the watch was instituting a starboard turn to 190 degrees, and the ship scraped against the reef and started to flood several of the compartments on its lower levels. Just before the turn that immediately led to the grounding, the OOW was distracted by a phone call on the bridge from the housekeeping staff, regarding a disturbance related to a loud party in a stateroom. The OOW was also required to silence a smoke alarm that had sounded on the bridge.

As soon as he felt the ship vibrate from contact with the reef, the master returned to the bridge and assumed the watch of the ship. At about 1:35 a.m. all of the watertight doors were ordered closed to prevent further flooding throughout the ship (Figure 1). Watertight door number 10 was later found open by the ship's safety officer and was then closed. After consultation with the senior officers and Marine Operations in Miami, the master decided to ground the vessel on a sand bank in Great Bay in St. Maarten.

At 1:47 a.m., the general emergency signal was sounded, and all passengers and crew were told to report to their emergency/abandon ship stations. The passengers were kept informed of what was happening over the public address system in French, English, Spanish, and German. By 2:20 a.m. all of the passenger cabins had been evacuated, and the lifeboats were prepared for evacuating the passengers from the ship.

At 2:35 a.m. the master intentionally grounded the ship on a sandbar in Great Bay, St. Maarten. Since this was accomplished successfully, the decision was made to evacuate the passengers by tenders from St. Maarten rather than via the lifeboats. The evacuation was carried out by the shore-based tenders in about an hour and a half.

What Went Wrong?

As with many incidents, no single error caused it to happen. In fact, a whole series of unsafe actions, decisions, and conditions caused this incident. There were organizational errors, navigational errors, and individual human errors. While a multitude of errors happened prior to the incident, the investigators found no fault with the actions of the master or the other members of the ship's crew after the grounding.

One of the most critical organizational errors was the master's not following the standards and procedures as laid out in the ship's International Safety Management (ISM) manual, also known as the Safety Management System (SMS). Because of this neglect to follow the established procedures, the officers on the bridge:

- did not set down a formal, written passage plan for this particular deviation into St. Maarten;
- did not follow the departure checklist;
- did not know exactly where they were when departing St. Maarten, as no one had taken or plotted a navigational fix;
- relied on only one navigational instrument, the ARPA;
- relied on only one navigational aid, the Proselyte Reef lighted buoy;
- had not updated the charts to reflect the information in the latest Notice to Mariners.

This last item is critical, as the latest notice let mariners know that the Proselyte Reef lighted buoy the OOW was using to navigate had moved 125 meters west of the position on the ship's chart. If the vessel departed port in a customary fashion, followed the procedures set forth in the SMS, had practiced good seamanship, or had even done one of the previous three, this incident might not have occurred.

The navigational errors were numerous as well. The OOW did not take an initial fix on the ship's position and did not account for the current and wind in his calculations with the ARPA. The Officer of the Watch also relied solely on the automatic radar plotting aid and did not take a terrestrial fix or utilize the global positioning system (GPS) with which the ship was equipped. It is against best seamanship practices to use a buoy for navigation as well.

Not surprisingly, the human factors in this incident were also many. The master decided to sail to the east side of Proselyte Reef, which is contrary to the usual southwesterly departure passage. The route the master chose is the most dangerous side to transit, as the current moves in a westerly direction, the wind is normally easterly, and the lighted buoy they were navigating by is positioned on the west side of the reef. The master was also suffering from a cold, which caused him to leave the bridge suddenly, and he had a managerial style that did not encourage communication of suggestions or questions by his bridge officers. The other officers of the bridge took no initiative to prepare a passage plan, record the passage of the vessel on the navigation charts, or even take additional readings from any of the other navigational aids to ensure that the ship was where they thought they were.

Figure 2: The bridge layout on the *Monarch of the Seas* may have contributed to the incident. USCG photo.

What's the Bottom Line?

Of the multitude of mistakes made that led up to the grounding, many might have not occurred if the master had embraced and caused his crew to follow the procedures laid out in the SMS. This lack of "buy-in" to the SMS meant that the sensible and required procedures in the manual were not followed. According to the lead Coast Guard investigator, if the procedures had been followed, the grounding would not have taken place. Why did the master not follow the SMS procedures? Whatever the reason(s), this and the other failures of the bridge team made this incident inevitable.

Recommended Solutions

There were many safety actions recommended to the cruise line. The most important and broad-reaching were:

- The company should establish a check and balance system whereby a designated officer, such as the safety officer or staff captain, shall independently verify and document compliance with ISM SMS guidelines, procedures, and job aids.
- The company should require ISM training for all ship's officers in its fleet.
- The company should market and promote the benefits of the SMS to all vessel crewmembers.

The ISM SMS intends the bridge officers to work as a team, with checks and verifications of tasks accomplished, to ensure the safe passage of the vessel from port to port. This navigational watch did not operate as a team, in support of one another. There was evidence that the master's strong and sometimes abrasive personality created reluctance among the crew to disagree or question the master's decisions. This attitude of unquestioning subservience established an unsafe condition, when combined with the master's confidence and familiarity with the areas the ship was transiting. The casualty report suggested that:

- The company's human resources personnel should develop and implement a personnel-screening program to ensure that ship masters and watch standing personnel hired or employed are suitable for the positions they intend to hold, bearing in mind the importance of teamwork and open communications.
- The company should provide bridge resource management training for all navigational watch standing personnel.
- The company should implement a team-building training program for all watch standing personnel.
- The company should design and implement a training program specifically targeting senior officers, regarding effective communications and effective teamwork with subordinates.

These suggested safety improvements would also address the lack of teamwork that was seen in this casualty. As stated in the casualty report:

"The lack of teamwork arose, due to the master's failure to involve the watch standers in the decision-making process regarding the St. Maarten departure route, as well as the ambiguity created by the master's confidence and overbearing presence. The senior members of the navigational team, the OOW and the staff captain, both expressed their surprise at the unusual and more dangerous departure course chosen by the master that took the vessel to the east of the Proselyte Reef, but failed to express their concern because they did not feel empowered to voice doubt in the master's decisions."

The investigators also found that there were ergonomic and human performance issues in the way the OOW conducted himself in this incident. The decision to rely solely on the automatic radar plotting aid to plot the Proselyte Reef lighted buoy as the sole reference point was contrary to the rules of good seamanship, his training as a navigational officer, and the vessel's established standard procedures. This lapse can be attributed to the human tendency to take the path of least resistance and do the easiest thing to get the job done.

This was combined with a poor layout of the navigation station, which made it much more difficult to watch and use the ARPA as well as the other navigational aids aboard the vessel, such as the GPS receiver. The chart table was placed well away from the automatic radar plotting aid, which was at the forward starboard side of the bridge. While this position for the ARPA allowed a good view of any traffic on the burdened or starboard side of the ship, unfortunately, all other navigation instruments and the charts were located aft and well away from that position (Figure 2). This required the navigational watch officer to physically move around the chart table to the rear and away from the automatic radar plotting aid.

It was also discovered in the investigation that the navigational watch officers relied heavily on the electronic instruments, rather than taking terrestrial navigational fixes. Taking terrestrial navigational fixes is somewhat time-consuming, requiring the placement of the azimuth bearing circles on the gyro repeaters (Figure 3), taking several bearings, and then plotting them on a chart. On this vessel, this was made more difficult by the physical layout of the ship. The gyro compass repeaters were blocked by equipment cowlings that allowed only minimal physical clearance. It was no small wonder to the investigators that the navigation watchstander did not use this method to verify the ship's position at any time.

Figure 3: The exterior starboard bridgewing repeater. USCG photo.

The OOW also failed to fully utilize the automatic radar plotting aid's capabilities. He never ground locked the ARPA nor did he manually input the wind and current values that would have allowed the ARPA to calculate the vessel's set and drift. If he had, he might have realized that the ship was a lot closer to the reef than he thought.

The recommended safety actions to address these issues were:

- The company should require all navigational watch officers to attend ARPA certification and periodic refresher training.
- The company should develop a brief, inhouse ARPA training refresher course on training aids that navigational watch officers must successfully complete on an annual basis, or when first assigned to a particular vessel.
- For each vessel owned and operated by the company, personnel should examine the physical bridge layout and work with the vessel's navigational watch officers to modify the design to permit the most effective, efficient, and safe navigation of the vessel. This examination should take into consideration locating navigation charts and plotting tools as well as electronic navigation instruments readout in close proximity to the primary navigating station.

Other issues that were addressed by the investigation team were the lack of corrections to the charts, the neglect to use the charts to plot the vessel's passage, and the function of the OOW and that of the staff captain. To prevent these types of issues from reoccurring, the investigators suggested that:

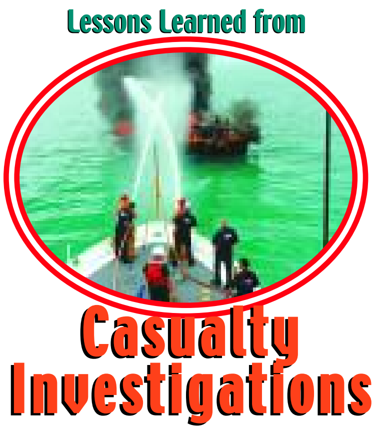
- The casualty report should be distributed throughout the company fleet and made required reading for the officers and all navigational watch standers.
- The company should completely separate hotel management responsibilities from the bridge crew to ensure that hotel problems do not compromise the safety of the ship.

Lessons Learned

The investigation team found 20 different lessons learned, which can be summarized:

- Operate as a team and communicate clearly with each other, especially when making an emergency or non-routine operation.
- Plan passages and make written records of the plans.
- Keep charts current and corrected.
- Practice good seamanship and do not be over-confident about your abilities or those of your ship or the ship's instruments.

***About the author:** Ms. Kriste Stromberg has a bachelor's degree in general studies science from Portland State University with mechanical engineering, physical science, and history coursework. Before becoming a technical writer, Ms Stromberg worked in libraries, museums, and archives, primarily conducting research and developing exhibits. She has worked for the Coast Guard with several different contractors since 1996.*



The Death of a Young Diver

Questions still grip many over offshore drilling rig tragedy.

by Ms. Daisy R. Khalifa
Special Correspondent to *Proceedings*

It is easier to grasp the complicated details of the 23-year-old commercial diver's death in 1996 by viewing the events of history in reverse. Starting with the U.S. Coast Guard's present stance on commercial diving regulations and tracing back to the actual day in March 1996 when the diver died at the base of an oil rig, less than 30 feet below the water's surface near Sabine Pass, Texas, one can better understand what went wrong.

The endorsements, for example, supporting the official U.S. Coast Guard (USCG) incident report, published after the diving accident, spelled out a number of critical issues, such as "the commercial diving regulations…were not followed…" and that "many people failed in their responsibilities..."[1]

The family of the diver viewed the USCG report and its endorsements, released in March 2001, as a "vindication" for the young diver, for it had been widely believed that the young diver's inexperience was the cause of his death.[2]

There were many entities caught up in a firestorm of conflict, culpability, and finger-pointing after the incident. At the same time the diver's family was settling a multimillion-dollar law suit on behalf of the diver's widow; federal agencies, associations, and private companies engaged for some time in disputes over accountability and responsibility in order to better understand why the death occurred and how to prevent such accidents in the future.

The Casualty

For about 18 months, the Mobile Offshore Drilling Unit (MODU) Cliffs Drilling Rig Number 12 had been "stacked," or taken out of service, in Sabine Pass. The rig was scheduled to be reactivated, which required its owner, Cliffs Drilling Company, to obtain a certificate of inspection. The company had requested Coast Guard approval for a special examination in lieu of dry docking (SEILOD), which was granted, thus calling for a dive inspection team. The rig was moved 10 miles offshore and the hull inspection was scheduled for early March.

On the afternoon of March 4, 1996, the ill-fated diver, who was a commercial diver employed by Texas-based G&G Marine, began an underwater inspection of Rig 12's mat. Two dive inspection team members accompanied him.

The dive lasted about three hours, in which the young diver moved around the mat under the direction of two members of the dive inspection team on the rig's deck. He was placing testing instruments on the rig so that measurements could be sent back to the surface.

At 4:45 p.m., he indicated he was having trouble breathing and shortly thereafter he quit communicating with his team. A rescue operation was quickly initiated but no one reached him for 35 minutes. At about 5:20 p.m., team member two reached the diver about 28 feet below the surface. Team member two found his teammate unconscious, floating face down near the mat. The diver's body could not float free, because a hand axe attached to his diving belt was fouled on a pipe on the rig's mat.

Team member two cut the lanyard and brought the diver to the surface, where he was lifted to the deck in a personnel basket. Members of the crew began cardiopulmonary resuscitation and loaded him onto a helicopter for transport to St. Mary's Hospital in Port Arthur, Texas. The helicopter arrived at the hospital at about 6:30, and the diver was pronounced dead at 10:30 p.m.[3]

Complex Reporting

The Coast Guard's official report on this commercial diving death is a complicated assemblage of facts, which together, in almost narrative fashion, present a number of distinct causes into the diver's death—from technical and regulatory to the purely physical realities. With 62 findings of fact, 34 subjects of analysis, 43 different conclusions, and 30 recommendations, the accident report cited the Coast Guard, the American Bureau of Shipping (ABS), the Occupational Safety and Health Administration (OSHA), the Association of Diving Contractors (ADC), and private companies such as the oil rig's owner, the dive team operator, and other industries as responsible parties, respectively, for a disparate array of reasons. Had some or all of these entities complied fully with dive operation standards for an oil rig inspection, potential errors and problems may have been discovered, and, perhaps, the dive operation aborted before it was too late.

A fair amount of the investigation is devoted to the deceased diver's faulty equipment, in particular the Quincy 325 air compressor furnished by his employer, which, according to the report, had been malfunctioning prior to being used for this particular assignment.[4] Compressors, like the one used on the day of the dive, sit at the surface and have a cylinder and piston assembly that compresses air and sends it to a volume tank used by the diver. The issue of poorly maintained equipment is examined in several findings of fact in the report, and the report illustrates a relatively lax set of equipment outfitting procedures on the part of the commercial diving company, and the company's owner.

Though the owner indicated that routine maintenance like checking compressor oil levels was done as equipment was loaded for shipping to dive sites, he said he did not check compressor 2 before it went out the night before the dive. One of the dive company's employees, a diver of seven years, who worked on occasion as an in-house maintenance person for the company, said he was familiar with all four compressors the company owned in 1996. A portion of his testimony reveals the possible poor condition of compressor 2, which was determined to be a contributing cause of the diver's death:

"[He] testified that [the company] often would not buy replacement parts to do ordinary equipment upkeep. As an example, [he] testified that…employees would put red shop rags or Kotex pads in a supply side air intake filter housing when factory specified air filters were not available…[He] also testified that compressor 2 had malfunctioned on a diving job several months before the Rig 12 job and had been set aside so it would not be used on other jobs.

Commercial diving regulations…were not followed…

To [his] knowledge, compressor 2 had not been repaired before the Rig 12 job. [Team member two] also did not know whether compressor 2 had a factory specified filter on [March 4] since he did not check the air filter housing before using the compressor."[5]

Explicit analyses about the deceased diver's gear, including his helmet, his main airline connections, his not having a second dive hose nor a bailout bottle (the latter was not required in dives less than 130 feet) pointed back repeatedly to the failure of compressor 2. The report concludes that the compressor was not properly maintained and tested, that it produced oil-tainted air, and that it produced inadequate air volume.[6] To clarify that the diver's own equipment was not to blame, the report stated: "The weight of the evidence indicates that compressor 2 never supplied air pressure above 100 psi. The most likely reason [his] helmet was not adequately ventilated is that compressor 2 was not producing adequate air quantity, pressure, or quality."[7]

Damaging Assumptions

Team member two had been a commercial diver and an employee for 13 years of the dive team company that hired out the divers for the rig inspection. Experience notwithstanding, the dive team of just three that day represented, in and of itself, another dangerous procedural shortcoming, for they were improperly staffed for an underwater inspection team. According to the report, not only was the dive team short two more team members promised to them, the dive company had failed to designate a dive supervisor, and likewise did not send the customary dive operations and safety manual with an enclosed letter appointing a dive supervisor to the Rig 12 dive location.[9]

The investigative report is laced with details about faulty equipment and inadequate staffing, sounding a call for concern not just about the dive team company—and small dive operations like it—but also about the roles of key regulatory parties on board Rig 12, including ABS officials and the Coast Guard.[10]

A Navigation and Vessel Inspection Circular (NVIC) serves Coast Guard personnel and maritime operators as industry "advice," but is generally regarded as a standard manual aid for different maritime operations. NVIC 12-69, a circular written in 1969 that is still in effect, clearly spelled out how the Coast Guard was to conduct SEILODS on oil rigs, though it did not impose requirements for evaluating divers.

NVIC 1-89, written 20 years later, to expand the SEILOD program to other classes of vessels, takes care to include diving operations in its guidelines. NVIC I-89 states:

> "Divers, Diving Equipment, and Operations: The underwater survey should not be conducted unless the inspector is satisfied that the equipment and procedures being used by the divers will provide a safe and meaningful examination of the ship. Safety must be foremost on the minds of all those working together on the actual diving operations…As required by 46 CFR 197.202, commercial diving operations taking place from vessels required to have Certificates of Inspection issued by the Coast Guard, regardless of geographical locations, must comply with the provisions of 46 CFR Part 197 Subpart B-Commercial Diving Operation."

Coast Guard inspectors arrived at Rig 12 at 10:30 a.m. on March 4 and worked on the vessel until 2:30 p.m. They met with class society personnel and rig personnel to plan inspections. According to team member two's testimony in the report, "although they knew commercial diving operations were underway, they did not visit the dive operation or inspect the dive station, its manning, or equipment."[12]

What followed was confusion over authority, which ultimately wound up as a Coast Guard oversight. Said the report: "According to the break-in marine inspector that day '[we] agreed that ABS would handle the entire inspection with regards to the underwater portion of the exam'."[13] The report continues on the matter:

> "Contrary to the break-in inspector's perception, the class surveyor did not believe dive supervision was an area of overlapping responsibility with the Coast Guard. The ABS surveyor had no expectations of supervising the dive because diving operation inspection was not within the mandate of ABS. ABS surveyors do not inspect diving operations as an ordinary part of their work and the ABS rules have no provisions for inspecting dive procedures or equipment."[14]

A senior marine inspector for the Coast Guard on Rig 12 that day agreed with the ABS surveyor that the Coast Guard, not the ABS, was responsible for inspecting dive operations. According to the report, he had only a vague memory of being aboard the vessel on March 4, and, furthermore, "believed no diving operations were underway that day."[15] He said he would "typically inspect a dive operation, if one were underway, when he performed a MODU exam…To do this he would use a MODU/SEILOD job aid…and ensure that all the items listed in the job were on board and available."[16]

Headcount

Team member two initially refused the hull inspection job of Rig 12 because he believed the deceased diver, who had done commercial dives for just two years prior to the assignment, was inexperienced, and he did not know the other diver, team member three. Team member three was president of Texas NDE, which specialized in nondestructive testing (NDT), and it was his company that was initially hired by the oil rig owner to perform the dive. Because, team member three did not have enough divers for the job, he subcontracted with the diver's and team member two's company. Team member two accepted the job assignment when his employer assured him two more divers would be joining what was, so far, a team of three.

The employer of team member two and the deceased diver insisted that his dive operations company, though no longer a member of the Association of Diving Contractors, complied with all ADC standards. An assignment such as the Rig 12 hull inspection, for example, only called for two divers and one tender, according to ADC standards. Facts in the report, however, contend that this commercial dive company still fell short on proper procedures for outfitting a dive operation.[17]

To that end, the vague determination as to who would act as dive supervisor on March 4 was critical. Said the report in a series of analyses:

> "[Team member two] did not consider himself the dive supervisor on [March 4 1996]. He testified that his conversation with [his employer] the night before convinced him that [team member three] would be dive supervisor…Despite adopting a narrow view of his responsibilities, [team member two] attempted to do some of the work he characterized as dive supervisor-type duties…while [the diver] was in the water, [team member two] directed [his] movements. [He] also worked the dive station, monitoring the gauges, communicating with [the diver]…Regardless of his intent [team member two] was undoubtedly the de facto dive supervisor."[18]

Indeed, the last minutes of the diver's life boiled down to the misunderstood roles of his two dive teammates:

> "…[Team member two] came to understand that [the diver] was not receiving enough air only after [the diver] said that he might have forgotten to tighten his airline. [Team member two] responded almost instantly by taking compressor 2 off-line and replacing it with a high-pressure air bottle… When [team member two] finally grasped the nature of the problem, he decided to send [team member three] down to effect a rescue. He made the decision because [team member three] was already in a neoprene wetsuit with a diving collar attached…But [team member two] overlooked several problems. Since there was no umbilical available, 20 minutes were wasted stringing together a welding hose to supply oxygen to a helmet…when [team member three] was put in the water he found the neoprene suit made him so buoyant he could not dive to [the endangered diver] and more time was wasted making a weight belt out of shackles. Finally, all of this time was wasted because [team member three], the least experienced diver by far, simply did not have the skill to effect a rescue under emergency conditions with improvised equipment… In the end, [team member two] was able to don [team member three's] helmet without a collar, dive to [his teammate below], and bring him to the surface—an evolution that took one dive and a matter of minutes." [19]

The report concludes that the compressor was not properly maintained and tested, that it produced oil-tainted air, and that it produced inadequate air volume.

Lessons Learned

In a 1998 *Houston Chronicle* feature about the diver's death, the article discusses that while USCG and OSHA have separate but similar regulations covering dive operations, the deceased diver's father contended "neither set of rules goes far enough and he believes the rules should be standardized by the two agencies."[20]

The report's endorsements echo the need for a far more alert, informed, and proactive dive operations community, aiming their words mainly at commercial entities as well as federal agencies. The report's conclusions and subsequent recommendations deliver a bleak 20-20 hindsight with the following observation:

> "Marine inspectors should have inspected the dive station on Rig 12 in accordance with Marine Safety Manual Vol.II… If they had, they likely would have determined that the diving operation lacked a dive supervisor appointed in writing, a dive operations manual, and a log with air test results for compressor 2."[21]

Upon the release of the USCG report, the Coast Guard issued a press release in April 2001 outlining the regulatory measures that resulted from the commercial diving casualty. Among them were improved diving regulations and better diving-related training for Coast Guard marine inspectors and accident investigators.

The publisher of *UnderWater* magazine, Howie Doyle, is a voice of the commercial diving industry and he wrote about the accident in 1998. His message served in part as a warning that there will always be

The family of the diver viewed the USCG report and its endorsements, released in March 2001, as a "vindication" for the young diver, for it had been widely believed that the young diver's inexperience was the cause of his death.

unsafe dive operators on the private side of the industry, and that Coast Guard and OSHA shall always be confronted with the need for better regulatory compliance. He championed a slightly modified theme, however, making the case that the commercial diving industry longs for better enforcement, not just new regulations.

