Allision of the Cargo Vessel M/V *Delta Mariner* with Eggner's Ferry Bridge, Tennessee River Near Aurora, Kentucky January 26, 2012

Accident Report
NTSB/MAR-13/02
PB2013-106636

National Transportation Safety Board

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Marine Accident Report

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National Transportation Safety Board

490 L'Enfant Plaza, SW
Washington, DC 20594

National Transportation Safety Board. 2013. *Allision of the Cargo Vessel M/V* Delta Mariner *with Eggner's Ferry Bridge, Tennessee River near Aurora, Kentucky, January 26, 2012*. Marine Accident Report NTSB/MAR-13/02. Washington, DC.

Abstract: This report discusses the allision of the cargo vessel *Delta Mariner* with Eggner's Ferry Bridge at mile marker 41.7 of the Tennessee River near Aurora, Kentucky, on January 26, 2012. No injuries were reported on the ship or on the bridge. Estimated costs to repair the vessel and remove bridge debris from its bow were $2,583,750. The Kentucky Transportation Cabinet (KYTC) reported total costs of more than $7 million for bridge repair and related items.

Safety issues identified in this report include bridge team performance on board the *Delta Mariner* and oversight by the ship's owner; the company's implementation of its safety management system and oversight of vessel operations; bridge lighting maintenance by KYTC; and the US Coast Guard's oversight of bridge navigation lighting and process for disseminating warnings to mariners. The National Transportation Safety Board issued recommendations to KYTC concerning effective bridge lighting and maintenance on July 25, 2012. This report includes recommendations to the Coast Guard regarding the maintenance of bridge navigation lighting and dissemination of broadcast notices to mariners; to the Federal Highway Administration with respect to state transportation department responsibilities regarding bridge navigation lighting; and to Foss Maritime Company, owner of the *Delta Mariner*, concerning passage planning, the expertise required of contract pilots, and clarification of their duties and responsibilities.

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Acronyms and Abbreviations

AB	able-bodied seaman
ABS	American Bureau of Shipping
ACL	American Commercial Lines
AIS	automatic identification system
BNM	broadcast notice to mariners
CFR	*Code of Federal Regulations*
COLREGS	International Regulations for Preventing Collisions at Sea, 1972
CPAP	continuous positive airway pressure
DPA	designated person ashore
ECS	electronic charting system
KYTC	Kentucky Transportation Cabinet
IMO	International Maritime Organization
ISM Code	International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention
ITC	International Tonnage Convention
M/V	motor vessel
NAVTEX	Navigational Telex
NBIS	National Bridge Inspection Standards
NTSB	National Transportation Safety Board
SMS	safety management system
SOLAS	International Convention for the Safety of Life at Sea, 1974
STCW	Standards of Training, Certification and Watchkeeping
S-VDR	simplified voyage data recorder
TVA	Tennessee Valley Authority
ULA	United Launch Alliance
USC	*United States Code*
VDR	voyage data recorder
VHF	very high frequency

Executive Summary

The M/V *Delta Mariner*, a cargo vessel carrying rocket components from the manufacturer in Decatur, Alabama, to Cape Canaveral, Florida, allided with Eggner's Ferry Bridge on the Tennessee River on the night of January 26, 2012, near Aurora, Kentucky. As the vessel approached the bridge, the bridge team maneuvered the *Delta Mariner* away from the main navigation span and toward a span providing insufficient clearance for the vessel.[1]

The National Transportation Safety Board (NTSB) launched an investigation to determine why the allision occurred and to identify measures to prevent the occurrence of a similar accident. The NTSB identified several safety issues during the investigation:

- Performance of the *Delta Mariner* bridge team and the contract pilot[2] hired to assist them, including passage planning, their understanding of their roles and responsibilities, and their use of navigation equipment.

- Effectiveness of the vessel's safety management system and safety oversight by Foss Maritime Company, the owner of the vessel.