> "Safety can be enhanced by tougher enforcement of existing regulations, not by adding tougher regulations," Doyle wrote. "The death of [the 23-year-old commercial diver] appears to be due to insufficient planning, and—if the facts as presented are correct—to a failure to properly equip a standby diver. All of the 'tougher regulations' in the world couldn't have saved him if the regulations that are currently in place couldn't do it."[22]

A point not lost on Coast Guard officials, one of the report's endorsements acknowledges an industry plagued with risks and challenges, and in need of the Coast Guard's full attention:

> "There were at least three diving casualty deaths in [District 8], since March 1996, that resulted directly from the person in charge or the dive supervisor's poor supervision and management. The Coast Guard's biggest impact on safety diving operations will be through effective regulations…comprehensive training and interactive partnership with the marine industry. Adoption of the recommendations spelled out in this report should be the first step toward the Coast Guard assuming its leadership role in commercial diving safety.[23]
>
> "Only one or two differences in myriad contributing causes," said the endorsement, "would likely have prevented this unfortunate death."[24]

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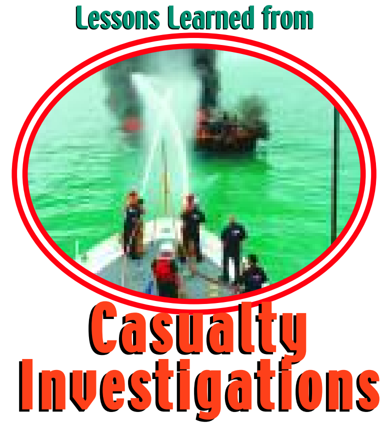
Endnotes

1 Second endorsement, p. 2.
2 *Seattle Post Intelligencer*, "The Real Story of a Diver's Death: Father's Persistence Brings Problems in Commercial Diving to Surface," by Margaret Taus, May 7, 2001.
3 USCG REPORT, *Investigation Into the Circumstances Surrounding the Commercial Diving Accident Onboard the Mobile Offshore Drilling Unit Cliff's Drilling Rig. No 12 on March 4, 1996 With the Loss of Life*, #16732, June 2, 2000.
4 USCG Report, p. 11.
5 USCG Report, p. 11.
6 USCG Report, p. 49.
7 USCG Report, p. 41.
8 USCG Report, p. 15.
9 USCG Report, p. 15.
10 USCG Report, p. 16.
11 USCG Report, p. 5.
12 USCG Report, p. 16.
13 USCG Report, p. 16.
14 USCG Report, p. 17.
15 USCG Report, p. 17.
16 USCG Report, p. 19.
17 USCG Report, p. 9.
18 USCG Report, p. 42.
19 USCG Report, p. 22.
20 *Houston Chronicle*, "Troubled Waters: Since Losing a Son in a Diving Accident, [Dead Diver's Father] Has Been Crusading to Spare Others His Family's Anguish. He Won a Settlement, But Wants More: Tougher Regulations", Richard Stewart, February 1, 1998.
21 USCG Report, p. 51.
22 *UnderWater* magazine, Essay: "Bridge Over 'Troubled Waters' Is Enforcement, Not More Regulations," by Howie Doyle, Spring 1998, Doyle Publishing Company,
23 Second Endorsement, p.1.
24 First Endorsement, p.1

Pushing The Limits

When a resilient clammer finally expired, taking with her two lives, commercial fishing found time to reflect on the basics of safety.



by Ms. Daisy R. Khalifa
Special Correspondent to *Proceedings*

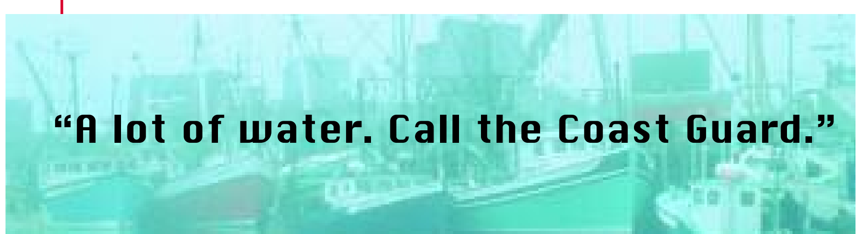
Except to a commercial fisherman, it is hard to imagine being one of just five crew returning home on a freezing January night in the North Atlantic aboard a 112-foot fishing boat, loaded with a quarry of some 400,000 pounds of clams. It is also hard to imagine that, with so much accomplished in little more than 24 hours, that events could turn tragic, quite literally, in the blink of an eye. In the case of the rugged fishing vessel *Cape Fear* and her crew, a quiet journey home after a bountiful day's work ended in less than 10 minutes, when two waves hit the vessel and she sank, taking with her the lives of two deckhands.

The loss of the vessel more than seven years ago, near Cuttyhunk Island, Mass., became something of a poster child of commercial fishing casualties for a variety of reasons. The incident was the first in recent legal history to garner more than $1 million in pain and suffering damages for the estates of the two fishermen who died at sea. It was the vivid and grim depiction of a seaman struggling for his life that transformed the lawsuit from that which would seek only economic damages to additional damages for conscious pain and suffering.

The success of the lawsuit, in turn, underscored a harsh reality for members of the commercial fishing trade: that failures in basic upkeep of safety equipment, such as operable immersion suits, suit strobe lights, and life rafts, coupled with disregard for basic safety regulations, stability guidelines, and complacency toward conditions aboard the vessel in the name of meeting fishing quotas, will cost lives. Put another way, had the crew taken the time to remedy an improperly closed clam tank hatch cover, properly maintain the immersion suits by regularly waxing the zippers, and adhere to basic guidelines within the vessel's stability book, among numerous 'active human performance failures' outlined in the U.S. Coast Guard incident report completed in late 1999 by CAPT G.S. Matthews, this incident may never have occurred.

What Happened

Cape Fear departed Sea Watch International Terminal in New Bedford, Mass. on a clamming voyage at 3:15 p.m. on January 7, 1999, following a foiled attempt to get underway on January 6. The captain of the vessel turned around the day prior because the weather was too severe, according to his testimony. The five-man crew included the mate and three deckhands. The crew sailed three hours and 45 minutes to the site



where the vessel clammed, 14 miles southwest of the entrance to Buzzards Bay. The captain and crew fished for more than 23 hours between January 7 and January 8, and, because the clams were plentiful in the area

PA2 Jacquelyn Zettles, USCG

they fished, they were able to quickly catch a full load—enough quahogs to fill all 130 cages aboard the vessel.

At 6:30 p.m. on January 8, the vessel departed the fishing grounds to head back to the New Bedford Terminal. Upon departure from the fishing grounds, according to the vessel casualty report, one of the port side clam tank hatch covers was left open three to six inches.

At approximately 7:55 p.m., a high water alarm sounded in the pilothouse for the hydraulic room. The captain went to the engine room to start an electric bilge pump to take suction and pump out the hydraulic room as a precaution.

At 8:00 p.m. the vessel was on autopilot at a speed of seven and a half to eight and half knots, near the entrance to Buzzards Bay. The wind was 20 to 30 knots from the southeast and the seas were six to eight feet from the southeast, along with sporadic snow and rain. Visibility varied between two to six miles.

Says the report: "[The captain] testified that the seas seemed to be getting calmer as they approached Buzzards Bay. Then, just before 8:00 p.m. two large waves hit the stern of *Cape Fear*…[The captain] called the [F/V] *Misty Dawn* on VHF radio channel 8, and told the mate, that they had taken 'two big ones,' and that 'she rolled hard two times.'"

At approximately 8:10 p.m., and just prior to realizing the *Cape Fear* was taking on water, the captain and three deckhands were in the pilothouse together "watching television, joking around and horse playing."

Says the report:

> "[The captain] and the deckhands noticed one wave which crossed over their stern, washed up on the back (number 3) hatch covers, and did not recede. The *Cape Fear*'s stern started sinking evenly at first, not listing to port or starboard. The *Cape Fear* capsized and sank within five minutes of the crew noticing this problem."

The captain, once again, called the *Misty Dawn*, a clam vessel from the same fleet that was two miles ahead of the *Cape Fear* and headed inbound to Sea Watch Terminal. He told them they were having problems and asked the *Misty Dawn* to turn around. When the mate on the *Misty Dawn* called back, asking "what's up?," the captain of the *Cape Fear* responded saying, "A lot of water. Call the Coast Guard."

The Icy Waters

The casualty report explains a series of rapid-fire events between the crew's first noticing water not shedding off the stern to its sinking five minutes later. In that time, says the report:

> "[Deckhand one and deckhand two] woke the mate, who was asleep in the berthing area. The entire crew began donning their survival suits…By the time the mate climbed the ladder from the crew berthing to the pilothouse, the water was starting to cover the number two port and starboard clam tank hatch covers. The mate estimated the *Cape Fear* sank within three minutes of when he was woken up….The mate saw [deckhand one] grab a suit from the walkway by the galley. The mate then got his suit from the walkway …and began donning it out on the deck between the galley and the watertight door and the engine room watertight door. This was the last time [deckhand one] was seen alive."

The mate and deckhand three, who was the only crew member unable to swim, both completely donned their suits, while the captain and deckhand two, according to the mate's testimony about what he saw, only had their suits halfway up.

After advising the *Misty Dawn* to call the Coast Guard, the captain "threw down the radio microphone and said to deckhand two and deckhand three, 'We have got to get out of this wheelhouse now.'"

The capsizing of the vessel caused the captain and deckhand two to enter the water about 20 to 30 feet apart. "The captain asked [deckhand two] if he had his survival suit on, and [he] said no—that he was trying and needed help. The captain told [deckhand two] that he was also having problems."

In the meantime, deckhand three was thrown to port, as the vessel rolled to port. The mate had entered the water nearby and been struck by a board used for standing while working the vessel's dredge. Uninjured, the mate, whose survival suit strobe light worked, was able to use the 10-foot board for floatation and he reached deckhand three. While deckhand three and the mate used the board to kick in the direction of the captain, the captain "tried donning his hood and zipping his suit several different ways, unsuccessfully. Finally, he gave up and just held the neck together, trying to get the water out of his suit and holding his hood down."

A rescue in the icy waters spared three of the five men their lives, as described in the report:

> "Once the captain, mate and [deckhand three] were together, they realized that no one had heard anything from [deckhand one]…The captain and mate then heard [deckhand two] for the last time. He was faintly hollering for help and said, 'Oh, God.' The captain estimated from the sound of his voice that [deckhand two] was approximately five to ten feet from them. They tried to find him, but never heard from him again… The three of them, the captain, the mate and [deckhand three] floated hanging on the board for a while. Then, they saw the lights of the *F/V Misty Dawn*. The survivors estimated they were in the water 20 to 30 minutes before being picked up by the *Misty Dawn*… None of the survivors ever saw the life raft in the water."

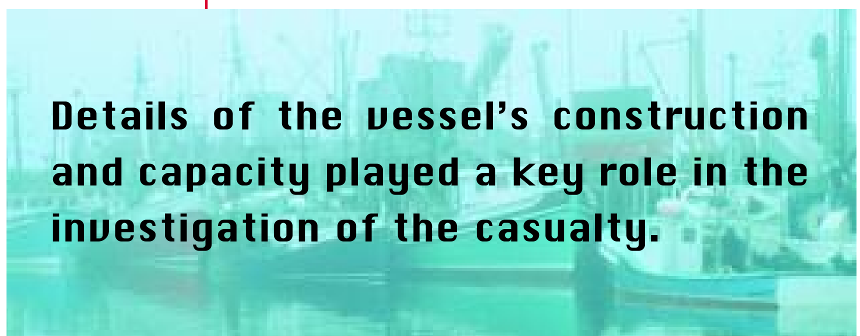
Deckhand one's body was found shortly after nine a.m. the next morning from the surf on the Gooseberry Island portion of Horseneck Beach, in Westport, Mass. He was wearing a partially donned survival suit, and the officers who found him noticed that his survival suit zipper was not zipped up. Deckhand two was never found and he was presumed dead. Early the same morning that deckhand one's body was found, a Coast Guard helicopter located an empty survival suit off of Slocum's Neck, Mass.

The Vessel

The *Cape Fear* was a 16-year-old clamming vessel used for ocean quahogs. At 112.8 feet, the vessel was a steel-hulled, Western Stern Clammer. In 1994, the *Cape Fear* was purchased by Cape Fear, Inc., a company in business since 1985 with a fleet of five clam boats. In addition to the F/V *Cape Fear*, the fleet included the *Misty Dawn*, *Jersey Devil, Miss Merna* and *John N.* The *Cape Fear* operated year round, and she had made 106 trips in 1998 for a total of 3,888 hours at sea. The average trip lasted 36.6 hours. A seasoned fisherman of nearly 20 years, the captain onboard during the casualty had been the vessel's only captain since the vessel had been purchased five years earlier.

In Spring of 1996, the vessel was lengthened, with the addition of a 21-foot mid body section. The new mid-body consisted of two new clam tanks for a total of six, which became the number two clam tanks port and starboard. They were covered by hatch covers with voids outboard of them, one port and one starboard. Also added were two double bottom fuel tanks, one port and one starboard

The vessel carried 120 to 130 clam cages, with 90 cages loaded into six clam tanks below deck and 40 cages on the main deck. Each of the six tanks, or holds, held 15 cages. Of the 40 cages on the main deck, 24 were at the waist—12 along the port rail, 12 along the starboard rail, and 16 on the hatch covers. A cage of clams holds about 32 bushels and *Cape Fear* carried more than 4,000 bushels home on a given trip. With one bushel weighing 90 pounds or more, a single cage of clams weighs upwards of 3,000 to 3,400 pounds. With 130 loaded cages on board, the vessel had been carrying home anywhere from 390,000 pounds— or 195 tons—of added cargo.


Details of the vessel's construction and capacity played a key role in the investigation of the casualty.

Cause and Analysis

Details of the vessel's construction and capacity played a key role in the investigation of the casualty, and the report chronicles in depth the construction of the vessel—from its pumping and electrical systems, to its various machinery installations, the new midsection construction, and the tank loading configuration. While routine for an investigative report, the complex and lengthy data furnished information necessary for the maritime and legal community to extract an answer for several crucial questions, among them: Was the vessel unseaworthy due to overloading?

And while overloading, downflooding, and lack of emergency preparedness, in addition to the crew's failure to adhere to basic stability book guidelines, loomed largely as the principal causes of the casualty—causes that are ultimately attributed to human failure—the report goes to great lengths to explain the mechanical and physical state of the vessel in order to illustrate how certain procedural and equipment failures might have been dealt with differently. In essence, the report, in and of itself, is an exacting, if not fundamental, precautionary case study.

Stability Book

At the time the vessel was lengthened, a naval architect from Propulsion Data Services drafted a preliminary stability book for the owner of the vessel and its parent company, based on calculations and vessel plans. The naval architect, who testified following the casualty, had conducted a stability test for the owners of the vessel in 1992, and completed a new stability book for the vessel's owner in mid-April 1996, and again in 1999. The stability book included a section on General Operating Condition dos and don'ts to serve as basic guidelines for the captain and crew. According to the report:

> "The results indicated that the stability of the *Cape Fear* as it was outfitted and equipped on 7 April 1996 was satisfactory for operation on exposed waters as a commercial clam fishing vessel. It was determined that there were no unstable operating conditions provided trim was kept to plus or minus two feet and the freeboard at the stern was maintained at 18 inches or more. A final stability book dated 9 April 1999 was drafted by the Naval Architect and mailed to [the owner] of the *Cape Fear*."

The stability book, according to the investigative report, was computed based on the assumption that the vessel would carry 120 cages—a number the naval architect arrived at based on the capacity of the three clam holds of 30 clam cages each, and 30 cages on deck. The naval architect testified that the *Cape Fear* was "easily loaded to its capabilities with the 30 cages on deck and 90 down below." While the stability book did not clearly limit the number of cages that could be carried on board, he testified following the casualty that more cages should not have been carried with the condition of the seas the vessels had experienced.

Upon realizing the stern was sinking, the captain slowed the vessel by putting it to idle, which, in normal circumstances, would cause the stern to rise. Given the stern was already under water... this may have been the wrong action.

Furthermore, says the report:

> "The *Cape Fear* carried 10 cages more than the Naval Architect had conducted stability calculations for in the 1996 stability book. The owner never contacted or consulted [the naval architect] concerning the carriage of 10 more cages. [The naval architect] testified that 10 extra cages on the *Cape Fear*, for the total of 130 cages, would affect two things. It would affect the vertical center of gravity so the range of stability is reduced. And, it makes the boat heavier, which makes it more susceptible to water coming on deck and other problems."

The matter of increasing the amount of cages aboard the vessel from 120 to 130, her load when she sank, was the first listed cause of the casualty under the category of 'active human performance failures.' Says the report:

> "The failure to load the vessel in accordance to the guidance in the stability book resulted in the vessel being overloaded and improperly loaded, and created a hazardous stability condition."

Testimony as to how the cage quantity came to be increased is described in the report and in the captain's testimony. Though a veteran fisherman, the vessel's captain had never held any merchant mariner's documents nor did he have a Coast Guard license of any kind, also the case for the mate and all deckhands aboard the vessel when she sank. Current regulations do not require operators of fishing vessels under 200 gross tons to be licensed or have any formal training, and gross tonnage for the *Cape Fear* was just under 200.

The report describes the captain's testimony as follows:

> "[The captain] was not at all familiar with the stability book, and he had only glanced at the front of it when it was first placed on aboard the vessel. He was not aware of the recommendations listed in the stability dos and don'ts…With the owner's knowledge and consent, [the captain] decided approximately a year before the casualty to carry 130 cages. After the vessel was lengthened, he gradually increased the number of cages from 115 to 130…[He] loaded the clam cages and the fuel and ballast tanks on the *Cape Fear* by experience, and did not reference the stability book. He testified that after years of working on the water and

knowing how the boat handled in rough weather, he knew how to do it by 'common sense'."

Given that the captain had successfully made more than 100 fishing outings carrying 130 cages the year before, several other key causes defined as 'active failures,' together, created a risk-laden situation. Among them, says the report,

> "The failure to maintain an 18-inch freeboard at the stern in accordance with the guidance provided in the stability book created a hazardous situation. The six to eight-foot following seas made this condition particularly hazardous, because the seas were able to wash over the stern...and the failure to properly secure the number 3 port clam tank hatch cover allowed water washing on the deck to enter into the number 3 port clam tank."

Technical Studies

The latter oversight concerning the unsecured hatch cover was a salient issue in terms of the welfare of the ship, and later on, when the courts were considering how to rule on causes of unseaworthiness. At the request of the investigating officer of the casualty, LT Patrick McGuire of the Coast Guard's Marine Safety Center conducted a casualty stability analysis. An elaborate series of tests using a computer model, General Hydrostatics Version 6.7, were used to complete the calculations.

In short, the test arrived at the fact that, because the clam hold hatches were not weather tight, this situation lowered the downflooding point from the stack 6.5 feet above the deck to the aft clam hold hatch covers. With the lower downflooding point, the vessel fails all stability criteria. Continues the report:

> "In the testified loading condition, downflooding through the open hatch would be accelerated by the combination of excessive water ballast, added weight from ten extra clam cages, an open hatch and six to seven foot following seas would have likely led to flooding of at least the after holds. In this condition the loss of the vessel is likely."

According to the report, in the early evening of January 8th as the last of the cages had been loaded into the clam holds, deckhand three, with the help of the mate, was closing the number three port hatch cover. The line that was pulled using a block and tackle to shut the hatch had a knot—instead of a splice—that prevented the hatch from closing completely, and the hatch was left open three to six inches.

At 7:30 p.m., the captain asked deckhand two about the hatch covers, and he told the captain that the number three port hatch was not closed completely, and that the number three starboard hatch was closed. This was the first time the open hatch had been reported to the captain. The captain testified he intended to have the deckhand close the number three port hatch using a "come along," but, says the report, "this was not attempted, and the hatch was never fully closed."

In the report, the naval architect provides a vivid description of the hazards of a partially open clam tank in his testimony:

> "If you fill the two aft holds, if they flood, then stability is greatly impaired. With a following sea breaking over the stern and a clam tank hatch open six inches… if you don't continuously pump, then it's only a matter of time before the hold will fill and the free surface and the weight becomes too much … the freeboard starts to deteriorate very rapidly…[He] further testified that if you were to flood one of those holds, that the list would be severe, and … eventually [you] would get flooding into one of the other holds, and unless you were able to pump it quickly, you could lose the boat."

In the case of the *Cape Fear*, the vessel flooded very rapidly unbeknownst to its crew. And, while the report cites a failure on the captain's part to take immediate and proper evasive action when the vessel was in imminent danger, the investigator states that he himself was unable to determine any particu-

"The flooding of the holds symmetrically is really the worst condition, because it's something that can creep up on you without knowing it's happening and because the boat is settling down evenly."

lar strategy for emergent evasive actions. Upon realizing the stern was sinking, the captain slowed the vessel by putting it to idle, which, in normal circumstances, would cause the stern to rise. Given the stern was already under water, the report speculates this may have been the wrong action, though it also states that turning it into the seas, which also stems water from flowing over the stern, could have caused the vessel to capsize.

As per the naval architect's opinion and as indicated in the stability book, a flooded number three tank hold would create a particularly severe problem. In this situation, "he said the boat should be turned into the seas so it is no longer taking water on the deck, and then attempts should be made to correct the flooding problem."

But, echoing the opinion of the investigative report, the architect's additional remarks are a chilling indication of how difficult any kind of evasive action might have been:

> "The flooding of the holds symmetrically is really the worst condition, because it's something that can creep up on you without knowing it's happening and because the boat is settling down evenly… You really need to watch your tankage back there and pump it as often as possible in the following sea to make sure this doesn't happen…you could be lulled into a false sense of security on a vessel of this type because the water going through the clams has a damping effect and it will actually make the boat feel more comfortable than if the water was not there."

Tragically Unprepared

As with the nature of all accidents, the speed with which they occur is often the most confounding factor. To that end, the causes that cite complacency, inattentiveness and, in particular, lack of emergency preparedness, seem all the more perplexing by virtue of illustrating situations that might never have happened but for a few routine measures.

The demise of the two deckhands is attributed in part to the 'active equipment failures' as listed in the report, and the careless maintenance of the safety gear, including the immersion suits. The only suit with a working strobe light was worn by the mate, who had the captain and deckhand three at his side when the *Misty Dawn* rescued them. The crew of the *Misty Dawn* testified, according to the report, that they were able to rescue the three crewmen because they spotted a strobe light.