- Maintenance of navigation lighting on Eggner's Ferry Bridge, overall responsibility for inspection and repair of Kentucky bridge navigation lighting, and the role of the US Coast Guard related to navigation lighting on bridges over inland waterways and broadcast warnings to mariners about potential navigation hazards.

Performance of bridge team and contract pilot. As the vessel approached Eggner's Ferry Bridge, the bridge team and contract pilot of the *Delta Mariner* were largely unaware of what lighting should have been visible on the bridge and which span allowed sufficient clearance for safe passage. The contract pilot and bridge team focused exclusively on the few lights visible on the bridge while ignoring readily available electronic charting system displays, which could have provided critical information about the vessel's position in relation to the bridge and the bridge's correct lighting scheme. Despite this lack of information, the contract pilot continued to direct the vessel toward a span that was too low for the *Delta Mariner*. Further, despite the contract pilot's apparent uncertainty, none of the bridge team challenged his directions.

Foss Maritime's safety management system and vessel management and oversight. The investigation revealed that the *Delta Mariner*'s safety management system, developed by the company more than 10 years earlier and in place at the time of the accident, was not effectively implemented. Overall, Foss Maritime provided ineffective oversight of the *Delta Mariner*'s operations. Due to the vessel's good safety record and the company's reliance on proactive safety measures and a crew of well-trained, experienced deep-sea mariners to provide a high

[1] For more detailed information on this report, visit http://www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA12FM006.

[2] The owner of the *Delta Mariner* regularly hired experienced towing vessel masters to guide and assist the bridge team for the portion of its inland rivers route between Decatur, Alabama, and Baton Rouge, Louisiana. For the purposes of this report, these individuals are referred to as contract pilots. They were not federally or state-licensed pilots but held Coast Guard–issued master of towing vessel licenses.

level of safety, the company became complacent regarding the safety of the vessel's operations. The investigation also found the expertise required of contract pilots was not clearly defined, and contract pilots and the *Delta Mariner*'s deck officers lacked clear understanding of the guidance expected from contract pilots while serving on the bridge of a vessel.

Navigation lighting on Kentucky bridges. Given that Eggner's Ferry Bridge was not properly lighted on the night of the accident, the NTSB investigated maintenance of lighting on Kentucky bridges that cross navigable waterways. The investigation found the Kentucky Transportation Cabinet (KYTC), the owner of the bridge, failed to effectively maintain the bridge's lighting in accordance with the Coast Guard–approved lighting plan. The KYTC also did not identify and resolve recurring lighting problems and their causes. The NTSB found personnel in the division performing repairs relied on inadequate knowledge of the correct lighting configuration and KYTC's oversight of its bridge navigation lighting maintenance was ineffective.

Coast Guard Bridge Administration oversight. The NTSB found the Coast Guard failed to identify recurring bridge lighting problems, and its process for verifying the resolution of bridge lighting problems was inadequate. The NTSB also determined the Coast Guard should consider more easily accessible means for warning mariners of potential hazards than its current broadcasts to mariners over VHF radio.

Based on analysis of the evidence, the NTSB determines the probable cause of the allision of the M/V *Delta Mariner* with Eggner's Ferry Bridge was the bridge team's exclusive reliance on the contract pilot's incorrect navigational direction as the vessel approached the bridge and the bridge team's failure to use all available navigation tools to verify the safety of the vessel's course. Contributing to the accident were Foss Maritime Company's failure to exercise effective safety oversight of the *Delta Mariner*'s operations and the failure of the Kentucky Transportation Cabinet to effectively maintain bridge navigation lighting.

Earlier in the investigation, due to the potential danger presented by inadequate bridge navigation lighting, the NTSB issued two recommendations to the commonwealth of Kentucky in April 2012. These recommendations addressed KYTC's responsibility for verifying the status and proper operation of navigation lighting on all Kentucky bridges over navigable waters and the need to develop inspection and maintenance procedures to ensure such lighting functions reliably. The NTSB determined that measures taken by the commonwealth and KYTC in response to recommendations by the NTSB addressed the issues satisfactorily and classified these recommendations "Closed—Acceptable Action" in November 2012.