The immersion suit lights, zippers, and retro reflective tape were not maintained on a set schedule. Furthermore, says the report, the captain and crew did not conduct safety drills in accordance with commercial fishing regulations (46 CFR 28.270) The regulations "specify that drills must include donning immersion suits. Had drills been conducted as specified in the regulations, potential problems with the survival suit zippers, lights and retro reflective tape may have been discovered and corrected prior to casualty."

Other causes of the casualty included, as well, those indirectly accountable—parties associated with the vessel, but listed under causes that were 'specific latent conditions.' The report cites: the owner, whose liability ultimately landed him in court as a result of the casualty; the underwriters who failed to conduct proper drills with the crews; regulators within the commercial fishing industry for not better monitoring the vessel systems and its construction history; and, to the Coast Guard's post-casualty drug testing regulations.

Recommendations

Of the recommendations and subsequent endorsements from the investigation into this casualty, a top priority called for the Coast Guard to establish a regulatory licensing project for masters and mates of certain types of commercial fishing vessels. Specifically that "a project requires licensing of masters and mates for certain types/class/size of commercial fishing vessels that operate beyond the boundary line including oceangoing clam vessels. This would ensure that they would have a good understanding of stability regarding their vessels. It would also ensure that the vessel, its equipment and lifesaving gear are maintained and operated properly in accordance with applicable regulations."

The same recommendation was made requiring merchant mariner documents on the part of master and mates, to which the Coast Guard endorsements unanimously agreed. The First District Commander's endorsement said the subject was discussed at the March 1999 meeting of the Fishing Vessel Casualty Task Force, stating the matter was "adopted for proposal for future rulemaking."

Overall, the recommendations suggest a fair amount of proactive involvement on the part of the Coast Guard in the affairs of oceangoing clam vessels. Included were recommendations for annual inspections, certifications, requisite stability instructions and developing industry standards regarding the material condition of the vessel, watertight integrity, seaworthiness, construction and frequency of dry-dock examinations.

However, while the broadening of the Coast Guard's role in commercial fishing was recommended, certain portions of those recommendations were not fully endorsed, given budget limitations and congressional sign off. But in terms of safety drills and improved life saving regulations as well as launching a major public outreach campaign aimed at the commercial fishing community based on this casualty, these recommendations were wholly supported.

As for civil penalties, the owner was cited for operating the vessel in a negligent manner, "[endangering] the life, limb and property of a person." The report states that the vessel's owner failed to ensure the guidance provided in the vessel's stability book was followed; failed to notify the naval architect of changes made to the *Cape Fear*; failed to ensure drills were conducted; and, failed to ensure lifesaving equipment was maintained and operable.

Moreover, the owner was held accountable in the report for violation of the Federal Water Pollution Control Act by discharging a harmful quantity of oil into the navigable waters of the U.S. Following the sinking, approximately 17,900 gallons of diesel fuel and 2,050 gallons of lube oil were discharged into Rhode Island sound and Buzzards Bay.

Legal Repercussions

The owner faced two lawsuits after the *Cape Fear* sank. In November 2002, a U.S. District Court in Massachusetts rejected his petition for exoneration or limitation of liability, and found that the vessel was unseaworthy based on overloading, leaving the fishing vessel's owner fully exposed to pending damage claims. Subsequently, the deaths resulting from the casualty raised the bar for conscious pain and suffering damages in maritime lawsuits, when the estates of the two deceased crewmembers sued the owner in federal court.

Because liability had been established in the previous lawsuit, the case on behalf of two crewmembers' families focused on damages. The plaintiffs prevailed after a moving account by one of the survivors who emotionally recounted deckhand two's final minutes alive in the water. The jury awarded the family of one crewmember $640,000 and $208,000 for the estate, awards that, with interest, exceeded $1.2 million.

The *Cape Fear* had sunk twice before the most recent casualty that took two fishermen's lives, but on both occasions she had been raised and put back into productive and profitable service. After the third sinking, the vessel was damaged beyond economical repair. On March 8, 2000, the *Cape Fear* was dropped 75 feet below the ocean's surface after being donated as part of the Moriches Artificial Reef off the coast of Long Island.

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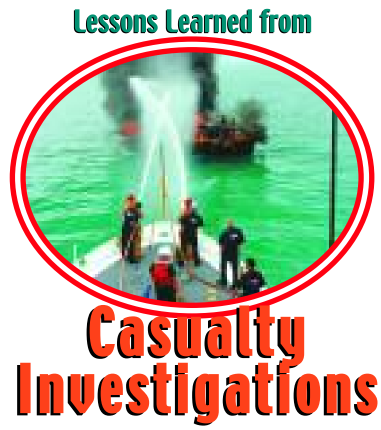
Endnotes

1 *Massachusetts Lawyers Weekly*, by Tony Wright, April 5, 2004.
2 United States Coast Guard, Investigation Into the Circumstances Surrounding the Loss of the Commercial Fishing Vessel Cape Fear, *Three NM SW of Cuttyhunk, Massachusetts on January 9, 1999 With The Loss of Two Lives,* by CAPT G.R. Matthews, Investigating Officer, page 78.
3 USCG Investigative Report, page 12.
4 USCG Investigative Report, page 13.
5 USCG Investigative Report, page 17.
6 USCG Investigative Report, page 16.
7 USCG Investigative Report, page 16.
8 USCG Investigative Report, page 18.
9 USCG Investigative Report, page 18.
10 USCG Investigative Report, page 13.
11 USCG Investigative Report, page 19.
12 USCG Investigative Report, page 19.
13 USCG Investigative Report, page 20.
14 USCG Investigative Report, page 20.
15 USCG Investigative Report, page 21.
16 USCG Investigative Report, page 50.
17 USCG Investigative Report, page 51.
18 USCG Investigative Report, page 78.
19 USCG Investigative Report, page 80.
20 USCG Investigative Report, page 71.
21 USCG Investigative Report, page 78.
22 USCG Investigative Report, page 56.
23 USCG Investigative Report, page 14.
24 USCG Investigative Report, page 55.
25 USCG Investigative Report, page 79.
26 USCG Investigative Report, page 78.
27 USCG Investigative Report, page 56.
28 USCG Investigative Report, page 79.
29 USCG Investigative Report, page 84.
30 USCG Investigative Report, page 96.
31 Endorsement, W.D. Rabe, page 2.
32 USCG Investigative Report, page 99.
33 USCG Investigative Report, page 78.
34 *Massachusetts Lawyers Weekly*, by Tony Wright, April 5, 2004.

Sudden Storm

Rough seas swamp a clammer.



by Ms. Kriste Stromberg
Special Correspondent to *Proceedings*

On January 5, 1999, this trip started much like any other for the men of the clam boat *Beth Dee Bob*. The captain was at the helm and the rest of the crew members were sleeping in their bunks in anticipation of the long work hours when they reached the clam beds. Once there, the deckhands prepared the equipment and the mate got to work, sailing the boat back and forth to fill the clam cages on their boat. When the clam cages were full, they could go back to New Jersey.

Fishing for clams is back-breaking and dangerous. Clams are dredged off the bottom of the ocean by a large metal dredge. To help the dredge along, a jet of water is pumped just ahead of the dredge to stir up the ocean floor and allow the dredge an easier passage through the sand and soils of the ocean bottom. When the dredge is judged to be full, it is hauled up on deck where the deckhands, direct the "take" through a shaker and onto a conveyor belt. The deckhands pick out the things that are not clams, starfish, rocks, and so on, and then open hatches along the conveyor to direct the catch to the clam cages down in the boat's hold. Clam cages measure three feet by three feet by six feet tall and you can fit 14 of them in a standard trailer. Clam boats try to take a whole number of truck loads to contribute to the economy of the clam industry. The *Beth Dee Bob* could carry 70 cages, which would fill five tractor-trailers. Those 70 full clam cages would weigh approximately 3,000 pounds each.

The Incident

The crew members had a good day's dredging and were ready to head back to port about 24 hours after leaving Point Pleasant, N.J. the day before. The cages in the hold were full, and cages in the forward wells were double-stacked, leaving the hatch covers partly open. Also partly open was a weather-tight door in the port side "dog house." This structure was the deck access to the engine room. It was partly open to allow an air duct to run from the engine room to the outside for greater ventilation. The sea was getting rough; a storm had moved in faster than the weather forecast had predicted. The vessel was taking water over the bow. The captain was in frequent contact with another fishing boat. It was to this second fishing boat, the *Danielle Maria* that the captain called about 1740 on


***Beth Dee Bob* in dry dock. USCG photo.**

The Vessel

Beth Dee Bob *was considered to be a state-of-the-art clam boat. It had been built in 1990 as a side-trawler. After an engine room fire that injured 2 crewmen, and a change in the fishing regulations related to clamming, it was refurbished in 1994 as a stern dredge. The original configuration had one "doghouse" (enclosed doorway to the area below deck) in the center of the aft section. The new configuration required a large "A" frame and a hopper between two doghouses. Another significant change related to the air intake and exhaust for the engines. Previously the exhaust piping was through the old centerline doghouse; after the renovation it ran through louvers on both of the doghouses. The air intakes also were moved. Originally they had been located in front of the booms; after the change another set of louvers was installed on the inboard side of the dog houses along with electric blowers. Apparently the ventilation was not sufficient, because sometime after the conversion was completed, a corrugated plastic tube was run from the port doghouse to the engine air intake.*

As a result of this major conversion, the vessel was required to undergo a new stability test. This stability test was conducted by a qualified naval architect. Stability is usually synonymous with lack of motion, but on the water, everything moves. So what does stability mean? When a boat is stable, it means that it will right itself to its correct and upright position after being disturbed. So a boat that quickly swings back upright is a more stable boat than one that only very slowly rights itself, even though it may feel just the opposite. This is one specific instance where a fishermen's experience and intuition can mislead him.

The architect conducted many tests, made many measurements and also made many assumptions in his report and the accompanying stability letter. A stability analysis is large and contains everything that could be said or measured about the vessel. The stability letter is much smaller, and is kept aboard the vessel. One of the major assumptions that the naval architect made was that unless someone was going through the door, all watertight and weathertight doors and hatches would be kept closed, especially when the vessel was underway and/or in bad weather. The stability letter also very specifically delineated exactly how the 70 cages of clams should be loaded on the boat:

48 cages in wells below deck
11 cages loose in clam wells
11 cages on deck aft of well

"Loose in clam wells" means that sheets of plywood were to be laid over the cages in the wells below deck and 11 cages worth of loose clams were to be piled in there. This is not desirable to the crew, as to unload the clams when they get to the packing company docks requires the clams to be shoveled out into cages, which are then loaded onto the trucks. The architect specified this manner of loading as the safest for the boat. He also stated the requirement that the vessel should keep all hatch covers closed weathertight.

Double-stacking the cages in the clam wells would prevent the hatch covers from closing completely. He also stated that the clam wells needed to be kept dry, as water in the wells would adversely affect the vessel's stability. This is one of the main areas where an experienced waterman's intuition leads him astray. Many boat captains will purposely allow water to gather in their clam wells because "the boat rides better." Which means that the boat, instead of reacting to the waves and quickly righting itself, will not be as quickly affected by the waves. Unfortunately this "stable" condition is actually less stable. The water in the hold of the boat sloshes back and forth, and can change the center of gravity of the boat and actually capsize it and keep it from righting itself. This condition is referred to as the free surface effect.

***Beth Dee Bob* stern before refit showing single "dog house." USCG photo.**

January 9th saying, "Taking on water big time." At 1740 the Coast Guard registered the transmission from the EPIRB. The *Beth Dee Bob* was down.

Danielle Maria radioed the Coast Guard with *Beth Dee Bob*'s LORAN coordinates and notified them that they were headed to that area to see if they could help. The Coast Guard had a helicopter doing exercises in the area, and it headed over to help as well, after being directed to pick up a dewatering pump from a nearby base. The Coast Guard also dispatched a 41-foot boat to assist in the rescue.

Ultimately there were three helicopters, two motor lifeboats, a cutter, and a C-130 involved in the search for the vessel and crew. When the boat sunk, only the mate managed to grab a life ring and was found suffering from hypothermia. He was pronounced dead at the hospital. Divers later found one of the deckhands dead inside the vessel at the bottom of the stairs leading to the deck. The captain and the second deckhand were never found.

The Investigation

Many of the past captains and mates of the *Beth Dee Bob* stated that whether or not they knew of the onboard stability letter, they did not read the stability letter (see sidebar). The one number from the stability letter that was of interest to the men was how many cages they could carry. Not one of the past crew members or fill-in crew interviewed for the investigation into the loss of vessel had completely read the stability letter.

After the casualty, and as part of the investigation, divers went down to the sunken boat to examine the condition of the vessel on the ocean bottom. The divers made video tapes of the conditions. These video recordings were shown to the past crew members and they said that, according to the control levers, the propulsion engines appeared to be in gear, but at idle and the clam pumps, which would have been used to keep the clam wells dry, appeared to be off or idling. At the time of the sinking, the vessel was apparently not moving forward and not pumping out the clam wells.

In a casualty investigation the Coast Guard uses many sources to figure out what happened. Investigators examine the wreckage, interview witnesses, check on the history of the vessel, and so on. In this case, one group of witnesses was missing: the crew. In this casualty there were no survivors. One man was found outside of the boat; the rescue swimmer who found him felt that the mate had only been dead a very short while. The mate had been unable to get into his survival suit.

The survival suit is intended to protect its wearer for hours in the sea. To achieve this degree of protection, the suit fabric is thick and bulky, making the suit hard to put on, and harder to zip up. Also because they don't expect to need the survival suits, many fishermen do not practice putting them on. Emergency preparedness and survival suit practice also takes time away from working and bringing in the clams as quickly as possible. The suits are often stored out of the way in lockers, away from the work and sleep areas.

Lessons Learned

Could this casualty have been prevented? Most likely, yes it could. If the crew had read and followed the instructions in the stability letter:

- the clam cages would not have been double stacked,
- the weather- and watertight hatches and doors would have been closed,
- the clam wells would have been kept dry.

Could the deaths have been prevented even if the directions in the stability letter were not followed? Very possibly. If the captain and crew had:

- conducted required safety drills,
- practiced putting on their survival suits,
- been more aware of the inflow water and donned their survival suits before the water was coming down the passageway and the boat was obviously sinking.

Bow of *Beth Dee Bob* after refit. USCG photo.

Stern of *Beth Dee Bob* after refit showing the "A" frame and dredge. The two new "dog houses" are visible on either side and in front of the dredge. USCG photo.

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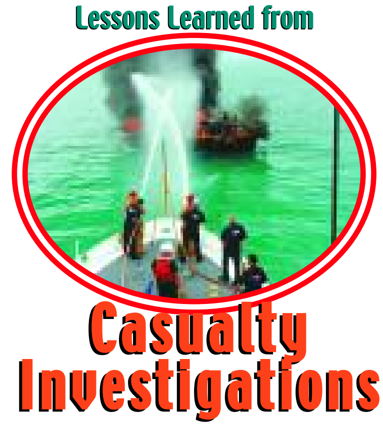

Swamped and Capsized

The loss of a fishing vessel.

by Ms. Jennifer Kiefer
Special Correspondent to *Proceedings*

Early on the morning of January 23, 2000, three family members set out for a fishing trip around the Gulf of Maine. Two days later, the vessel was lost at sea with only one survivor. As family and friends mourned the loss of the two other men, the Coast Guard initiated a formal investigation and made a disquieting discovery: The accident should never have happened.

The Accident

The *Two Friends*, a 61-foot commercial fishing vessel, had set sail from Portland, Maine, to drag for ground fish. Rough weather on January 25 cut short their trip and they began to head back for Portland. It was on this journey home that the troubles began. According to testimony gathered afterward from the survivor, the rough weather had doggedly followed them and around 4:00 p.m. the lazarette bilge alarm sounded. The captain energized the bilge pump and the alarm condition cleared. But the alarm soon sounded again and could not be cleared. Concerned that the stern might be flooding, the captain turned the vessel downsea, allowing waves to carry over the stern and onto the deck. Unfortunately, some of the water entered the engine room and the accommodations house and flooded all deck openings, none of which were watertight. With the watertight integrity compromised, damage control efforts were useless. The crew recognized the gravity of the situation, realized the vessel was in danger of capsizing, and hurriedly transitioned from vessel recovery to vessel abandonment.

They were too late. Only 20 minutes after the first bilge alarm had sounded, the vessel suddenly capsized. The life raft had not yet been deployed, and the only member of the crew who had fully donned his survival suit was inextricably caught under the vessel as it rolled over. He was never seen again. The remaining two men, forced to watch their family member disappear in the chaos, still had survival battles of their own to fight. Neither man had fully donned his survival suit. For some reason, the captain was unable to get his left arm into the suit; the exposure left him open to the elements and he died as a result of hypothermia and drowning shortly after entering the water. The third crew member also had difficulty donning his suit. The bulky hooded sweatshirt he was wearing prevented him from getting on the hood of the survival suit. This, too, left him partially exposed to the elements. But he kept a firm hold on the vessel's Emergency Position Indicating Radio Beacon and waited for rescue.

As with most accidents, there are a number of factors that led up to and exacerbated the problem... The Coast Guard's response to the casualty has, therefore, also been multifaceted.

Approximately three hours later, the Coast Guard found him. The body of the captain, held on to by the surviving crew member as long as possible, was recovered by the Coast Guard the next day. No attempts were made to find the vessel because it sank in such deep waters. The third crewmember's body was never found.

Figure 1: Damage control trainers are used to illustrate damage control procedures and increase awareness of typical flooding risks.

The Investigation

Just two days after the sinking, the Coast Guard convened a formal investigation to determine the cause. Admittedly, without the vessel itself, much of the investigation's conclusions could not be fully determined. But testimony from the lone survivor and expert witnesses aided greatly in the investigation. The information that surfaced highlighted a major concern the Coast Guard has long harbored regarding the commercial fishing vessel industry: essential vessel maintenance issues such as stability and watertight integrity had been severely compromised and led to a completely preventable accident.

The vessel had just received modifications prior to this voyage, and it was these modifications that the investigators quickly focused on. Indeed, the accident was ultimately attributed to a structural failure of the rudder port tube, which had been among the parts modified. When the rudder port fitting was reconstructed, it was augmented with higher power controls, designed to increase its structural load. Unfortunately this modification simultaneously reduced its overall structural strength. When the vessel encountered the rough weather at sea, the investigation concluded "that a structural failure likely occurred of the hull or a hull fitting in the lazarette, most likely the rudder port fitting, thus allowing seawater to flood the space."[1] Although the passage area that flooded was equipped with a watertight plate, that plate was not properly secured at the time of the accident. Had it been secured, the investigation surmised that the vessel may have been able to retain sufficient stability.

Why, one might ask, would a recent modification—an assumed improvement—so quickly be considered the culprit? The answer is simple. Without a set of guidelines or regulations to outline stability or watertight integrity requirements during vessel modifications, the owner was free to choose the type of repairs he wanted. Testimony from the investigation showed that when the owner upgraded the manual steering controls to hydraulic assist, he chose the repair that was cheaper, rather than the repair that was considered more correct. While he saved approximately five times the financial amount with this option, the cheaper, less correct repair potentially weakened the assembly's overall structure, ultimately costing the owner his life and that of a crewmate.

As with most accidents, though, there are a number of factors that led up to and exacerbated the problem of the rudder port fitting. Regulations, poor vessel repairs, and human error all combined to create the deadly disaster. The Coast Guard's response to the casualty has, therefore, also been multifaceted.

Coast Guard Response

According to Mr. Mike Rosecrans, Chief of the Fishing Vessel Safety Division at Coast Guard Headquarters, the accident factors noted with the *Two Friends* are unfortunately all too common. Rosecrans points to three areas—maintenance knowledge, stability and watertight integrity, and crew preparedness— where he feels an increase in mariner education can substantially prevent similar accidents.

Maintenance Knowledge

"Maintenance of a vessel is the owner's and master's responsibility," remarks Rosecrans. "It must be seaworthy. Good marine practice indicates they should be performing self checks before they get underway." As mentioned, the lack of regulations regarding vessel modifications placed the burden of safety upon the vessel owner. Without the full understanding of how the repairs could affect the vessel's watertight integrity, the owner chose his option on cost. As the owner was under no regulatory obligations to choose the more correct (and more expensive) option, the repair was not in any regulatory violation. Understandably, finances are often a determining factor with vessel repairs. But had the reconstruction of the rudder port fitting been reviewed by an engineer, the potential problems could have been discovered beforehand and corrected. While the final—correct—repair would have ultimately cost much more, the vessel could have better retained its seaworthiness and very possibly evaded the accident.

Even without the rudder port repair, though, the vessel was already considered "at-risk" by the Coast Guard. The vessel had originally been built as a shrimp boat for the Gulf of Mexico and exhibited some of the known risk factors similar to other Gulf shrimp boats that had migrated to the New England area. The outward appearance of the vessel also concerned the Coast Guard. The captain of the vessel had been contacted by the local Coast Guard fishing vessel safety team numerous times in attempts to offer a voluntary dockside exam. The vessel's last voluntary dockside exam had been in February 1994, when 14 deficiencies were noted. Since that exam, the captain had refused all offers of Coast Guard assistance. Without the regulatory authority, the Coast Guard could not check up on the proper maintenance of the vessel, and its seaworthiness continued to deteriorate.

Stability and Watertight Integrity

Statistics show that over half of all commercial fishing vessel fatalities occur from vessels flooding and sinking. Flooding of the lazarette should not cause a vessel to sink. In this case, the access cover between the lazarette and the void space forward of it were not secured, and allowed the flooding to occur. The surviving member commented during the investigation that he had questioned the captain about the watertight subdivision, but the captain still chose not to secure it. Had the captain fixed the problem, he would have created a watertight seal to help prevent the flooding. Although safety indicated that the access cover should have been secure, the vessel was not required to have watertight subdivisions belowdecks and was therefore not in violation of any regulations.

Maintenance knowledge, stability and watertight integrity, crew preparedness— three areas in which an increase in mariner education may prevent similar accidents.

Rosecrans recommends meetings between naval architects and vessel masters to help explain such issues. "If the mariners understood the importance of watertight integrity," comments Rosecrans, "perhaps they wouldn't be so blasé about it. Many don't understand the mechanisms by which vessels can sink. Part of our job in the Coast Guard is to get them to better understand it."

One of the Coast Guard's efforts involves damage control trainers (Figure 1). These multifaceted trainers are used to show mariners basic damage control procedures and increase their awareness of typical flooding risks. Tools such as the trainer are invaluable, especially considering a recent Coast Guard analysis of fishing vessel casualties that found the leading cause of vessel losses between 1994 and 2004 was flooding.[2] Knowledge of stability and watertight integrity issues are paramount.

Crew Preparedness

The third area where improved mariner education can help prevent accidents is, not surprisingly, preparedness of the crew itself. Says Rosecrans, "Preparedness of the crew is vital when there's an emergency because they need to act promptly. Time is crucial, so their actions need to be instinctive. Regulations only focus on survival equipment, so if they don't know how to use the equipment it's no good. They have to practice their drills every month."

The problems experienced by two members of the *Two Friends* clearly illustrate this problem. Neither the captain nor surviving crew member was able to completely don the survival suit. The survivor was prevented from completely donning his suit because of the binding on his hooded sweatshirt. Had he engaged in drills before the accident, he might have been aware that the bulky sweatshirt and its binding could cause a problem. Testing of and training with survival suits are critical to their serviceability and effectiveness.

Regulations

Regulations resulting from the 1988 Commercial Fishing Industry Vessel Safety Act (Title 46 Code of Federal Regulations, Part 28) focus mainly on lifesaving and firefighting equipment. This concentration on emergency response, rather than the prevention of vessel loss leaves maintenance responsibility (and hence, knowledge) of the vessel's structure and watertight integrity solely with the vessel owner and operator. Where necessary and/or costly repairs are needed, it is therefore up to them to recognize the need and make the corrections. According to the recommendations in the Coast Guard's report of the *Two Friends*, mariners need to be "cognizant of and eliminating where possible potential sources of flooding and ensuring that repairs and modifications made to their vessel are done properly, consulting with a qualified engineer when appropriate." [3]

Outreach Efforts

Because official guidance is currently lacking, the Coast Guard must rely heavily on educational initiatives to improve the safety culture of the industry. Two places where the Coast Guard is trying to strengthen its direct communication link with industry are through the Commercial Fishing Industry Vessel Safety Advisory Committee (CFIVSAC) and through Coast Guard Voluntary Dockside Exams.

Statistics show that over half of all commercial fishing vessel fatalities occur from vessels flooding and sinking .

Commercial Fishing Industry Vessel Safety Advisory Committee

CFIVSAC provides a great opportunity for all members of the maritime community to come together and discuss options for improving safety. Established in 1988, the group meets annually to provide advice and make recommendations regarding safe operations of commercial fishing vessels. The committee is comprised of members who have expertise and experience in the commercial fishing industry and reflect both a regional and representational balance. Members also include representatives of naval architects or marine surveyors, manufacturers of vessel equipment, education or training professionals, and underwriters.

At the July 2005 meeting, numerous tasks were created to improve the safety of uninspected commercial fishing vessels. Some of the tasks included an evaluation of communication methods between the Coast Guard and industry, development of a log book for tracking vessel work/modifications, recommendations on stability training, and recommendations for addressing stability in new construction and vessel modifications. The committee will address these items and continue to look for all ways possible to educate mariners and improve the industry's safety level.

The Best Practices Guide to Vessel Stability booklet, prepared with the help of the committee, provides mariners with an informative introduction to stability. Filled with clear, easy-to-understand graphics, the booklet covers a wide range of topics to help mariners avoid unsafe stability conditions. Beginning with a simple introduction on stability, the booklet then delves into issues such as initial versus overall stability, the dangers associated with free surface, and prudent seamanship. The booklet can be found on the web at www.uscg.mil/hq/g-m/cfvs/Stability%20Book%202nd%20Ed%202004.pdf. Copies of this booklet can also be obtained by contacting one's local Coast Guard Commercial Fishing Vessel Safety Program. Mariners can find the nearest office by calling the Coast Guard's toll-free number: 800-368-5647.

Voluntary Dockside Exams

The voluntary dockside exam program, which began in 1992, is an excellent resource for mariners. Exams are conducted only at the request of a vessel owner or operator, and are performed at a pier or mooring to avoid interfering with fishing activities. During the exam, the Coast Guard examiner can explain which federal safety regulations apply to the specific vessel and offer educational information on various safety measures.

There are no penalties or fines if the vessel does not meet the requirements of the exam. However, a list of safety discrepancies is provided to the vessel, thereby offering the vessel owner/operator a valuable worksheet for improving the safety of the vessel and its crew. Receiving a Voluntary Dockside Exam decal (upon completion of a successful exam, including when the listed discrepancies are corrected) shows compliance with federal safety requirements (Figure 2). Some insurance companies also offer discounts for vessels bearing valid decals.

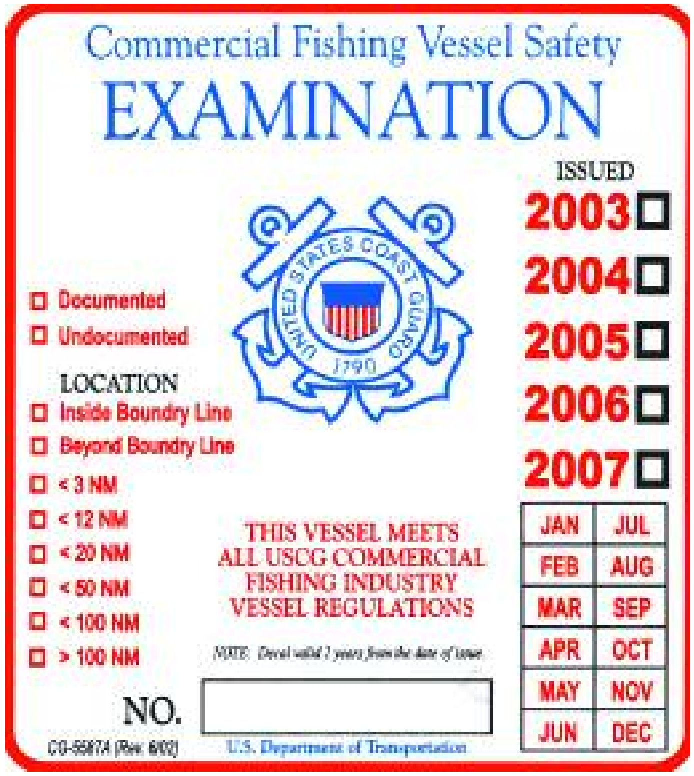

Figure 2: Voluntary Dockside Exam decal.

According to Mr. Kevin Plowman, Commercial Fishing Vessel Safety Examiner for Coast Guard Sector Northern New England (where the *Two Friends* accident occurred), the exams provide an excellent opportunity for safety training with vessel crews. "I feel that safety training is as important as vessel examinations," notes Plowman, "and I devote a lot of my time to provide training to the owner/operators and their crews during the exams." Such an educational—and free—opportunity is simply too valuable to ignore.

If the offer of a free exam isn't enough to encourage mariners, data extracted from the Coast Guard's marine casualty databases just might. Between 1994 and 2004, there were 1,398 lost vessels listed (documented and state registered). Of those 1,398 lost vessels, 80% had no current valid exam—873 (62%) never had an examination, 257 (18%) had expired fishing vessel decals—261 (19%) had current fishing vessel decals, and 7 (1%) had an unknown exam status. Had those vessels received voluntary dockside exams, the safety discrepancies that existed might have been discovered and the accidents prevented. A call to the Coast Guard's toll-free number can direct mariners to the nearest examiner.

In Conclusion

"Knowledge is power," wrote English author and philosopher Sir Francis Bacon in 1597. Three simple words strung together by a man over 400 years ago, yet this phrase still resonates soundly today. In the commercial fishing vessel industry, where mariners must rely upon their own experiences, knowledge is the tool that can guide mariners safely through their perilous work. With continued safety efforts on the part of both Coast Guard and industry, accidents such as this can be prevented.

Endnotes:

1 Coast Guard Report of Investigation into the Circumstances Surrounding the Incident Involving F/V *Two Friends* on 01/25/2000.

2 Analysis of Fishing Vessel Casualties: A Review of Lost Fishing Vessels and Crew Fatalities, 1994 – 2004.

3 Coast Guard Report of Investigation into the Circumstances Surrounding the Incident Involving F/V *Two Friends* on 01/25/2000.

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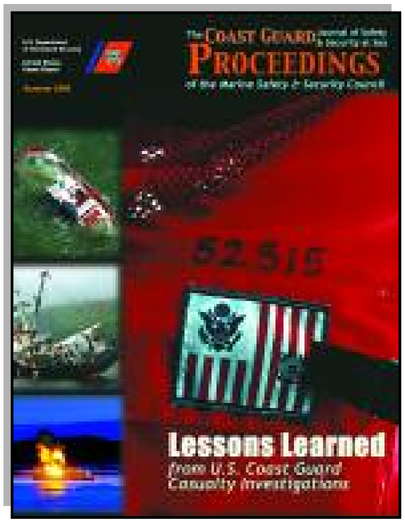

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PROCEEDINGS Magazine, Summer 2006

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Reader's Survey

Lessons Learned from Casualty Investigations

Crisis in the Bering Sea

The fire and explosion aboard a commercial fish processor.

by Ms. Betty Lynn Sprinkle
Special Correspondent to *Proceedings*

A 180-foot distant water freezer longliner, the fish processing vessel *Galaxy* had recently been inspected by the American Bureau of Shipping.

On August 1, 2002, the vessel departed its home port of Seattle, Wash. on a three- to four-month trip to fish for Pacific cod in the Bering Sea. The trip was interrupted by a fire in one of its two main generators. The crew handled that fire-fighting effort quickly, with no casualties. The vessel arrived in Dutch Harbor in early October to replace a faulty generator. On October 12, the fish processing vessel left the port and headed to the fishing grounds near St. Paul and St. George Islands.

The next several days of fishing were uneventful. Over the six-day period from October 14 to 19, the crew caught and processed 80,000 to 100,000 pounds of product.

On October 20, 2002, the crew was retrieving long line gear in the Bering Sea, approximately 30 miles southwest of St. Paul Island. The temperature was about 35 degrees Fahrenheit and the water was 43 degrees Fahrenheit. The winds out of the north-northeast at 20 to 30 knots brought an occasional snow squall, with 12- to 15-foot seas. The vessel was holding position to finish processing the catch on board.

The Incident

At around 4:22 p.m. crew members saw smoke on several decks and notified the captain. The captain activated the fire alarm and the fire teams responded to the starboard side upper engine room hatch. The chief engineer went to the lower level entrance to the engine room, looking for the source of the smoke. Nonessential personnel were instructed to evacuate to the aft upper deck or the forward main deck.

At the upper engine room hatch seven crew members were attempting to battle the fire. The chief mate opened the hatch and entered the space, wearing a self-contained breathing apparatus (SCBA). When the chief mate came out of the space, he stated the fire was "too much."

Actions Aboard

The chief engineer came to the same conclusion at his location in the lower level and decided to activate the fixed CO_2 system. He ran up two decks to inform the captain. He did not convey that information to the fire-fighting team.

Thinking the CO_2 system had been activated, the chief mate ordered several crewmembers to open exterior watertight hatches, to ventilate the smoke from the space in which they were standing. Two of the crew who were fire team members remained with the chief mate.

Smoke began to overwhelm the three fire team members, and they ran to the stern of the vessel and opened the gear setting hatch. The chief mate and the two fire team members asked crew members on the top deck to throw them lines. While the fire team was attempting to evacuate through the gear hatch, an explosion occurred. The force from the explosion ejected all three men through the hatch. Fortunately, several crew members saw the men thrown from the vessel and immediately threw line and buoys to them.

The chief engineer was attempting to discharge the CO_2 system when the explosion occurred. He was

The captain quickly activated the fire alarm and the fire team responded quickly. They did not, however, have the knowledge or training to recognize a backdraft explosion situation nor to deal with it...their actions to ventilate the main deck probably contributed to the explosion.

knocked off his feet, lost his flashlight and his bearings and did not succeed in discharging the system. He then crawled through the work deck, located stairs to the main deck, and found his way outside to join three crew members on the forward main deck.

Man Overboard

Meanwhile, the crew on the top deck threw a ring buoy to one of the crew in the water and pulled him up the entire height of the vessel.

A second crew member in the water also got a line and was being hauled up on the stern of the vessel by crew members. The 20-foot seas caused the vessel to pitch and swing him into the hull with such force that he was knocked unconscious. He let go but his leg was tangled in the line and he did not fall back into the water. Crew members then lowered him into the gear setting hatch he had been blown out of. The crewman found his way to the top deck several minutes later; he does not recall exactly how he got to the top deck.

The chief mate apparently was hurt during the explosion and, though he got to a life ring, he could not hold on and fell into the water during the crew's attempts to haul him back in.

Immediately after the explosion the three crew members that were sent up two levels, moved to the aft cargo hatch to retrieve survival suits from the bin located there. One of these three was the vessel's designated rescue swimmer. After donning his survival suit, he jumped into the water with a ring buoy and safety line to rescue the chief mate. The rescue swimmer swam through the 15–20 foot seas to the chief mate, and was able to reach him. However, the chief mate was unable to assist in his own rescue, and he slipped away from the rescue swimmer's grasp.

During this rescue attempt, the crew on the top deck managed to launch the starboard side life raft. Crew on board urged the rescue swimmer to swim to the life raft, which he did. He was too exhausted by this time to pull himself into the raft. Realizing this, the chief engineer jumped into the raft to assist him. The chief engineer left instructions for the remaining crew to gather survival suits and buoys and get them to the bow of the vessel. Once in the raft, the engineer was being slammed and pinned against the hull of the *Galaxy* by the rough seas. After several attempts, he pulled the rescue swimmer into the raft.

Inside the raft, the chief engineer desperately tried to put together the plastic paddles so he could maneuver the raft. The paddle parts were duct taped together. The engineer's hands were cold and the survival suit severely limited his manual dexterity. He finally got the paddles assembled and used them to assist with moving the raft to the stern of the ship. However, the plastic paddles quickly broke.

Mayday

While the crew was occupied with the man overboard rescues, the captain returned to the wheelhouse to issue a mayday. Finding the wheelhouse filled with smoke and most materials in it either on fire or red hot, the captain made several forays into smoke-filled areas to locate a working radio. He received a severe burn to his arm in the process. He eventually found an emergency radio and sent a mayday signal to the Coast Guard LORAN Station St. Paul.

A second explosion and fireball from the engine room vents set the wheelhouse on fire. The new explosion separated the 21 crew members on the top deck from the four on the main deck, and from survival suits located on the main deck.

The captain knew how important the survival suits would be if they abandoned ship, so he made another attempt to acquire them for the crew on the top deck. In this attempt, he fell 20 feet from the wheelhouse to the forward main deck. He received additional burns and broke several ribs. Separated from the crew on the top deck, the captain was unable to direct the ship abandonment.

Abandon Ship

With the captain injured and other crew members injured or lost, the chief engineer, in the life raft, took over evacuation and directed the abandonment of the vessel. The raft was 35–50 feet below the level of the top deck and he had trouble convincing the crew on the top deck to jump, despite rapidly deteriorating conditions on the ship. Finally one person jumped into the raft and 11 others followed, jumping directly into the life raft alongside the burning vessel.

Two other crew members attempted to abandon ship via the life raft. One jumped, but landed in the water instead of the raft. The rough seas took him so far away from the raft so rapidly that the crew was unable to rescue him. He was in a survival suit and the crew hoped he would survive until help arrived. Another crew member, unwilling to jump 50 feet into a moving target, attempted to lower himself into the life raft by two lines he tied to himself. Unfortunately the lines were not long enough and he was trapped on the side of the burning hull too far away from either the raft or the deck for crew members to help. The lines eventually either broke or burned in two and the crew member went into the water. He was not wearing a survival suit, and his body was recovered about two hours after the explosions.

Once the 12 crew members from the top deck were onboard the raft, someone cut the sea painter and freed the raft from the *Galaxy*. The life raft then drifted by the four crew members stuck on the main deck, and one person jumped into it as it went by. The three remaining did not respond as quickly and the raft drifted away.

Back on the top deck, one crew member and a National Marine Fisheries Service observer onboard the craft jumped into the water after the raft had pulled away from the ship and the fire had come closer. The crew member, one of the three who had originally been ejected by the explosion, had a survival suit on but the observer did not. She jumped into the water, holding onto a life ring and wearing pajamas and a rain jacket. They attempted to swim to the raft but it moved too swiftly away from them. They stayed in the water, with the crew member keeping the observer's head out of the water for nearly two hours, before being recovered by a Good Samaritan vessel, the *Clipper Express*.

The Coast Guard Response

Once Coast Guard LORAN Station St. Paul received the Mayday from the captain, several rescue activities were put into motion. A fixed wing aircraft was launched from Air Station Kodiak. The Coast Guard broadcast information to all ships in the general vicinity. Responding to the call for assistance were fishing vessels the *Blue Pacific*, *Horizon* and *Clipper Express*. The *Blue Pacific* reported to COMMSTA Kodiak a visual sighting of the vessel with people still onboard.

A Coast Guard helicopter was dispatched and rescued three crew members from the top deck and two on the bow of the main deck. One person from the main deck jumped into the water and was rescued by the *Blue Pacific*.

After the crew was rescued, the Coast Guard continued searching for those missing for another 48 hours. After the search efforts for the missing concluded, efforts were then made to find the *Galaxy*, without success. As many hatches were open to the sea at its last sighting, it was presumed to have sunk.

Conclusions

The fire originated in the engine room, and though the exact source cannot be determined, there is no evidence the vessel's refrigeration system, hydraulic system, or equipment containing oxygen, acetylene, or propane caused or contributed to the explosion. All witness accounts describe a backdraft explosion.

The captain quickly activated the fire alarm and the fire team responded quickly. They did not, however, have the knowledge or training to recognize a backdraft explosion situation nor to deal with it. They also incorrectly determined that the CO_2 system was discharged, and their actions to ventilate the main deck probably contributed to the explosion.

The crew's response to the multiple man overboard incident was exceptional in view of the conditions and location of the crew. The rescue swimmer's individual actions to rescue the chief mate were extraordinarily heroic.

While the locations of the life rafts and survival suits on the *Galaxy* met both Coast Guard and ABS requirements, in this real-life situation, this proved problematic. The life raft installation was inadequate for quickly launching the rafts with minimal effort by the crew. The placement of the majority of the survival suits in a single location made them inaccessible to the largest group of crewmembers when the fire came between them. On commercial fishing vessels, life ring buoys are the primary equipment used to recover a man overboard. However, a life ring is not effective in recovering an injured person. The lines on the life ring buoys are of insufficient diameter to pull a ring buoy, with a person in it, through the water.

The placement of the majority of the survival suits in a single location made them inaccessible to the largest group of crewmembers when the fire came between them.

The plastic paddles intended for use with the life raft were rendered unusable by being duct taped together, were inadequate for maneuvering the raft in 15-foot seas, and broke while attempting to serve their purpose.

The Coast Guard responded in a timely and appropriate manner to this incident. The actions taken by LORSTA St. Paul to provide a communications watch during the Bristol Bay red king crab fishery and to serve as the initial response coordinator for this rescue were exceptional. The captain, after several attempts to find working equipment, finally issued the mayday over a VHF channel. Had LORSTA St. Paul not been offering this service, the rescue would have come much more slowly. The forward deployment of the CG6021 helicopter to Cold Bay, Alaska, also significantly improved the response time to the *Galaxy*.

The master and crew of the *Clipper Express*, *Blue Pacific*, and *Glacier Bay* were instrumental in the rescue and recovery of the crew from the *Galaxy*.

Lessons Learned

The lessons from the *Galaxy* casualty emphasize the value of both fire and abandon ship drills. It is essential that all crew know their roles during fires and other emergencies, are familiar with the location and operation of safety and rescue equipment, and can rapidly and readily assume their assigned duties.

One problem noted was that all emergency training is done in English. English was not the native language of nearly half of the crew aboard *Galaxy*. Safety training organizations approved by the Coast Guard should develop safety videos and training programs for non-English speaking commercial fishing crews to assure that all crew members are familiar with the emergency responsibilities and duties. Commercial fishing vessel owners and operators should provide drill instructor training for lead non-English speaking factory and fish processing personnel to ensure that all non-English speaking crew members know their emergency response duties.

It is essential that all crew members know their roles during fires and other emergencies, are familiar with the location and operation of safety and rescue equipment, and can rapidly and readily assume their assigned duties.

Another issue is the lack of formal training for specialized positions. Currently no specific standards or training proficiencies exist for rescue swimmers, fire hose team members, or persons required to wear SCBA. These positions require wearing of special equipment and may require individuals to perform difficult or sometimes life-threatening duties.

The report also recommends that for vessels where it is the policy to notify the master of the vessel prior to discharging the CO_2 system, owners should install an independently powered emergency communication system between the wheelhouse and the CO_2 room to allow immediate notification.

The difficulty of launching the life raft from the vessel shows that fishing vessels need to install life raft arrangements that allow for the raft to be launched by a single person. Though one of the life rafts was inaccessible because of the fire, neither of them could be launched by a single person. Both life rafts required several crew members to remove them from the station and to launch. What is missing from current regulatory language is wording that ensures a life raft can be easily launched before the vessel sinks. Systems do exist that allow a single person to launch the life raft.

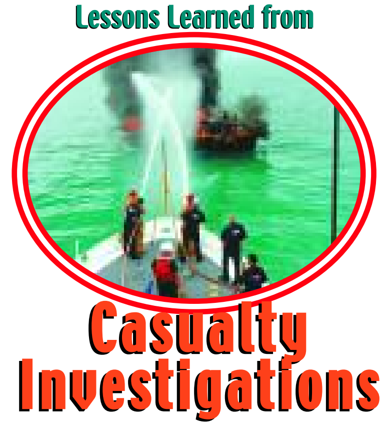
This casualty also showed the inadequacy of plastic life raft paddles currently approved for use in SOLAS A and SOLAS B rafts. The investigation recommends that the Coast Guard, through the International Maritime Organization develop regulations to require that life raft paddles in SOLAS A and SOLAS B rafts be designed of sturdier materials.

Subsequent to the investigation, the Seventeenth Coast Guard District recognized the extraordinarily heroic efforts of the ship's captain, chief engineer, the crew member who saved the fisheries observer, and the rescue swimmer. The Seventeenth District also recognized the efforts of the masters and crews of the *Blue Pacific*, *Glacier Bay*, and the *Clipper Express* with public service awards.

About the author: *Ms. Betty Lynn Sprinkle is a free-lance writer living in Alexandria, Va. In her 25 years of writing, she has covered such diverse topics as the construction industry, health care, higher education, and employment for national trade magazines, medical newsletters, university publications, and the* Washington Post.

Fire in the Engine Room

Many events led to fire and subsequent casualties.



by Ms. Betty Lynn Sprinkle
Special Correspondent to *Proceedings*

The SSG *Edward A. Carter, Jr.* was a containership chartered by the Military Sealift Command to transport explosive cargo as part of its Prepositioning Program for the U.S. Army. Purchased in late February of 2001 by Maersk Line Ltd., the ship was in drydock at the Norfolk Shipyard Company (Norshipco) in Norfolk, Va. until mid-June of 2001. While there, the ship renewed its hull and machinery classification certificates and Certificate of Inspection and upgraded its cargo handling equipment. It departed Norshipco early on the morning of June 13 and arrived at the Military Ocean Terminal, Sunny Point (MOTSU) the following day. By the middle of July, the vessel was loaded with 1,212 containers of Class 1 explosives, holding a total net explosive weight of five million pounds. The vessel was to complete loading Class 1 explosives before departing the south wharf of the MOTSU at the end of July. Its intended destination was the island of Diego Garcia in the Indian Ocean.