As a result of the investigation, the NTSB issues additional safety recommendations to the Coast Guard concerning chronic bridge navigation lighting problems and the effectiveness of broadcast notices to mariners in alerting vessel bridge teams to potential hazards. The NTSB also recommends Foss Maritime Company address concerns regarding the expertise expected of contract pilots, the duties and responsibilities of the bridge team, and passage planning for the *Delta Mariner*. The NTSB further recommends the Federal Highway Administration alert state department of transportation bridge maintenance divisions to the circumstances of this allision and their responsibility to maintain bridge navigation lighting in accordance with Coast Guard regulations.

1. Accident Information and Circumstances

1.1 Accident Overview

The M/V *Delta Mariner*, a US-flagged roll on/roll off cargo vessel owned by Foss Maritime Company and operated by Foss Atlantic, Inc., departed Decatur, Alabama, about 1800 central standard time on January 25, 2012. The vessel was carrying rocket components from United Launch Alliance (ULA), a space industry manufacturing and assembly operation, to Cape Canaveral, Florida. The ship's intended route was along the Tennessee River to the Ohio River at Paducah, Kentucky, then south down the Mississippi River to the Southwest Pass and the Gulf of Mexico to Florida. (See figures 1 and 2.) The voyage typically took 8 to 10 days.

Figure 1. M/V *Delta Mariner***.** Photo by Ronny Maes, http://www.vesseltracker.com, accessed February 7, 2013.