The Event

On Saturday, July 14, 2001, all the engineers except the chief engineer went to the engine control room for a mid-afternoon break. The wiper left around 3:30 p.m. to return to the second level to work. The first assistant engineer and electrician stayed in the control room. The second assistant engineer began a transfer of heavy fuel oil (HFO) from tanks within the engine room.

The heavy fuel oil began to spill over the HFO settling tanks, into the vent piping. The HFO flowed along the common vent piping and into the main engine mixing tank, which holds diesel oil. Continuing to flow, the mixed HFO and diesel oil spilled onto the first level and covered the solid deck plating. Eventually the combined fuels spilled over the first level deck coaming and onto the auxiliary boiler exhaust stack. The exhaust stack was hot enough to ignite the fuels. The resulting fire sent intense heat, black smoke, and flame through the aft levels of the engine room and inside the fidley. The diesel and heavy fuel oil mixture

Residual oil on deck in the vicinity of the incinerator exhaust stack of the 03 level of the engine room. Fire damage is visible in the surrounding area. USCG Photo.

continued to cascade down from the first level and second deck raining fire onto the third platform level.

At one minute after four, the fire detection alarm sounded. The first assistant engineer checked the smoke detection panel to find five separate zone indicator lights active. He silenced the alarm and, along with the electrician, went to the generator room on the third platform level, where they saw thick smoke pouring out. They quickly returned to the engine control room and called the master to report the fire. The master proceeded to the bridge to energize the starboard fire pump. After waiting for pressure to develop in the piping system, he left the bridge and went to the starboard main deck gangway phone to call MOTSU security.

When the second assistant engineer heard the fire alarm, he went to the engine room to check and saw smoke and fire coming from the auxiliary boiler. He observed material falling down from the base of the boiler.

Assumptions and Actions

Thinking that a broken diesel fuel line was the cause of the fire, the electrician attempted to extinguish the flames at the base of the boiler with a dry chemical extinguisher, but it was no match for the flames and smoke pouring down from above. He looked up to discover the electrical cable rack above him was on fire. Next he heard a loud "whoosh" and saw dense smoke. He heard a call to evacuate the engine room and ran through thick smoke, up the starboard side ladder to the forward engine room catwalk. At the same time, both the first and second assistant engineers left the engine room.

Five-inch drain line from the HFO fuel tank vent collection chamber on the 03 level of the engine room. USCG Photo.

The electrician and second assistant engineer were sent to the fire control room to shut down the ventilation fans and fuel pumps and close the emergency fuel valves. The electrician shut down the fuel pumps and ventilation fans and closed the emergency fuel valves attached to each of the HFO and diesel oil storage and service tanks.

The third mate attempted to enter the engine room to investigate the source and location of the fire. The electrician and an AB were both outfitted with self-contained breathing apparatus (SCBA). They tried to get to the engine room through the fire door in the elevator room on the second deck, but were prevented from doing so by heavy smoke and intense heat.

When the chief mate heard the alarm, he went down to the starboard ladder to repair locker #2 and told the chief cook and chief steward to dress out in firemen's outfits. The chief mate ordered the second mate to take charge of the response team on the 03 level. When the second mate reached the 03 passageway, he found heavy smoke and intense heat. He saw smoke escaping from three sides of the fire door, which leads from the galley into the fidley.

When the chief mate got to the fire control room, he found that neither the main nor the emergency fire pump had been operating. He did not see any of the valves or pump lights energized on the fire control panel. He instructed the first assistant engineer to get the emergency generator on-line. The generators started working shortly thereafter.

The chief steward, chief cook, and steward assistant dressed out in fire suits and SCBAs and began to water the door leading from the 03 level into the fidley with two fire hoses. The group attempted to open the fire door leading into the fidley but the heat was too intense for safety. As the smoke increased in that area, the second mate ordered the team to evacuate.

After evacuating the 03 level, the second mate went to the bridge to start the starboard fire pump and access the bridge level repair locker. He then opened the port bridge wing fire station valve to provide water to cool the exterior of the exhaust stack. While his attempt to put water in the exhaust fan vent louvers failed, the second mate was able to cool the stack externally. He then attempted to close the two exhaust fan fire dampers but the smoke made this impossible. After dressing out in a fireman's uniform and SCBA, he succeeded in closing one of the two vents.

Firefighters Arrive

At this point, the chief mate directed the boatswain to assist with getting a gangway placed from the pier to the opened starboard sideport door to assist the shoreside fire team with direct access to the engine room.

Firefighters from the MOTSU fire department arrived at 4:10 p.m. and by 4:20 were onboard. They met the master near the gangway and attempted to get a muster and a summary of the fire response actions by the crew. The firefighters recommended the master use the fixed CO_2 system to help battle the fire. They then heard someone might be in the engine room. As the firemen were in fire suits and SCBAs, they entered the engine room to determine the location of the fire and attempt to rescue the missing person. The heat and smoke were too intense even with protective gear and they returned to the main deck.

Man Overboard

At this point, the first assistant engineer heard someone report cries for help. He looked over the port side and saw the wiper in the Cape Fear River near the port sideport door. The first assistant engineer ran to the port side main deck and tossed a ring buoy into the water. The wiper could not reach the ring buoy and it drifted away from him. The first assistant engineer walked forward on the main deck to follow the wiper and tossed another ring buoy with a line attached three separate times. The wiper was struggling in the water and made several attempts to reach the ring buoy but was unable to do so. The first assistant engineer saw the wiper stop treading water and fall beneath the surface of the water. He told one of the firefighters that the wiper was in the water and to call for assistance. Within three minutes of seeing the wiper sink, the first assistant engineer saw a Coast Guard utility boat approach the ship. He yelled to the boat crew to show them where he last saw the wiper.

CO_2 System Unresponsive, Low Water Pressure

The first assistant engineer then went down to the port mooring deck and was ordered by the master to release the fixed CO_2 system. He and the electrician donned SCBAs and entered the port pipe tunnel to access the fire control room together. They attempted to release the CO_2 that protects the engine room spaces by opening the two master control valves. The heavy smoke prohibited them from seeing the small "pony" bottle cylinder valves that needed to be opened to activate the system. The electrician reported to the master that they were unsuccessful in releasing the CO_2.

With additional instructions from the master, the electrician and the third mate attempted to activate the system from the CO_2 room. Two MOTSU firefighters went with them in the second attempt to activate the system. Smoke in the CO_2 room was even more intense than in the fire control room. They heard sounds and saw a change in the smoke, which they thought indicated that the CO_2 was released; later investigations showed that it was not.

Open discharge valve from HFO (Heavy fuel oil) transfer pump in the lower level of the engine room. Oil and fire damage is visible. USCG Photo.

Six firefighters took two charged hoses through the open starboard sideport door into the engine room. Shoreside fire hoses were charged by fire trucks located on the wharf and were supplied from nearby fire hydrants. The shoreside fire teams did not use any of the ship's fire hoses because pressure was too low.

Two teams of firefighters used a water and foam mixture to cool the hot spots located below the main engine in the aft sections of the engine room. About 1300 gallons of aqueous film forming foam, collected from local fire department inventories, was used to fight the engine room fire.

Evacuation

When crew members reported the emergency generators were not working and they had no water pressure to fight the fires, the shoreside firefighters ordered the crew to evacuate the ship. By then enough firefighters and equipment were on the pier to take over the firefighting duties. All told, 150 firefighters from 30 surrounding county and city fire departments responded to the fire, providing personnel support and equipment. The fire crews were successful in containing the fire to the aft sections of the engine room and preventing the heat and fire from spreading into the cargo, with its five million pounds of explosive materials.

Within six hours, the fire was under control and within 10 hours, it was completely extinguished. The 32-foot fire boat from the Wilmington Fire Department arrived on the scene at about 6:20 p.m. and personnel used its fire monitor to cool the sideshell plating on the port side of the engine room space. A 107-foot tug operated by MOTSU arrived two hours later, at approximately 8:20 p.m. The tug's crew directed the three fire monitors to cool the aft end of the engine room exhaust stack above the main deck. The fire was mostly confined within the engine room, preventing the fire tugs from having a direct impact on the fire.

After the shoreside firefighters had been working on the fire for about an hour and a half, a thermal imaging camera from a volunteer fire department was brought on board to assist their efforts. The camera revealed hot spots to the two fire teams, allowing them to attack the fire and move further aft. The camera identified the highest concentration of heat right below the main engine, on the third platform level. The fire was under control by 10:00 p.m. and entirely out by 1:30 a.m. on July 15.

Total damage to the ship was estimated at $15 million dollars. Two lives were lost in this incident. The third assistant engineer died of smoke inhalation and the wiper drowned in the Cape Fear River. The third assistant engineer was working on the third level deck when the fire broke out. The coroner's report stated that he died of smoke inhalation. The wiper apparently jumped out the sideport door to flee the fire and was unable to tread water or to swim to the two life rings that were cast to him. The Coast Guard vessel was unable to find the wiper in the river.

Contributing Factors

Several situations contributed to the cause of the fire and complicated its containment. A device that monitors the storage tank overflow had been malfunctioning for several weeks, causing false alarms. The alarms had been disabled and did not alert the crew that the storage tanks were overfull. The engineers knew about this situation, but did not attempt to repair it, nor did they alert the master to the situation. These actions bypassed critical safety features of the system.

The engineers disconnected a venting pipe for maintenance two days prior to the fire and it was not reconnected before starting the transfer of fuel. No warnings were placed to prevent using the HFO transfer pumps while the vent was disconnected. The engineers failed to trace the lines they were disconnecting or to notify the master that they were performing such maintenance. A great deal of damage from the fire was found in the area where the disconnected vent pipes were located.

A pencil wedged into the High Tank Level Indicator audible alarm panel. Position of pencil holds switch in "Acknoweldge" position. The alarm would never sound to warn of a high tank level when the switch was in this position. USCG Photo.

The heavy smoke that accompanied the fire prevented access to some of the firefighting equipment on board and also hindered efforts to extinguish the fire. While the steward crew members followed their fire drill instructions, the engineering crew could not meet at their designated place because of smoke. This crew was not prepared with an alternate course of action.

Two sideport doors on the vessel were left open for ventilation and, consequently, did not contain the fire within the engine control room. On the plus side, these doors provided direct access to the engine room for the shoreside firefighters to attack the fire.

The master delayed orders to use the low-pressure CO_2 fire suppression system, which might have suppressed the fire much earlier. While crew members made two attempts to activate the fire suppression system, apparently the CO_2 was never released. The release of the system is dependent on electrical power, which is often unavailable in a fire emergency. The system also required a three-step process to activate, which crew members found awkward to implement. Finally, even though instructions for activating the system were displayed, the heavy smoke coming from the fire made reading and following those instructions impossible. The open sideport doors would have made the CO_2 system less effective in suppressing the fire because of a lack of containment.

Despite having held a fire drill the very morning of the fire, testimony at the investigation revealed many crew members did not follow their prescribed activities or report to their designated stations. A general failure

Fire damage to equipment and gear on the 03 level of the engine room. USCG Photo.

of leadership during the crisis contributed to confusion and delays in dealing with the fire. The failure of the master to muster the personnel may have delayed rescue attempts for the third assistant engineer. While local firefighting support arrived quickly to the *Carter*, the fire tug from MOTSU took three hours to reach the site.

Recommendations Made and Actions Taken by the Coast Guard

As a result of this incident, the investigating officer recommended 13 items for maintaining safety and preserving lives aboard vessels of this nature. Those recommendations included:

- American Bureau of Shipping training programs to keep surveyors familiar with fixed firefighting systems (especially the low-pressure CO_2 systems);
- that vessels with sideport doors that form part of the hull, have the ability to close from remote positions;
- the MOTSU fire brigade obtain a thermal imaging camera to locate hot spots in vessels in port;
- the USCG Marine Safety Office in Wilmington and MOTSU work to reduce the response time for MOTSU's fire tug from four hours to one;
- that appropriate offices determine which ships still use the low-pressure CO_2 systems and notify the owners of the potential problems with them.

Actions Taken:

In response to this incident the following actions have been taken:

- Modifications to the surveyor's instructions for vessels of this type have been presented.
- The *SSG Carter* has installed a system to close the sideport doors remotely.
- The MOTSU fire brigade obtained a thermal imaging camera.
- The Marine Safety Office and MOTSU have reduced the response time for the fire tug from four hours to one.
- The Coast Guard issued a safety alert in March 2002 concerning problems with low-pressure CO_2 systems and notified owners of similar class vessels of potential problems with the system.

Disciplinary actions taken

The second assistant engineer agreed to a two-year suspension of his license and agreed to undertake additional firefighting training. The chief engineer had his license revoked for misconduct. There was no action taken against the master.

Lesson Learned

While the untended transfer of fuel oil is the primary cause of this casualty, many factors contributed to the engine room fire and subsequent events. The method of dealing with the tank level indicator and false alarms prevented personnel from having accurate information about the storage tanks. A lesson to be learned from this is that alarm and safety devices are placed in systems for a purpose, and engineers and crew bypass them at their peril.

Despite having documented reviews of procedures, many of the ship's crew failed to attend to their required duties or man their stations during the fire emergency. A general lack of leadership by the master delayed appropriate responses. Fire drills and training need to be taken seriously and held frequently. Crew members need to be familiar with their duties during a crisis and able to perform them without fail.

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Lessons Learned from

Casualty Investigations

Painful Lessons after the Fact

Queen Isabella Memorial Bridge allision sends a call to towing operators for best practices.

by Ms. Daisy R. Khalifa
Special Correspondent to *Proceedings*

When the Queen Isabella Causeway Bridge in Texas officially became the Queen Isabella Memorial Bridge in March 2004, the name change served as a poignant reminder of the hazards of maritime life. Those particularly aware of why the bridge had been renamed include a patchwork of individuals—among them, U.S. Coast Guard personnel, federal and Texas state officials, commercial towing operators, those with interests in South Padre Island tourism, and, most importantly, the friends and family of the people for whom the bridge has now become a tribute.

The circumstances surrounding the collapse of three piers along the bridge on September 15, 2001, are both frightening from a human interest perspective and laden with reasons that reinforce the Coast Guard's stepping up its regulatory role in commercial towing. Indeed, many of the recommended measures based on the investigation of the allision between the barge tow M/V *Brown Water V* with the Queen Isabella Causeway, in which eight people were killed after driving off the severed bridge, consistently return to enforcing strict rules for inland waterway towing vessels and their operators.

Traffic demonstrates the vital lifeline the bridge/causeway is between South Padre Island and the Rio Grande Valley. Photo courtesy of Valerie D. Bates, Rio Bravo Gallery.

According to the investigation, the apparent cause was ultimately the negligence of the towing vessel's relief pilot. However, three subsequent agency endorsements emphasized the role of contributing factors, among them how strong currents affect massive barges, as well as towing vessel limitations that can arise with certain barge configurations. Other key navigational and transportation issues were also addressed. These included the installation of driver alert mechanisms along the Texas bridge, voyage planning analysis procedures, and enhanced anchoring standards. But for the most part, the report and the endorsing memos sent a strong message to the private towing industry calling for improved voyage planning in intracoastal waterways.

Coast Guard Cutter *Mallett* crewmembers and Department of Public Safety personnel survey the damage done to the Isabella Causeway near South Padre Island, Texas, September 15, 2001. A tug pushing four barges allided with the causeway, causing 10 cars to fall into the water. CWO2 Robert Wyman, USCG.

The Incident

In the dark, early morning hours of September 15, 2001, the *Brown Water V* was pushing four loaded hopper barges in single file through the channel between the Texas mainland and Long Island. The channel moves into the Laguna Madre ("Mother Lagoon") before entering a bend, toward the Queen Isabella Causeway Bridge. The bridge carries the only road that connects South Padre Island, a popular Texas tourist destination, to the mainland.

The vessel departed from Brownsville, Texas, earlier that evening, under the control of the vessel's pilot; at midnight the relief pilot took the helm. The vessel was headed northeast along the waterway, where it would clear the Long Island Swing Bridge at 1:45 a.m. and enter into the Laguna Madre channel. Exactly 15 minutes later, it veered west of the navigation channel and allided almost head-on with the Queen Isabella Causeway Bridge.

There was some damage to the alliding barge, but no flooding. USCG Photo.

The towing vessel's four barges, which carried nearly 3,000 tons of steel and phosphates, collided with the piers that support the bridge, which caused the collapse of two 80-foot sections. This collapse caused vehicles to plunge 85 feet into the water, through the missing bridge sections, resulting in eight deaths and three injuries. The first barge snapped upon impact, and currents forced the vessel and remaining barges westward, away from the allision point. Later that day during the rescue search, a third section of the bridge collapsed but caused no injuries.

The Investigation

Hearings over the allision between the *Brown Water V*, which is owned and operated by Brown Water Marine Services Inc., and the Queen Isabella Causeway commenced almost immediately following the event. The damaged bridge, which is the longest in Texas at 2.37 miles, crippled the economy of South Padre Island in the three months that it remained closed for repairs, according to a report in the *Corpus Christi Caller-Times*.[1]

The "One Person Formal Board of Investigation" report examined nearly 20 separate topics to declare an ultimate, single determination of the apparent cause. As stated in the report: "The apparent cause of this casualty was [the relief pilot's] failure to exercise reasonable care according to the standards of the ordinary practice of good seamanship." The section concludes with the statement: "There were no contributing causes to this casualty."[3]

The report spurred a fair amount of discourse during the subsequent formal approval process regarding the final conclusions of the report of investigation. Ultimately, upon final approval that served to officially close the investigation, the Commandant supported the Commander, Eighth Coast Guard District Marine Safety Division's opinion that, while it agreed with the report that "[the relief pilot's] negligence was the root cause of the casualty… the [Division] disagrees with the investigating officer's and the experts' opinions that the strong currents, high tide, and horsepower limitation of the M/V *Brown Water V* weren't contributing factors to the cause of the accident."[4]

This line of thinking, dealing with tide and current conditions and the notion that "strong currents and their influence cannot be ignored"[5] and that "the current and tide were contributing factors,"[6] served to underscore what, in addition to other operational issues, everyone ultimately agreed upon beyond the fate of the relief pilot himself: Enhanced voyage planning requirements must be enforced for the towing vessel industry.

Analysis

The investigative report's findings of fact examined in detail 17 topics to disclose all material facts related to the casualty. Among the topics were:

- records of the dead and injured;
- parties of interest;
- the vessel's crew;
- drug and alcohol testing;
- the vessel and its barges; and
- the bridges' vicinity and its history.

Also reported at length were the weather conditions, current direction, current speed and, of particular note, setting up for the currents. These sections of the report spurred further examination in the endorsing memos about whether or not strong currents, high tide, and horsepower limitations of the vessel were contributing factors to the allision.

The vessel's route under discussion is an area in the Gulf Intracoastal Waterway that runs in a general north-south direction along the Texas coast and includes a channel between Long Island and the mainland. The *Brown Water V* traversed a section of the Gulf Intracoastal Waterway that runs north from the channel entrance at the south end of Long Island known as the "Y" because it is shaped like an upside-down "Y." The route continues up the channel to the Long Island Swing Bridge that connects Post Isabel to Long Island, at roughly the north end of Long Island. This entire section of the channel is known locally as the "S" curve due to its shape. From the Long Island Swing Bridge, the channel then moves into the Laguna Madre before it enters a bend toward the Queen Isabella Causeway Bridge.

According to the analysis, when the vessel entered the "Y" at the south end of the "S" curve between the mainland and Long Island, "[the relief captain] did not know the channel current in the 'S' curve was running hard at the time."

As the vessel continued northbound into the channel between the Long Island Swing Bridge and the Queen Isabella Causeway Bridge, the analysis stated that "the vessel and its tow were being pushed in an east to northeast direction by the hard running channel current. The speed of the channel current is a direct indicator of the speed and force of the flats crosscurrent that the M/V *Brown Water V* and its tow were about to enter. "

Coast Guard Cutter *Mallett* crewmembers take a look at a car that was damaged when the Isabella Causeway collapsed September 15, 2001. CWO2 Robert Wyman, USCG.

The analysis continues: "As the head of the tow passed Long Island and the spoil area east of the island and neared aid 149, the flats currents began working on it. The vessel and tow were now being affected by two separate currents—a hard running channel current, pushing the entire configuration northeast, and a flats current, pushing the head barge northwest. As the 851-foot long vessel and tow configuration sailed past the current-sheltering island and spoil area, the inrushing flats crosscurrent increased its effect, and the head of the tow began swinging to port. Because [the relief pilot] was not aware of the crosscurrent and had not set up for it, the converging currents overwhelmed the configuration."[7]

The analysis was supported from a consensus opinion of four experienced mariners who served as expert witnesses. Among them, a captain familiar with the area and the facts surrounding the casualty, a forensic marine engineer, and two towing vessel operators. Three of the expert witnesses agreed with the testimony of the fourth witness, which describes how the vessel's barge reached a point of impact with the bridge in the following manner:

"The head of the tow continued swinging northwest in response to the increasing effect of the flats crosscurrent, while the stern of the towboat continued to be pushed northeast by the channel current. This swinging action pivoted the stern of the *Brown Water V* into the shallows on the east side of the channel near aid 149. Whether or not the towboat bumped bottom, this pivoting action had taken control of the configuration and the flats crosscurrent swept the configuration west, out of the channel and into the bridge."[8]

Other Factors

The relief pilot, who was the only person who had information about the events in the minutes before the allision, gave three pre-hearing statements, but chose to exercise his Fifth Amendment right not to testify at the formal hearing. He stated he was in the channel when he bumped bottom. However, because there was no place in the channel that was less than 12 feet deep and the *Brown Water V*'s draft was 8 feet, six inches, it was likely, according to the report, that, when he stated he was in the channel, he meant he was between the red and green aids to navigation. The red and green aids to navigation do not define the edge of the channel.[9]

The analysis stated that, while the relief pilot knew where the channel passed under the bridge, he was not to the point of trying to pass under the bridge when he lost control. He was not lining up to center the vessel under the bridge but was trying to make a bend in the channel, using Coast Guard aids as reference points. The report concludes that the green channel centering lights were not a cause or contributing cause to the casualty and that "the current was a factor but not a contributing cause."[10]

In the six months prior to the September 15 casualty, the current speed, which was determined to have been "running hard," had equaled or surpassed that on three occasions. Comparing the methodology and judgment of other towing vessel operators, who were familiar with the "S" curve prior to entering the bend before the Queen Isabella Causeway Bridge, was an important means by which the investigator assigned sole cause of the casualty to the vessel's relief pilot.

Among those who testified was the M/V *Brown Water V*'s pilot, who was off-duty and asleep aboard the vessel on the morning of the casualty. The captain testified about the importance of knowing the currents prior to entering the curve before the bridge. "If you didn't set up right, you could lose it in there," he said.[11]

The expert witness familiar with the channels in that area testified on setting up for the currents, stating that, "In my opinion, anybody that runs in there ought to know which way the current is running." The pilot of the M/V *Bruce Bordelon*, which made the transit northbound to the Queen Isabella Causeway five hours before the *Brown Water V*, also testified that he "tried to get all the information he could concerning the current prior to entering the curve before the [bridge]."[12]

Based on these testimonies, the report illustrated the critical matter of a vessel operator's accountability and arrived at the conclusion in his analysis that "the current was foreseeable by a prudent mariner and the casualty was not inevitable." The Coast Guard investigator invoked the decision of Michael Hugh Quinn, Vice Commandant on Appeal, U.S. Coast Guard, 2217, in which Quinn stated: "An accident is said to be inevitable not merely when caused by an act of God, but also when all precautions reasonably to be acquired have been taken, and the accident has occurred notwithstanding."[13]

Conclusions

The incident report arrived at eight separate conclusions concerning the casualty. Of the vessel itself, the report concluded that the vessel's equipment did not contribute to the casualty; that it was capable of han-

The construction site for the Queen Isabella Causeway Bridge came to be known as "barge city" to the crew. Photo courtesy of Valerie D. Bates, RioBravo Gallery.

dling the tow as configured and that the configuration did not contribute to the casualty; and that the vessel had sufficient horsepower to safely navigate through the Queen Isabella Causeway, if suitable precautions had been undertaken prior to entering the bend.

Furthermore, said the report, in spite of the fact that two green navigation channel centering lights beneath the causeway were not lit, they did not contribute to the casualty; nor did the Coast Guard, whose aids to navigation were on-station and working properly. As for physical conditions in the channel, the conclusions stated that the channel was the proper width and depth at the time and did not contribute to the casualty. Additionally, the report stated that "the channel between the Long Island Swing Bridge and the Queen Isabella Causeway Bridge is subject to crosscurrents and can be subject to hard-running crosscurrents. Either of these, by themselves, could cause a problem; both together could increase the problem."[14]

In the report's final conclusion, the relief pilot was held responsible. The report stated: "As a licensed operator, [he] was responsible for ascertaining that his vessel could safely traverse the planned route. This included knowledge of the state of the currents…[The relief captain] took no steps to determine the conditions, especially the current and crosscurrent, prior to proceeding into the bend."[15]

The report included a recommendation to revoke the relief pilot's Coast Guard-issued license, which he had held for 12 years. Shortly after the accident, the vessel operator surrendered his license. The Coast Guard did not pursue criminal charges against him.

Lessons Learned, Recommendations, and Repercussions

Of the reports' four recommendations, three of which involved disciplinary action against the relief pilot and another crewmember, one recommendation advised distributing the report to area agencies and entities for possible bridge protection action. In the time that the report took to be completed, particularly during the fact-finding hearings early on, many parties, including attorneys for the owner of the *Brown Water V*, questioned the overall safety in the Laguna Madre of the "S" curve on the approach to the bridge.

Another article in the *Corpus Christi Caller-Times* shortly after the incident referred to discussions among maritime and legal experts about straightening the ship channel to eliminate the "S" curve near the bridge and placing a current meter in the channel to alert mariners of unusually high currents. Coast Guard officials stated that "buoys lining the channel were moved into shallower water to accommodate the wide turns mariners must make there," to which attorneys for the vessel's owner said, "…The curve and the buoys induce mariners into shallow waters and [they] called the curve an accident waiting to happen."[16]

To that end, a final point within the analysis of the investigation about the location of the Queen Isabella Causeway Bridge should not be overlooked. Citing a 1980 Army Corps of Engineers' publication, "Engineering and Design—Layout and Design of Shallow-Draft Waterways," the investigative report highlights a section, which stated in part, "as a general rule, bridges should not be located in a bend, just downstream of a sharp bend, or where crosscurrents can be expected."

The last comment within the analysis reflects more on that important point:

"…While this casualty was caused by the failure to set up properly, mechanical failures such as a loss of steering or loss of power could result in a similar catastrophe anytime the current is running hard and despite the degree of care exercised by the vessel's operator."[17]

The recommendations provided by the report's expert maritime witnesses included immediate, tangible improvements. They suggested installing a tidal current meter and warning signs; widening the channel; mandating extreme current closings; installing moorings for tows in extreme tidal currents; and installing allision prevention cells around the channel approaches. They also recommended two short-term solutions: limiting tow length on eastbound, nighttime transits until a permanent solution is applied and installing current warning signs.

Good Seamanship Makes Good Commerce

In the endorsement by the commander of the Eighth Coast Guard District, the issue of enhanced voyage planning requirements was strongly encouraged. This recommendation was reiterated in the Commandant's Action. Cited was an earlier regulatory proposal "directly connected to this particular case"[18] on "Fire Suppression Systems and Voyage Planning for Towing Vessels" from the 1997 Notice of Proposed Rulemaking.

The proposed regulations required that companies keep documented policies and procedures in place to address decision-making criteria related to risk and route analysis of voyages. Five of the proposed requirements could have prevented the casualty, said an endorsement memo.

Included are such regulations as requiring thorough reviews of navigation charts for intended routes; forecasted weather conditions; extracts from tide and tidal current tables; intended speed and estimated times of arrival at anticipated waypoints; and Master's standing orders for closest points of approach, special conditions, and critical maneuvers.

However, at the time the endorsement was written in late 2003, this proposed set of rules from 1997 was only applied to towing vessels operating in unprotected waters, beyond the baseline of the territorial sea. "In light of the accident," said the memo, "we recommend that Commandant reconsider applying the voyage planning requirements to all towing vessel voyages." The Commandant's memo then outlined the means by which the actions would be enforced.

The final endorsements to the report of investigation by both the Commandant and the Commander, Eighth Coast Guard District through the formal approval process of the investigation, played an integral part in rounding out the report's conclusions that otherwise pointed largely at [the relief pilot]. While, indeed, the pilot's negligence was the central cause, the report's additional data provided meticulous insight into other important factors surrounding the event. Relying on the report's comprehensive data, the endorsements made sure to place a fair amount of emphasis on the important circumstances that aggravated the cause of the casualty, such as current conditions, vessel horsepower, and barge configuration, to further illustrate the possible consequences of poor planning combined with the unforeseen forces of nature.

About the author: *Ms. Daisy Khalifa is a freelance writer and has worked in the communications field for 17 years. She has written feature and business articles for a variety of publications covering law, technology, telecommunications, real estate, architecture and history. A native of California, Ms. Khalifa lives in Arlington, Va.*

Endnotes

[1] *Corpus Christi Caller-Times*, by Lety Laurel, Oct. 9, 2001.
[2] *San Antonio Express-News*, by Macarena Hernandez, May 7, 2005.
[3] U.S. Coast Guard, One Person Formal Board of Investigation, Allision Involving the M/V *Brown Water V* and the Queen Isabella Causeway Bridge, September 15, 2001, Gulf Intracoastal Waterway, Port Isabel, TX, by James Wilson, (Report and Commandant's Action released, April 28, 2005), page 25.
[4] Corpus Christi Caller-Times, by Lety Laurel, Oct. 9, 2001.
[5] San Antonio Express-News, by Macarena Hernandez, May 7, 2005.
[6] U.S. Coast Guard, One Person Formal Board of Investigation, Allision Involving the M/V *Brown Water V* and the Queen Isabella Causeway Bridge, September 15, 2001, Gulf Intracoastal Waterway, Port Isabel, TX, by James Wilson, (Report and Commandant's Action released, April 28, 2005), page 25.
[7] Wilson report, page 22.
[8] Wilson report, page 20.
[9] Wilson report, page 23.
[10] Wilson report, page 23.
[11] Wilson report, page 19.
[12] Wilson report, page 19.
[13] Wilson report, page 24.
[14] Wilson report, page 25.
[15] Wilson report, page 23.
[16] *Corpus Christi Caller-Times*, by Jeremy Schwartz, Oct. 12, 2001.
[17] Wilson report, page 24.
[18] Endorsement by the Commander, Eighth Coast Guard District, December 5, 2003, page 4, item #5.

Sunset view of the rebuilt Queen Isabella Causeway Bridge. Photo courtesy of Valerie D. Bates, Rio Bravo Gallery, 2002.

Rock Ahoy!

The grounding of the *Waters*.

By Petty Officer Sara Francis
U.S. Coast Guard, 17th District Office of Public Affairs

A beeper went off in the dark. LT Danielle Wiley, supervisor at the U.S. Coast Guard Marine Safety Detachment in Kodiak, Alaska, looked at the clock. The red 3:00 a.m. beamed. There had been another grounding.

The Grounding

It was June 18, 2004. The Alaska State Trooper vessel *Cama'i* left St. Herman's Harbor in Kodiak at 9:35 a.m. An hour later, Wiley and I were in the Ouzinkie Narrows. It was raining hard. Fog was thick. The GPS indicated the grounded boat's position nearby. All at once the fog shifted, like someone had pulled back a curtain. In front of us rested the 70-foot wooden boat *Waters*. Its bright blue hull loomed on the rock pinnacle. It was almost perfectly upright, as if Neptune himself had set it there (Figure 1). We circled the scene carefully. The Number 4 dayboard was broken off the mounting. It lay on the rock. Blue hull paint was visible on its red surface.

The crew of the *Waters* had been en route to Kodiak from a lodge on the Katmai Coast to pick up supplies. The tide was high at the time, nine and a half feet. The skipper stated later that he had slacked the boat's speed in the narrows because of the weather, and that his reduced maneuverability, combined with the tidal current to drag the boat sideways onto the rock. He said the strong eddy

Figure 1: The *Waters*, aground. Petty Officer Sara Francis, USCG.

Aids to Navigation

"Twelve feet, 10 feet!" A watch stander on the focsle of the ship called back to the bridge. "Eight feet" was the next cry. The 225-foot black hulled ship loomed closer to the massive rock that lay ahead. Twenty-knot winds and rain slapped the crew on the weather decks and the four-man team on the rock. "Three feet!" The 2,000 ton ship came to a halt. Not quite a year after the *Waters* grounding, the crew of the Coast Guard cutter *Spar* and the Aids to Navigation Team, both out of Kodiak, repaired the day-board.

Executive officer, LT Shawn Decker, was piloting the Kodiak-based cutter *Spar*. The cutter is equipped with a single controllable pitch propeller, bow and stern thrusters, which give it the maneuverability it needs to tend buoys offshore and in restricted waters. This was a particularly tricky bit of navigation. Prior to approaching the rock, the crew deployed a small boat and made exact soundings of the area near the rock with the small boat's fathometer. On approach to the rock, the cutter crew had deployed the anchor. By catching and dredging, they used the anchor as a tether to keep the vessel from surging forward to wreck the ship on the rock that had damaged many other vessels. The dayboard now sits about six feet higher than before. It is more visible in high tides, and debris doesn't drift into the dayboard, damaging it.

had surprised him, because he had found no mention of it in his copy of *The United States Coast Pilot*. He also said the dayboard wasn't visible until the *Waters* was upon it.

He and his crew had smartly plugged the fuel vents before departing for the nearby Ouzinkie village in a skiff. They arranged for salvage with a local operator, but he had no luck the following morning in a high tide just over nine feet. Next, the fishing vessel *Alpine Cove* tried to tow the *Waters* off the rock, but the current prevented steering and put too much strain on the tow-line. Finally—several days after the grounding—the tug *Kodiak King* got the *Waters* off the rock in a nine-foot tide. The damage consisted of an inch-deep penetration in the hull, caused by the day-board's stub. Water seeped through the damaged caulking. Divers from the nearby village made temporary repairs, and the *Waters* sailed to Kodiak, where the staff at Fuller's Boatyard hauled it out and replaced the broken board.

Follow-up

Meanwhile, Wiley thought about what the skipper had said: He believed the cause of the grounding was tricky currents combined with scant information in *The United States Coast Pilot*. It's a series of nine volumes that contain supplemental information hard to display on a nautical chart, compiled by a division of the National Oceanic and Atmospheric Administration. You can order the *Coast Pilot* or download parts of it from the Office of Coast Survey (chartmaker.ncd.noaa.gov/nsd/coastpilot.htm).

Near the rock where the vessel grounded, the *Coast Pilot* indicates that currents can set a boat into danger quickly—but it doesn't elaborate on tidal direction. What's worse, the deepest water lies just off the rock, so the *Coast Pilot* recommends favoring the rock, over the nearby shoals. Add to that some recent tectonic activity, and it was possible that changes in the hydrography had altered the flow of water in the narrow passage.

Wiley eventually determined that the skipper's decision to enter the narrows during a period of extremely limited visibility was the cause of the grounding. The decision required reduced speed, which reduced the boat's maneuverability. This particular skipper should have known better, since he was familiar with the area. He even mentioned having towed other vessels off the same rock.

To prevent future accidents, Wiley contacted NOAA and suggested providing additional information about the currents in the *Coast Pilot*. Until the updated version of the *Coast Pilot* becomes available, the best advice for recreational boaters is to pay attention to tidal charts, watch the currents, and sail only with good visibility.

About the author. *PO Sara Francis enlisted with the Coast Guard in 2000 after high school. She is now a first class petty officer and works in Public Affairs. Prior to Public Affairs she was a small boat engineer in Northern Michigan. Four of her five years have been served in Alaska. She currently lives in Anchorage with her husband and daughter.*

Two Teams Can be More Efficient Than One

U.S. Coast Guard, Customs and Border Protection team up to board oil tanker.

By Petty Officer Sara Francis
U.S. Coast Guard, 17th District Office of Public Affairs

The white truck moved down the highway to the Coast Guard Marine Safety Office. Petty Officer Clint Mooers was going to pick up his gear and his partner for a vessel boarding in Nikiski. "We have a high wind warning in effect for Turnagain Arm and the higher elevations," chimed a man on the radio. Mooers knew that the flight to Kenai would be bumpy.

The Preparation

Once armed, Mooers and partner Petty Officer Brady Osborne met the rest of the boarding team at Security Air near the Ted Stevens International Airport. The Customs and Border Protection (CBP) officers were Jack Glover and David Kumpost. Brian Kreowski, an agriculturist with CBP, was also with the team. A security boarding is an examination of a vessel (including the cargo, documentation and persons onboard) carried out by an armed boarding team to deter acts of terrorism and/or transportation security incidents.

CBP is mandated to board any vessel that is a foreign arrival. When CBP and the Coast Guard need to board the same vessel, it makes sense to combine the two into one team. A Coast Guard boarding team consists of at least four members. By using members from both services, the total number from each service can be reduced, allowing more total manpower to be available. Combined teams expedite the boarding process for the Coast Guard, CBP, and the vessel crew, by allowing all the issues to be addressed simultaneously. Additionally, the vessel crew only needs to stop their routine once to accommodate a boarding team.

"It's a good chance for us to cross-train and develop partnerships," said LT Tim Callister, chief of port security at the Marine Safety Office. "By becoming familiar with other agencies' procedures, we are able to identify potential discrepancies and notify appropriate personnel for action."

There are several benefits to combined Coast Guard/CBP boardings. U.S. Coast Guard and CBP

Figure 1: Petty Officer Clint Mooers is the last to board the Securities Air flight to Kenai. Petty Officer Sara Francis, USCG.

jurisdictions are different but complementary. The Coast Guard's main interests are security and safety. CBP officers process the cargo, enforce the Immigration and Naturalization Act, and look for agricultural concerns. PO Osborne added that when Coast Guard personnel augment CBP teams, this gives more effective officer safety, since CBP teams are usually two to three personnel. When the team breaks off to accomplish their missions, no one has to be on their own on the vessel.

The Boarding

The five-man team boarded a twin prop plane and strapped in (Figure 1). It was 9:30 a.m. The sun wouldn't rise for another half-hour. As soon as the plane was airborne, the high winds began to toss it around. The team would land in Kenai, after about a 20 minute flight, and then drive another 15 minutes to Nikiski to board the ship, *Angelica Schulte*. The *Angelica Schulte* is one of two crude oil tankers in the Vorsetzen Bereederungs- und Schiffahrtskontor GmbH & Co.'s fleet. It is the company's newest ship, launched in 2005. The vessel is flagged out of Liberia, with its homeport in Monrovia, Liberia. The crew is comprised of men from Romania, Venezuela, Latvia, Russia, Ukraine, and the Philippines.

The 797-foot tanker rested at the Kenai Pipeline Dock (Figure 2). As the team approached, they surveyed the vessel. A black and red hull, two stories high, with a green deck greeted the men. As they came onboard, a crewman signed each member into the ship's security log, checked their identification, and issued them a guest badge (Figure 3).

Figure 2: Petty Officer Brady Osborne surveys the vessel *Angelica Schulte* from shore. Petty Officer Sara Francis, USCG.

The sun had just begun to rise and the green decks gleamed. The crew joked that the snowfall during the voyage had washed the deck clean. Another crewmember led them to the interior of the ship. On the second deck of the superstructure, the team was met by the captain, and PO Osborne delved into a box of passports and began verifying the crew's identifications, checking each passport against the crew manifest and the ship's advance arrival notification report (Figure 4).

Inspection

During the examination process, each passport is closely examined for authenticating markers like security fibers and holograms and for telling errors, such as misalignments, misspellings, and mismatching inks. Finally, the photos are compared to the passport holders in person.

All 20 crew members were present and had proper documentation: either a D1 or a D2 visa. The visa allows the holder to conduct business in the U.S. for a period of 29 days. The holder must then leave when his business is concluded or when the 29-day period is up, which ever comes first. A D1 visa is used for a person who enters and leaves the U.S. on the vessel. A person disembarking the ship permanently and returning to another country requires a D2 visa.

The Coast Guard teams check logs (Figure 5), crew manifests, security plans and procedures, and visually inspects safety equipment. Although checking safety equipment is not related to security, it is part of the Coast Guard's mission to maintain the safety of life at sea. Boarding teams do not include marine investigators, so if a major violation is noted, it is immediately reported to the COTP. Coast Guard members can enter any common space. To enter a private space, they must have the permission of the crew or have probable cause that a violation of a federal law is being committed. CBP officers, on the other hand, have border search authority and can search any space they deem necessary.

PO Mooers and CBP officer Glover made rounds of the ship, starting on the bridge and working their way down to the engine room. The captain escorted

Figure 3: A crewman aboard the 797-foot *Angelica Schulte* checks Petty Officer Clint Mooers' identification, while Petty Officer Brady Osborne signs the ship's log. Petty Officer Sara

Figure 4: CBP Officer David Kumpost and USCG Petty Officer Brady Osborne process a box full of passports aboard the *Angelica Schulte*. Petty Officer Sara Francis, USCG.

Figure 5: Petty Officer Clint Mooers reviews the logs with Captain Marian Mihalcea. Petty Officer Sara Francis, USCG.

them to the bridge, where Mooers reviewed the log and continuous synopsis report. He verified that the crew had conducted their pre-arrival checks, and that the logs were synchronized. The chief security officer took the men on a tour of the vessel, to verify that all of the restricted spaces were locked and safety equipment was in compliance. After walking the length of the main deck and inspecting the boatswain's store, the chief engineer took the two into the engine room.

A space the size of a small basketball court and three stories high, engineering was immaculate. Mooers couldn't find an oil spot (Figure 6). The 14,000 Kilowatt Sulzer engine looks like a Rolls Royce in the center of the room, silver and shining. A maze of white catwalks carries crewmembers to each level.

In the spare parts room, Glover rifles through some bags of rags and a few parts boxes, looking for anything out of the ordinary, but comes up empty-handed. The crew was eager to show off their vessel and answer any questions. The team inspected the shop room and the control room, before meeting up with the rest of the boarding team. Each space is uber-tidy.

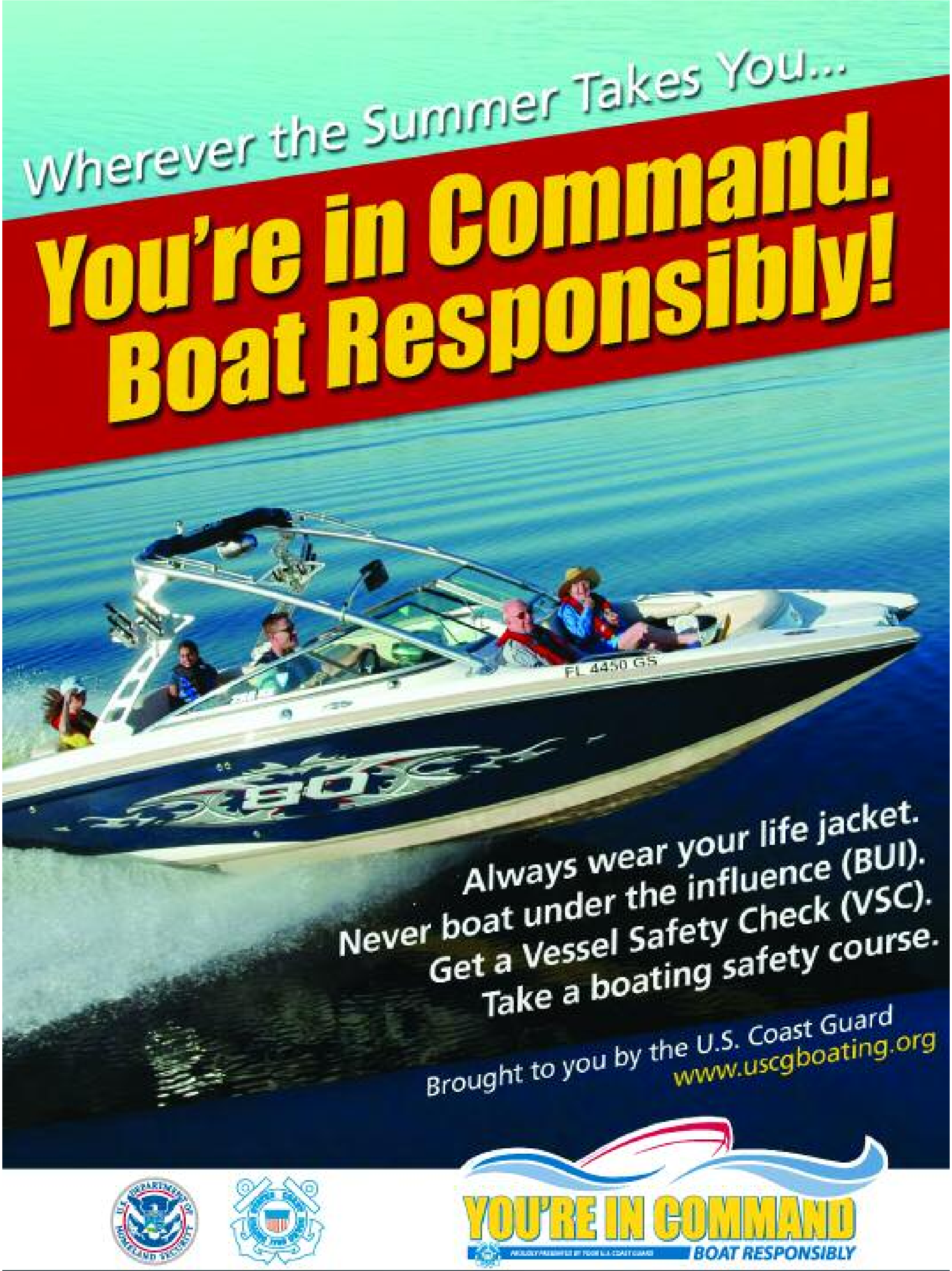
While the others are engaged in their missions, the CBP agriculturist Kreowski makes his rounds in the galley, stores area, and takes a look at the ship's trash. Agriculturalists are trained to look for potential pest threats. These may be rats or insects, such as the Asian Gypsy Moth. The moths are a threat to North American forests. Other insects can threaten crops and orchards. With the current concerns about bird flu, agriculturalists document any kind of poultry onboard. The crew is allowed to have just about any type of food, as long as it stays onboard the vessel.

Finally, the team inspects the trash to make sure it's being regulated. Trash must be either stored or incinerated onboard. If trash needs to be offloaded, the team makes sure it's taken to a regulated landfill.

Its mission accomplished, the boarding team found all the paperwork and spaces to be in order. The *Angelica Schulte* crew was cleared to load petroleum from the Kenai Pipeline and headed for the next port of call.

About the author. *PO Sara Francis enlisted with the Coast Guard in 2000 after high school. She is now a first class petty officer and works in Public Affairs. Prior to Public Affairs she was a small boat engineer in Northern Michigan. Four of her five years have been served in Alaska. She currently lives in Anchorage with her husband and daughter.*

Figure 6: Officer Jack Glover follows Chief Engineer Guido Caseres through the *Angelica Schulte* engine room. Petty Officer Sara Francis, USCG.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MARINE CREDENTIALS

AS OF DEC. 31, 2005

As planned, Proceedings is again publishing statistics on the make-up of U.S. merchant marine personnel. This is the second year that we have published statistics of this type. Previous statistics appearing in Proceedings (those that were published annually until 1995) were based on the licensing transactions executed by the Regional Examination Centers and amounted to workload measures that could not be used to provide a breakdown of the U.S merchant marine population and its qualifications. The numbers provided with this article represent mariners with the qualification indicated as of December 31, 2005.

As noted last year, it is not possible in the space available to list all of the alternative combinations of credentials issued by this complex program. We have patterned the listed categories after previous reports, and it is our hope that these provide sufficiently informative detail. Where qualifications are in transition (for example, the transition from Operator Uninspected Towing Vessel to Master Towing) and there are mariners holding both qualifications, they have been combined.

Please Note: Many mariners hold more than one qualification. The numbers presented here endeavor to capture all of those qualifications. For example, a mariner holding a license as a 1600-ton Master and an Unlimited Second Mate, would be counted in each category. Similarly, a Chief Engineer, Steam and Motor, is counted in each propulsion category.

We hope this breakdown is useful to you and welcome your suggestions for improvements.

U.S. Merchant Marine: Summary Statistics

	TOTAL	WITH STCW
Mariners with an MMD only	67,637	16,582
Mariners with a license only	99,023	4,157
Mariners with both a license and an MMD	41,343	27,790
TOTAL	208,003	48, 529

U.S. Merchant Marine: MMD-holder Statistics

	TOTAL
Mariners with one or more qualified Deck Dept. ratings	36,007
Mariners with one or more qualified Engine Dept. ratings	16,406
Mariners with any Tankerman rating	18,069
Mariners with only entry–level ratings	39,560
Mariners with only entry–level ratings + lifeboatman	2,684

Licensed Deck Department

Description	Number of Mariners
Master Ocean Any Gross Tons	3,393
Master Near Coastal Any Gross Tons	87
Chief Mate Ocean Any Gross Tons	833
Chief Mate Near Coastal Any Gross Tons	2
Second Mate Ocean Any Gross Tons	1,578
Second Mate Near Coastal Any Gross Tons	7
Third Mate Ocean Any Gross Tons	3,367
Third Mate Near Coastal Any Gross Tons	100
Master Ocean Not More Than 1,600 tons	5,213
Master Near Coastal Not More Than 1,600 tons	2,644
Mate Ocean Not More Than 1,600 tons	288
Mate Near Coastal Not More Than 1,600 tons	926
Master Ocean Not More Than 500 tons	568
Master Near Coastal Not More Than 500 tons	1,118
Mate Ocean Not More Than 500 tons	64
Mate Near Coastal Not More Than 500 tons	173
Master Ocean Not More Than 200 tons	173
Master Near Coastal Not More Than 200 tons	2,303
Mate Near Coastal Not More Than 200 tons	1,023
Master Near Coastal Not More Than 100 tons	26,708
Master Uninspected Fishing Industry Vessel	811
Mate Uninspected Fishing Industry Vessel	251
Master (OSV)	157
Chief Mate (OSV)	1
Mate (OSV)	29
Master Great Lakes and In. Any Gross Tons	291
Mate Great Lakes and In. Any Gross Tons	227
Master Great Lakes and In. Not More Than 1,600 tons	154
Mate Great Lakes and In. Not More Than 1,600 tons	55
Master Great Lakes and In. Not More Than 200 tons	104
Mate Great Lakes and In. Not More Than 200 tons	13
Master Inland Any Gross Tons	1,044
Mate Inland Any Gross Tons	204
Master Inland Not More Than 200 tons	512
Mate Inland Not More Than 200 tons	330
Master Inland Not More Than 100 tons	7,509
Mate Inland Not More Than 100 tons	47
First Class Pilot	3,678
OUTV/Master Towing	14,355
2ND-Class OUTV/Mate (Pilot)	194
Apprentice Mate (Steersman)	310
Operator Uninspected Passenger Vessel	32,092
Assistance Towing Endorsement	22,222
Offshore Installation Manager (OIM)	1,772
Barge Supervisor (BS)	741
Ballast Control Operator	380

Licensed Engine Department

Description	Number of Mariners
By grade; regardless of propulsion	
Chief Engineer	3,629
1st Assistant Engineer	1,534
2nd Assistant Engineer	1,901
3rd Assistant Engineer	4,861
Chief Engineer (Limited-Ocean)	1,497
Assistant Engineer (Limited-Ocean)	487
Chief Engineer (Limited-Near Coastal)	499
Designated Duty Engineer	2,370
Chief Engineer Uninspected Fishing Industry Vessel	598
Assistant Engineer Fishing Industry Vessel	110
Chief Engineer MODU	122
Assistant Engineer MODU	0
Chief Engineer (OSV)	711
Engineer (OSV)	8
By grade and propulsion*	
Chief Engineer Motor	3,207
1st Assistant Engineer Motor	1,069
2nd Assistant Engineer Motor	1,224
3rd Assistant Engineer Motor	3,868
Chief Engineer Steam	2,168
1st Assistant Engineer Steam	974
2nd Assistant Engineer Steam	1,127
3rd Assistant Engineer Steam	3,952
Chief Engineer Gas Turbine	2,702
1st Assistant Engineer Turbine	988
2nd Assistant Engineer Turbine	1,110
3rd Assistant Engineer Turbine	2,500

**Note:* Many engineers may hold licenses valid for more than one type of propulsion. In the "By Grade and propulsion" table, an individual is counted in each propulsion category for which he/she is licensed.*

Licensed Radio Officer and Certificates of Registry

Description	Number of Mariners
Radio Officer	329
Chief Purser	179
Purser	70
Sr. Asst. Purser	28
Jr. Asst. Purser	130
Medical Doctor	76
Professional Nurse	71
Surgeon	3

Marine Credentials

Merchant Mariner Document Ratings

RATING	Number of Mariners
Able Seamen	
AB-Special	3,600
AB-Limited	3,428
AB-Unlimited	11,454
AB-Special(OSV)	2,843
AB-MOU	2,344
AB-Fishing	151
AB-Sail	305
Qualified Member of the Engine Department	
QMED-Deck Engine Mechanic	168
QMED-Deck Engineer	912
QMED-Electrician	1,160
QMED-Engineman	172
QMED-Junior Engineer	1,473
QMED-Machinist	738
QMED-Oiler	4,439
QMED-Pumpman	1,225
QMED-Refrigeration Engineer	820
QMED-Fireman/Watertender	2,376
QMED-Any Rating	774
Lifeboatman	
Lifeboatman	19,888
Tankerman	
Tankerman-Pic	4,248
Tankerman-Pic (Barge)	8,482
Tankerman-Engr	845
Tankerman-Asst	4,608
Licensed Officer Ratings	
Any Unlic Rating in Deck Dept Except AB	1,051
Any Unlic Rating in Deck Dept Incl AB	13,660
Any Unlicensed Rating in Engine Dept	10,844
Cadet/Deck or Engine	3,296
Entry Level Mariners	39,560

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Learning to Fight Fatigue

Companies find new ways to improve crewmember endurance

by Mr. William Abernathy
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U.S. Coast Guard Human Element and Ship Design Division

"Learning is the only thing the mind never exhausts, never fears, and never regrets," said Leonardo da Vinci. When it comes to dealing with life's problems, few things are as beneficial as lessons learned from the past, providing useful information to solve problems.

Risk is one problem that everyone can relate to. Risks are important to life—you have to take some if you want to accomplish anything worthwhile! The question is, how do you manage risk sufficiently enough so that losses can be avoided? Prevention Through People (PTP) continually asks that question with the maritime industry in mind, and is dedicated to developing ways to manage risk by improving safety on vessels.

One way to improve safety is to make certain that vessel crewmembers are physically and mentally healthy, able to maintain strength and alertness on the job. When they cannot, crewmembers are far more likely to make errors that can put themselves or the vessel in danger. To reduce the risk of accidents, PTP addresses the problem of crew fatigue through a system known as crew endurance management. In an effort to reduce fatigue-related accidents, PTP promotes fatigue risk management to segments of the "24/7" maritime industry around the country.

The U.S. Coast Guard offers a voluntary program called the Crew Endurance Management System (CEMS) to control the risk of these accidents, promoting endurance techniques to companies around the country. Here, the Coast Guard makes recommendations on how crewmembers can manage the factors common in all segments of the maritime industry that can increase fatigue, reduce endurance, and contribute to accidents.

What Do We Learn?
Lessons learned are central to what CEMS is all about. In order for companies and crew to reduce the risk of fatigue-related error, they have to know what it takes to build and maintain human endurance. Also, it must be clear how to apply endurance management to life on a vessel. To do this, CEMS offers an ongoing step-by-step process, aimed at guiding companies through methods that keep their crewmembers' energy and alertness high during work hours.

Since many crewmembers stand night watches and don't get enough sleep while working on vessels, it is challenging to help them maintain their performance. CEMS offers a program of important steps to educate companies on how to do exactly that. The first step is to arrange a working group to spur the cycle along. This group is known as a Crew Endurance Work Group (CEWG), and it facilitates the use of many of the crucial lessons learned that crewmembers need to combat fatigue on the job. Once a CEWG is set up, it analyzes the problems associated with particular vessels and determines what can be done to reduce risk factors for fatigue on that vessel.

Based on this assessment, the CEWG develops a plan outlining recommendations to improve conditions and enhance endurance. This Crew Endurance Plan (CEP) addresses all of the major CEMS components critical to improving vessel conditions and managing fatigue risk factors.

Learning Healthier Lifestyles
To get started, participants in CEMS must keep in mind five major components of successful crew endurance management:

- education,
- environmental changes,
- light management,
- trained coaches, and
- schedule changes.

Individual vessels and companies should address these different areas according to their needs and resources, and they should move at their own pace. To evaluate the effectiveness of these measures, the Coast Guard recently conducted a demonstration project using CEMS techniques. Seven towing companies agreed to participate in the project, providing vessels and crews. A representative from each vessel (usually its captain) answered a series of questions about the results. The results help to show what lessons learned in endurance management can accomplish.

Education is especially important when it comes to promoting the lessons learned in CEMS. One lesson learned is that people can adjust the "red zone," the daily period of low energy and alertness in the body. This is important, for example, so that night-watch crewmembers can change their periods of lowest alertness to times outside their working hours. It is also important that participants in CEMS learn about good sleep habits, the effects of diet and sleep on energy levels, the importance of exercise, and the effects of stress. Nearly 60 percent of all crewmembers received instruction in the use of CEMS.

Trained coaches perform a key service to the crew by teaching them how to combat fatigue and by promoting healthy behavior. The coaches lead by example, displaying good personal habits for maintaining endurance, while encouraging crewmembers to follow suit. They also provide and explain information to the crew on important endurance matters such as diet, exercise, sleep, and body clock management.

"Since having been involved in the CEMS program, I have personally gained a great deal of insight concerning sleep patterns," said Lead Tankerman Houston Money at Barge Everglades. "I have been able to make some adjustments to my daily habits that have greatly improved my mental and physical health."

Joann Salyers, a safety supervisor and CEMS expert at Blessey Marine Services Inc., described an instance where lessons learned from CEMS led to healthier behavior. "One excessive coffee drinker was in the habit of loading his many cups of coffee throughout the day with a large amount of sugar," said Salyers. "Through the implementation of CEMS, he was encouraged to reduce his coffee intake and drink more water. He says this change has made him feel better—a fact substantiated by his crew—who report him to be much more relaxed and easier to live with."

Improving Vessel Living

Changing crewmembers' work and rest environments is crucial to helping them to get enough sleep and rebuild their energy and alertness. Crew sleeping quarters should be as dark and as quiet as possible, so that crewmembers can sleep comfortably and not be interrupted. New mattresses, darker sleeping quarters, improved heating and cooling, and reduced noise and vibration are all helpful in improving work and rest environments.

Crewmembers also need healthy, comfortable air quality in their sleeping quarters so that they can rest comfortably. Air quality can be improved by installing air filtering machines in the crew quarters, providing the consistently cleaner, cooler air necessary for quality sleep.

Good diet and nutrition are important to energy and health and contribute to long-term endurance. In the project, vessel representatives were asked whether or not the food provided on board conformed to recommendations in CEMS guidelines. The demonstration project found that 27 out of the 32 vessels reporting a healthy diet (84 percent) showed a reduced risk of fatigue. CEMS expert Captain Michael W.

Vessel crewmembers often need to spend lengthy periods of time at sea, and many of them stand night watches. Therefore, it is important that they maintain sufficient physical and mental endurance to do their jobs safely. USCG Photo.

Bowman of Kirby Inland Marine, LP says that better nutrition and more exercise, recommended by CEMS, is changing vessel life for the better. "We have been changing how [crewmembers] exercise by putting new equipment on vessels, especially for cardio exercise," said Bowman. "The crew also has had education on healthier food to improve diet. For example, we used to go through a lot of Coke on vessels, but after education in CEMS, we went to bottled water, which of course is much healthier."

Participant companies reported healthy changes in their crews when they tried out some of the recommendations. "Crews feel better," said Captain Don Hinson at Penn Maritime, Inc. "They are more relaxed. We are making our vessels quieter through small changes in the environment. Crewmembers drink more water and they eat better."

Companies that participated in the demonstration project

American Commercial Barge Line LLC

American Electric Power River Operations

Blessey Marine Services, Inc.

Kirby Corporation

Marathon Petroleum Company LLC

Moran Towing Corporation

Penn Maritime Inc.

Finally, the vessel environment can be changed to carry out CEMS by introducing light management. This technique involves controlling light input to the eyes in order to help keep the body awake and alert during watch and avoiding the same input to help a person fall asleep afterward. The idea is to shift people's biological clocks so that alertness peaks during work periods, while the lowest energy levels (red zones) occur during rest periods. Crewmembers need only be exposed to bright lights for short periods during work shifts. Bright light suppresses the production of melatonin, the hormone triggered in periods of darkness when sleeping is normal.

Final Steps

Watch schedule changes are a final component of CEMS, and should only be applied when all other CEMS components are in place. The changes should be made so that crewmembers can obtain seven to eight hours of uninterrupted sleep in a 24-hour period. At the very least, they should get 6.5 hours of sleep plus a two-hour nap per 24-hour period.

Under a 6 on-6 off watch, two watch standers take turns working six-hour watches, then take six hours off, with each worker standing two watches in any 24-hour period. A better alternative is a 7-7-5-5 watch, in which each person works one five-hour and one seven-hour watch, separated by one seven-hour rest period and one five-hour rest period. Even better, 8-8-4-4 systems involve persons working one four-hour and one eight-hour watch, separated by one eight- and one four-hour rest period. These alternative watch schedules allow workers more time to rest and regain their energy. In the demonstration project, 13 vessels changed from a 6 on-6 off watch rotation to either a 7-7-5-5 or an 8-8-4-4 rotation.

"We are presently working the 8-4 schedule," said Captain Dan Rogers at M/V *Big Al*. "It seems to be working well for us. We did hear a little grumbling from the pilots from time to time because of the longer working period at night, but we have addressed this by backing up the watch even further, so they now get off watch at 0400 and then sleep hard from 0400 to 1200."

CEMS Reviews

The demonstration project shows that the lessons learned in CEMS can do a lot to fight crew fatigue. The Coast Guard hopes that CEMS will become more widely used as more people learn about it and understand its benefits. Most of all, the hope is that crewmembers will pick up lessons from CEMS and take better care of themselves.

"The crewmembers receive a good education in healthy practices," said Bowman. "Since we started with CEMS, they have learned to have a better diet and to get more exercise."

Introducing companies to crew endurance management can help to build an organizational culture dedicated to stronger awareness of and attention to crew safety. The Coast Guard hopes that voluntary programs like CEMS will encourage many companies to address crewmember fatigue, especially since it is in their best interest to minimize the risk of vessel accidents. Lessons learned in fatigue risk management are great ways of persuading companies that the program will benefit them.

About the authors:

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Places of Refuge Decisions

Public affairs challenges.

by LCDR Benjamin Benson
Public Affairs Officer, U.S. Coast Guard First District

The ship is a wreck. It is listing badly, spilling oil, and threatening to break up and sink. It needs a place of refuge, and the master wants to bring this potential disaster into your port. You and your public affairs team have a significant challenge ahead.

The Challenge

The 2005 Canuslant exercise participants tackled this type of situation in Bar Harbor, Maine. Canuslant is the U.S./Canadian biennial exercises of the Atlantic Geographic Annex to the joint maritime pollution contingency plan. Held at the picturesque College of the Atlantic, the exercise explored places of refuge through education, breakout groups, a tabletop exercise, and equipment deployments. The 150 participants focused on the decision-making process, Gulf of Maine response capabilities, assessment criteria, and obstacles to success.

Public opposition was rapidly identified as a serious potential obstacle to the successful resolution of a place of refuge situation. Captain Mike Balaban of Transport Canada reminded the participants that the places of refuge concept has a long maritime tradition. Heading for the nearest safe harbor has always been a natural response to a crisis at sea.

A finback whale skull at the College of the Atlantic, Bar Harbor, Maine. LCDR Benjamin Benson, USCG.

Today, however, ships typically carry large amounts of oils and hazardous materials that can foul a shoreline. Responders and the public have a greater sensitivity to the environmental consequences of a spill, resulting, in some cases, in denial of refuge to a stricken vessel.

The International Maritime Organization's resolution A.949 (23), *Guidelines on Places of Refuge for Ships in Need of Assistance*, adopted December 5, 2003, notes that: "when a ship has suffered an incident, the best way of preventing damage or pollution from its progressive deterioration would be to lighten its cargo and bunkers; and to repair the damage. Such an operation is best carried out in a place of refuge." The guide, however, continues by acknowledging that "to bring such a ship into a place of refuge near a coast may endanger the coastal State, both economically and from the environmental point of view, and local authorities and populations may strongly object to the operation."

The balancing of risks to the vessel and its crew, and to the coastal community is a key issue in places of refuge decisions. The IMO guide states that: "granting access to a place of refuge could involve a political decision which can only be taken on a case-by-case basis with due consideration given to the balance between the advantage for the affected ship and the environment resulting from bringing the ship into a place of refuge and the risk to the environment resulting from that ship being near the coast."

Given a place of refuge request, technical experts first must tackle the incident specifics: What is the situation? What are the stresses? What is the weather? Where can they get to? What resources are endangered there? What assistance is available there?

The U.S. and Canadian Coast Guard, salvors, and maritime professionals know how to tackle such risk assessments, and, through exercises like Canuslant and plenty of real-world cases, they are well-practiced at finding cooperative solutions. Their task may be daunting, but they will get the job done. They will find a logical, defendable, best option.

With this best option in hand, the next action is to gain the needed support to implement this option. NIMBYism (not-in-my-backyard) is the great challenge. Even the best solution, if poorly presented, can leave one trying to do the right thing against all the forces an impassioned community can muster.

Tabletop Exercise Scenario

Dr. Sean Todd, of the College of the Atlantic, briefed Canuslant participants regarding the dynamics of the Gulf of Maine. "This is one of the best places in the world to see marine mammals. They come here to get wet and fat."

The gulf, which runs from Cape Cod, Mass., to the Bay of Fundy, Canada, and out to Georges Bank, includes three climatic zones. Most critically to the places of refuge issue, Dr. Todd noted that the currents run around the gulf like "a giant washing machine." Thus, a major pollution incident will not be isolated. Further, as the fish and whales do not recognize international U.S./Canada boundaries, international cooperation is necessary. "If you're going to solve this problem, you must have all stakeholders," Dr. Todd pointed out, "and you've done that here."

In the Canuslant tabletop exercise scenario, a tanker carrying gasoline from Canada to Boston was struck midships by a dry bulk carrier. The bulker could continue its voyage, while the tanker had a breached hull, was leaking oil, and needed a place of refuge.

The U.S. and Canadian participants quickly figured out that the vessel was in U.S. waters and that the nearest potential place of refuge was the exercise location, beautiful and environmentally sensitive Bar Harbor, Maine. The urgency was raised by nasty weather coming from the southeast.

Public Affairs Response

Before tackling this public affairs challenge, the incident command should focus on the communication needs, lest you find yourself talking without a purpose. The purpose here is to garner support and cooperation to implement the technical solution determined to be best. The response also needs to mitigate local NIMBY impulses. Overall, public confidence in the organization needs to be preserved.

According to public relations theory, the open-systems approach is the most effective public relations model.[1] The correlation of the open-system approach to greater satisfaction with the public affairs results was recently empirically shown in a study of Coast Guard Marine Safety Offices following the September 11, 2001, attacks.[2]

An open-system organization effectively interacts with its environment (the public) and is oriented toward growth and development. The organization's public relations function takes input from the public and reconciles it against the organization's desired relationships with the public. The organization takes this information and responds to reconcile differences. The open organization communicates with its public and adjusts itself and its goal states to maintain an equilibrium.

The system builds and maintains public confidence as the public not only sees the organization being open about what it is doing, but also being receptive to the public's concerns. An organization perceived as hiding its activities, or even worse, disregarding the public's concerns, may suffer a long-term loss of confidence. If the public does not trust that the organization will be open about activities that could affect them, and if they do not believe their concerns will be taken seriously, they may resort to any number of methods to protect their self-interest, other than cooperating with the organization.

It was evident that the Canuslant participants recognized the inherent public affairs challenge. Not only did the topic come up regularly in discussions, public affairs issues were included in many of the breakout groups' reports.

The public communications breakout group saw the purpose of communications as preparing the environment for successful operations. The group tackled:

- segmenting audiences and messages (determining who the audiences are and what messages are appropriate for each); and
- choosing the right level of engagement (actively engaging versus a more passive approach).

Segmenting

There is no general public. The fishing community does not

Rear Admiral David P. Pekoske, left, then Commander, First U.S. Coast Guard District, and Mr. Larry Wilson, Assistant Commissioner, Canadian Coast Guard, Maritimes, observe the CANUSLANT 2005 equipment deployment. LCDR Benjamin Benson, USCG.

have the same concerns as shippers. Residents of a coastal community will have different concerns than port business employees. National and international environmental groups have yet another set of interests. In a places of refuge situation, these audiences, their concerns, and how they typically receive their information (media, influencers, civic groups, etc.) need to be determined. Local knowledge is a great source, as is a review of local media. This review should not only attend to the loudest voices, but should try to identify and attend to the lesser media, such as blogs or even graffiti. The responders might be asked to pay attention and advise the public affairs staff of anything relevant that they see or hear. This is the listening part of public communications.

Messages then need to be both tailored and targeted to these specific audiences. Coastal residents may need information on preparations to protect them from a spill. Shippers will want to know about waterway access issues. Fishermen will have their own concerns. Some will worry about economic risks, while others may see economic opportunity.

Each tailored message must not conflict with the other messages. Anticipate that people in one group will attend to the messages you give to other groups. Further, your audience will include people who belong to multiple categories. Address your target audience directly, but remember the other audiences are also listening.

A goal of places of refuge messaging is to turn "us-them" thinking into "we" thinking. A community may get the impression that they are expendable and have been chosen to "take the bullet." The use of pre-established contingency plans and cooperative efforts with the stakeholders, such as a unified command, helps by showing that a reasonable process was used to choose the course of action and that the community is not being excluded from decision making.

Showing that the organization is prepared for negative outcomes is important. However, too much emphasis on prevention may increase the perception of danger. Audiences who see the preparation without fully understanding the situation may think: "If they are doing so much to protect us, it must be really bad." The goal is to educate and realistically reassure, without belittling or alarming.

The Right Level of Engagement and the Dangerous Temptation to Keep Quiet

In Canuslant, the level of engagement decision was one of the trickiest addressed. While there can be no NIMBY response if the publics do not know what is happening, the most awful public wrath may be conjured if things go badly in secret.

Sculpture at the College of the Atlantic, Bar Harbor, Maine. LCDR Benjamin Benson, USCG.

Not communicating is never a good option. The public communications breakout group, however, noted that who to communicate with, at which level, and at what time in the event's lifecycle should be considered strategically. Key players, those with a need to know, including certain political leaders, must be engaged early. The incident command needs to have agreement on the communication plan with them. A more passive approach with the clear concurrence of local key players may be appropriate, if the negative event risks are deemed low enough. Not creating undue alarm is an appropriate consideration. This is a case-by-case judgment call upon which the parties need to agree.

Given the risks of appearing secretive, the default position must be to publicize the activities. The danger in doing less outreach lies in a public perceiving that they are being subjected to a hazard without their consent or even knowledge. Such a perception can lead to both opposition in the immediate case and a long-term deterioration of trust. Another risk of communicating less is that government secrecy is itself news. Being perceived as secretive on a public safety issue can become a much bigger problem than the places of refuge situation alone. Such negative impressions may lead to abandonment by some key players the response depends on.

If the key persons agree to a lower level of engagement, the incident command still needs to be ready to speak about the issues openly if and/or when the story breaks. Plain sight activities, easily apparent to the casual observer of the operation, must be considered. Bringing an unusually large vessel with visible damage into a small port will be noticed. Do not try to deny the obvious; it will only ruin your own credibility. A public affairs failure can sink your best plans; the open-system approach is your safest bet.

Rear Admiral David P. Pekoske, right, then Commander, First U.S. Coast Guard District and Mr. Larry Wilson, Assistant Commissioner, Canadian Coast Guard, Maritimes, center, get a briefing on the exercise equipment deployment from John J. Dec, First Coast Guard District, Marine Safety Division. LCDR Benjamin Benson, USCG.

Table Top Exercise Resolved

The Canuslant tabletop exercise led to some tough soul searching and decision making. At one point, the U.S. representatives went up to Canada—just upstairs to the library—to cooperatively develop the needed best option. This is the type of cooperation a places of refuge situation demands.

Pros and cons of various places to bring the ship along the Gulf of Maine were carefully weighed. Finally, with a sigh of relief, the participants concurred. Given the approaching storm, the vessel would be best served, and the whole Gulf of Maine would be best protected, if the vessel sought refuge in St. Mary Bay, Nova Scotia.

At the close of the table top exercise, the public affairs challenge of preparing the environment for successful operations was only beginning. A places of refuge situation provides unique challenges to port authorities. While tackling the technical problems, the players need to agree on a reliable public affairs plan to enable implementation. There lies the challenge. Doing it well brings success.

About the author: *LCDR Benjamin Benson, First District Public Affairs Officer, started his career at boat units and as an Aviation Survivalman. After Officer Candidate School, he served in Port Operations, Inspections and Investigations. He wrote his thesis on ICS and Public Relations at San Diego State University, earning his masters in communications.*

Endnotes

[1] See Cutlip, S. M., Center, A. H., & Broom, G. M. (2000). Effective public relations (8th ed.). Upper Saddle River, NJ: Prentice Hall. See also the discussion of the two-way symmetrical model in Grunig, L. A., Grunig, J. E., & Dozier, D. M. (2002). Excellent public relations and effective organizations: A study of communication management in three countries. Mahwah, NJ: Lawrence Erlbaum.

[2] See the author's master's thesis: The Incident Command System's Effect on Public Relations Excellence at http:// babenson.home.att.net.

U.S. Department of Homeland Security

United States Coast Guard

The Coast Guard Journal of Safety at Sea

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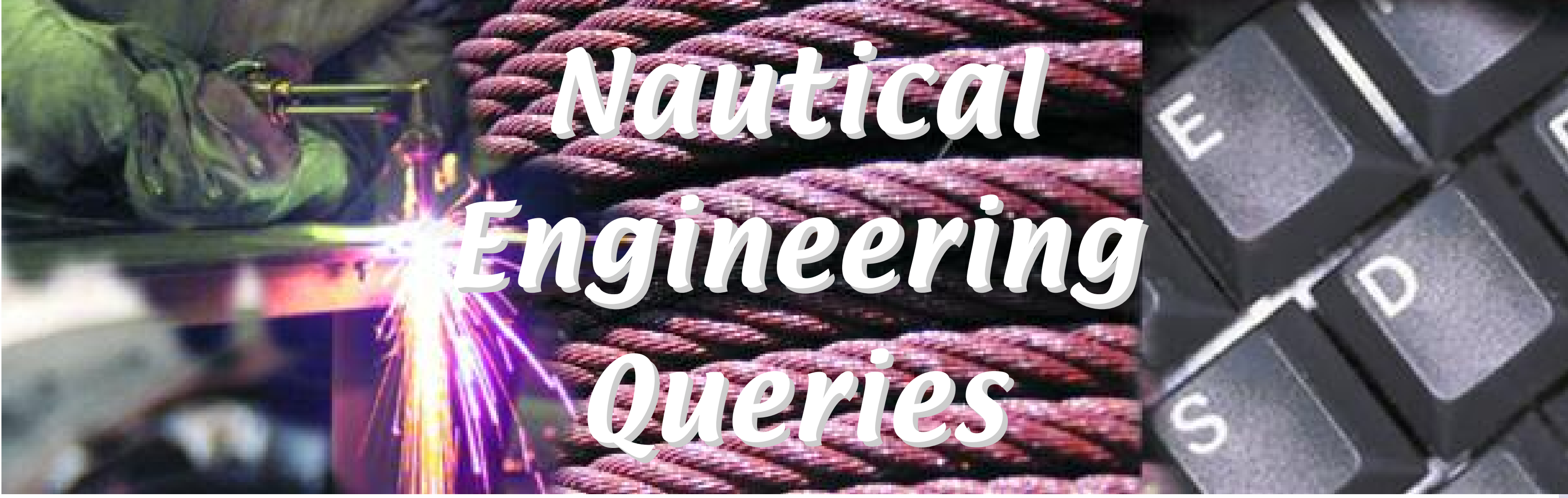
We look forward to hearing from you soon, and we hope you have enjoyed this issue of ***PROCEEDINGS****!*



Nautical Engineering Queries

1. Which statement is true concerning two-stage air ejector assemblies?

Note: A "Jet pump" is a sub-classification of dynamic pumps, such as eductors, hydrokineters, and of course air ejectors. These units are used to move fluids through the inter-active change in the kinetic energy of the motivating fluid.

A. Air is removed from the condensate as it passes through the tubes.
  Incorrect Answer: Air ejectors are designed to remove air and non-condensable gases which tend to accumulate in the condenser. Air cannot be removed from the condensate passing through the tubes of the inter and after-condenser. The main condensate in the tubes merely serves as the cooling medium to condense the steam exhausting from the air ejector assemblies.

B. In the after-condenser, the air ejector motivating steam is condensed and returned to the main condenser via the loop seal.
  Incorrect Answer: In the after-condenser (second stage), the air ejector motivating steam is condensed and returned to the condensate system via the atmospheric drain tank. In the inter-condenser (first stage), the air ejector motivating steam is returned to the main condenser via the loop seal.

C. The first stage air ejector takes suction on the second stage to increase vacuum.
  Incorrect Answer: The first stage air ejector takes suction on the main condenser, and the second stage air ejector takes suction on the first stage inter-condenser, which when operating together results in a condenser vacuum of approximately 28.5 inches of mercury.

D. The steam/air mixture from the main condenser is discharged by the first stage jet pump to the inter-condenser.
  Correct Answer: The steam/air mixture drawn from the main condenser is discharged by the first stage (air ejector) jet pump into the inter-condenser. As the exhaust steam condenses, a loop seal directs the condensate to the main condenser while the air and non-condensable gases are drawn out by the second stage (air ejector) jet pump. The resultant second stage steam, air and non-condensable gas mixture is discharged into the after-condenser, where the steam condenses and drains to the atmospheric drain tank, while the air and non-condensable gases are vented to the atmosphere.

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2. When metal is tempered, it becomes ________.

Note: Tempering, or drawing, is the process of reducing both the degree of hardness and strength of a metal by reducing its brittleness. Hardness is a property of metal that relates its resistance to indentation, and is a function of the percentage of its carbon content. The higher the percentage of carbon content, the harder the metal, and characterized as being more brittle. A brittle metal will break easily and without noticeable deformation (without warning). Soft metal has a conversely lower percentage of carbon, and is used where high strength is not a concern as it becomes more plastic. Softer metals are easier to handle and fabricate.

A. harder
  Incorrect Answer: Tempering decreases the hardness of metal.

B. corrosion resistant
  Incorrect Answer: Tempering has no effect on corrosion resistance as this is a function of its iron composition and associated alloys.

C. less brittle
  Correct Answer: Tempering is the process of controlled heating and cooling of metal to lessen its brittleness.

D. more brittle
  Incorrect Answer: Tempering reduces the brittleness of the metal, rendering it less susceptible to fractures.

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3. Which statement is true concerning operational factors affecting the degree of superheat in a single furnace boiler?

Note: Operational factors that affect the degree of superheat in a single furnace boiler include rate of combustion, temperature relationship of the feed water to its design requirements, amount of excess air passing through the furnace, amount of moisture entrained in the steam generated, and the condition of the superheater and water screen tube surfaces.

A. As the rate of combustion increases, the degree of superheat increases throughout the entire firing range.
  Incorrect Answer: An increase in steam demand results in an increase in the rate of combustion, that results in an increase in sat-

urated steam generating rate, which in turn results in an increased steam flow through the superheater. The rate of heat absorption by the steam flowing through the superheater increases more rapidly than the increasing rate of steam flow and the superheat temperature while increasing, rises slowly at first until the boiler is operating at near full power. At full power, the rate of steam flow stabilizes resulting in the rate of heat absorption in the superheater to decrease, and the degree of superheat ceases to increase and may decrease slightly even though the rate of combustion had increased.

B. With a constant firing rate and steam consumption equal to generation, a decrease in the incoming feed water temperature results in a superheat temperature decrease.

Incorrect Answer: At a constant firing rate, a decrease in feedwater temperature will result in a superheat temperature increase. If the feedwater temperature decreases, less saturated steam will be generated for the load and the quantity of the fuel being burned. The reduction in steam flow will also result in the corresponding steam pressure, forcing the combustion control to increase the rate of combustion. The resulting increasing combustion airflow results in deeper combustion gas penetration into the generating tube bank. The available heat no longer available to effectively heat the water in the water screen tubes is now increasingly transferred to the superheater, resulting in an increase in the superheater outlet temperature.

C. With large amounts of excess air, superheater outlet temperature will decrease due to lack of sufficient time for heat transfer to take place.

Incorrect Answer: A large amount of excess air repositions the "center" of combustion closer to the superheater tube bank. The available heat no longer available to effectively heat the water in the water screen tubes is now increasingly transferred to the superheater, resulting in an increase in the superheater outlet temperature.

D. Carrying boiler water total dissolved solids higher than normal could result in a decrease in the degree of superheat.

Correct Answer: Carrying the boiler water total dissolved solids higher than normal may result in moisture carryover into the superheater. Consequently, much of the available heat will be given up to transform the entrained moisture to steam before the addition of sensible heat to the saturated steam can occur to increase the temperature in the superheater, thereby resulting in a decrease to the superheat outlet temperature.

4. When troubleshooting an alkaline storage battery, a weak or dead cell is best located by ________.

A. checking the specific gravity of each cell

Incorrect Answer: The specific gravity of the electrolyte (potassium hydroxide) in an alkaline (nickel-cadmium) battery is 1.200 at 60°F, and essentially remains constant, regardless of charge. Therefore, checking the specific gravity would be ineffective in locating a weak or dead cell.

B. visually inspecting each cell's electrolyte level

Incorrect Answer: The cell's electrolyte level is not an indication of the state of charge. However, maintaining the electrolyte at the "full mark", by the addition of distilled water, would result in less space inside the battery for the accumulation of explosive hydrogen and oxygen gases.

C. load testing each cell with a voltmeter

Correct Answer: Because the specific gravity of the electrolyte is essentially constant, regardless of charge, the battery condition must be determined with a voltmeter such as a digital voltmeter, during charging or discharging. Open circuit voltage of a nickel-cadmium battery is 1.2 volts per cell, and when connected to a load, remains fairly constant up to 90 percent of its rated capacity. Repeated over-discharging below 1.1 volts per cell will damage the battery.

D. measuring the electrolyte temperature with an accurate mercury thermometer

Incorrect Answer: The electrolyte temperature does not provide an indication of the state of charge or discharge of an alkaline battery. However, to limit gassing, the electrolyte temperature should not be allowed to exceed 115°F (46°C) when charging the battery. In addition, a mercury thermometer should never be used to measure electrolyte temperature, as an accidental breakage of the thermometer could result in sparking and an explosion.

Nautical Deck Queries

1. You are to sail from Elizabethport, N.J., on 17 November 1983 with a maximum draft of 27 feet. You will pass over an obstruction in the channel near Sandy Hook that has a charted depth of 25.5 feet. The steaming time from Elizabethport to the obstruction is 1h 50m. What is the earliest time (ZD +5) you can sail on 17 November and pass over the obstruction with 2 feet of clearance?

Note: When computing height of tide correction utilizing Table 3 of the Tide Tables you are not to interpolate.

A. 0059
Incorrect Answer.

B. 0121
Correct Answer: In the Tide Tables, on November 17th, the Sandy Hook reference station numbers contain the low tide correction at 2300 (Nov 16) of -0.1 ft. and the high tide correction at 0518 of 4.5 ft. for a range of tide of 4.6 ft. (4.5′-(-) 0.1′) and the duration of rise then is 6h-18m (which is the difference between 2300 to 0518). The height correction of 3.5 ft. to safely pass over the obstruction is derived by adding the ship's 27 ft. draft to the required 2 ft. under keel clearance, and then subtracting the charted depth of the obstruction of 25.5 ft. In Table 3 of the Tide Tables, for the range of tide of 4.6 ft. the nearest value of 4.5 ft. is to be used. Then on a horizontal line from 4.5 ft., locate the 1.0 ft. correction to height (the last value being the difference between your required height correction of 3.5 ft. and the nearest hi/low water which is 4.5 ft. at 0518). Upon locating 1.0 ft., proceed in the same column, Duration of Rise, to the horizontal intersection of 6h-20m (which is the nearest value to the actual duration of rise of 6h-18m.) At this intersection the time of 2h-07m is indicated as the time from nearest high water. Subtracting 2h-07m from the high tide at 0518 will result in 0311 as the time the vessel will have the minimum required under keel clearance. Then subtracting 1h-50m hours steaming time (dock to the obstruction) from the time of 0311 (clearing the obstruction), will result in 0121 as the earliest possible time a ship may sail.

C. 0159
Incorrect Answer.

D. 0221
Incorrect Answer.

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2. The moon is subject to four types of libration. Which of the following is NOT one of these types of libration?

Definition of libration: A real or apparent oscillatory motion, particularly the apparent oscillation of the moon, which results in more than half of the moon's surface being revealed to an observer on the Earth. The appearance results, even though the same side of the moon is always towards the earth, as a result of the moon's period of rotation and revolutions occurring at the same rate as that of the earth.

A) Libration in latitude
Incorrect Answer: This libration depends on the variation of the position of the moon's axis in respect to the observer, causing the alternate appearance and disappearance of either pole. Libration in latitude occurs because the axis of rotation is not perpendicular to the plane of the orbit, so an observer in the northern hemisphere can sometimes see over the north pole and under the south pole.

B) Diurnal libration
Incorrect Answer: Otherwise known as parallactic libration, this libration brings into view on the edge of the apparent disk of the moon, at rising and setting, some parts not in the average visible hemisphere. The earth's rotation results in the observer to see slightly different parts of the moon at different times.

C) Physical libration
Incorrect Answer: This libration appears as a result of a small pendulum-like rotational oscillation of the moon with respect to its radius vector around its own center of gravity.

D) Horizontal libration

Correct Answer: This is not a libration of the moon.

The fourth type of libration is the libration of the longitude. This libration is dependent upon the position of the moon in its elliptic orbit, resulting in a small area near the visible eastern and western edges of the moon to alternately be visible or not visble each month.

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3. INTERNATIONAL ONLY. If a towing vessel and her tow are severely restricted in their ability to deviate from their course, the towing vessel shall show lights in addition to her towing identification lights. These additional lights shall be shown if the tow is_______________.

International Rule 27(c): A power-driven vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course shall, in addition to the lights or shapes prescribed in Rules 24(a), exhibit the lights or shapes prescribed in subparagraphs (b)(i) and (ii) of this Rules. Also note, the term SHALL in the rules is prescriptive, requiring the correct application of the Rule. The term MAY is permissive, and is only voluntary under the Rules.

A. pushed ahead

Incorrect Answer: International Rule 27(c) limits its application to vessels towing astern, however vessels pushing ahead or towing alongside MAY show the restricted in ability to maneuver lights and shapes in addition to their towing identification lights

B. towed alongside

Incorrect Answer: International Rule 27(c) limits its application to vessels towing astern, however vessels pushing ahead or towing alongside MAY show the restricted in ability to maneuver lights and shapes in addition to their towing identification lights.

C. towed astern

Correct Answer: International Rule 27(c) states that restricted in ability to maneuver lights and shapes will be in addition to the lights prescribed specifically in Rule 24(a). International Rule 24(a), under Rule 24 Towing and Pushing, refers to vessels towing astern only (Rule 24(c) refers to towing vessels pushing ahead or towing alongside). International Rule 27(c) is different from Inland Rule 27(c) in that Inland Rule 27(c) refers to Rule 24 in itself, encompassing all three types of towing functions.

D. All of the above

Incorrect Answer: Only answer C is correct and All of the Above cannot be accepted.

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4. Regulations concerning the stowage, lashing, and securing of timber deck cargoes aboard general cargo vessels may be found in the _______.

A. International Cargo Bureau Regulations

Incorrect Answer: The International Cargo Bureau does not develop regulations regarding stowage of cargo but rather the registration, inspection, certification, and documenting of cargo handling equipment.

B. Load Line Regulations

Correct Answer: The regulations concerning the securing of timber deck cargoes are located in the Code of Federal Regulations, Title 46 Subchapter E, Load Lines, Subpart 42.25, Special Requirements for Vessels Assigned Timber Freeboards.

C. Rules and Regulations for Cargo and Miscellaneous Vessels

Incorrect Answer: The Code of Federal Regulations, Title 46 Subchapter I, Cargo and Miscellaneous Vessels, contains regulations on inspection and certification, construction and arrangement, fire protection equipment, and vessel control and miscellaneous systems and equipment.

D. Vessel's classification society rules and regulations

Incorrect Answer: Vessel classification societies set standards for ship design, construction, and the "through-life" compliance of rules and regulations promulgated by the international maritime community.

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The barge anchor pawl that, had it been in the down position during the transit down the Hudson River, would have kept the anchor from letting go.

A dry cargo barge moored on August 8, 1999. Anchor shows debris picked up as the anchor dragged along the bottom of the Hudson River earlier that morning. The barge anchor severed a natural gas pipeline crossing the Hudson River at Poughkeepsie, NY. Only the anchor brake held the anchor in place. The towing vessel crew did not use the anchor pawl because the pawl would have prevented the use of the radio-controlled switch installed on the barge to prevent the barge from drifting ashore during ocean tows. The crew of the towing vessel did not know the barge they were pushing was dragging anchor until emergency responders alerted waterway users to the pipeline accident. U.S. Coast Guard Photo.