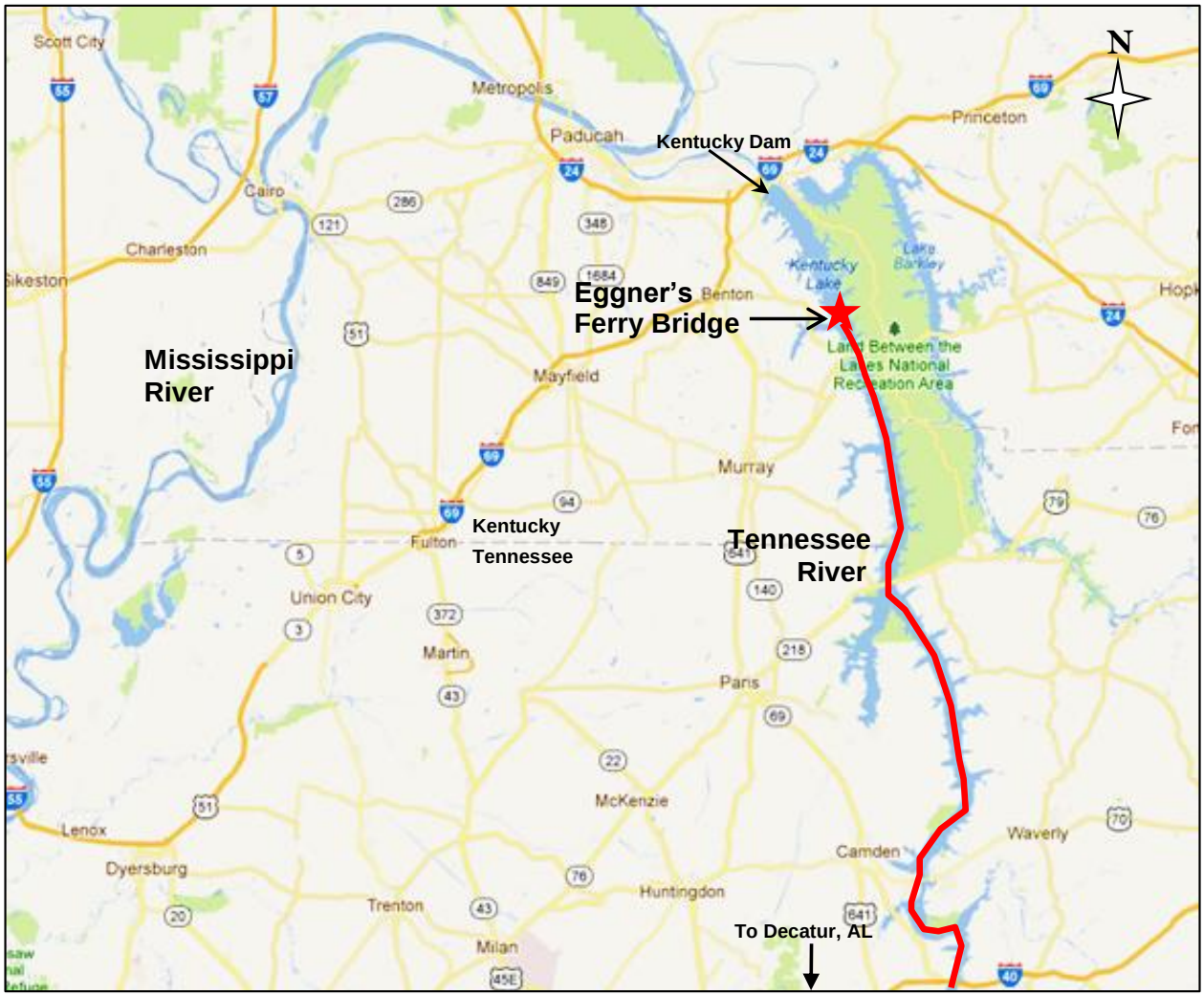

Figure 2. Route of the *Delta Mariner* on the Tennessee River from Decatur, Alabama, to Eggner's Ferry Bridge shown in red. Star indicates accident site.

On the evening of the next day, January 26, the *Delta Mariner* approached Eggner's Ferry Bridge at mile marker 41.7 on the Tennessee River (see figure 3). At 2001 central standard time, the vessel allided with a bridge span that provided insufficient vertical clearance for its passage (the lowest of four navigable spans). The *Delta Mariner* was traveling about 11.5 mph when it struck the bridge and tore away a 322-foot span, including a portion of US Highway 68.[3] Bridge debris lodged across the bow of the ship. The vessel sustained minor damage to its bow area, but its cargo was undamaged. Traffic was light on the bridge at the time of the accident, and vehicles traveling on the highway stopped before reaching the missing span. No injuries were reported on the vessel or on the highway, and no pollution was reported.

[3] Historically, distances on inland rivers are measured in statute miles; therefore, speed is given in miles per hour.

Figure 3. Eggner's Ferry Bridge, Tennessee River. Photo by US Coast Guard.

During the day of the accident, the *Delta Mariner* transited in rain, heavy at times, and reduced visibility. By evening the rain had subsided, and crewmembers reported visibility was good.

A total of 16 crewmembers were aboard, along with two contract pilots and two representatives of ULA, the cargo owner. Foss Maritime hired experienced towing vessel masters to guide and assist the *Delta Mariner* bridge team for the portion of its inland rivers route between Decatur and Baton Rouge, Louisiana. For the purposes of this report, these individuals are referred to as contract pilots. They were not licensed as pilots but held Coast Guard–issued master of towing vessel licenses.

In the pilothouse as the vessel approached the bridge were the master, chief mate, third mate, an able-bodied seaman (AB), and a contract pilot. Although the chief mate was the senior officer on watch, he was acting as helmsman at the time of the accident. The third mate was the other deck officer on watch. The master of the *Delta Mariner* arrived on the bridge about 10 minutes before the accident for a routine visit but was not on watch at the time. The AB was serving as lookout.

The National Transportation Safety Board (NTSB) launched a team of investigators to the scene on Friday, January 27, 2012. The Coast Guard was the lead investigative agency for the accident. NTSB investigators retrieved and reviewed the voyage data recorder (VDR) and data from the electronic charting system (ECS) from the vessel. While on scene and during the following months, NTSB investigators conducted interviews, collected documentation, and

participated in the Coast Guard Eighth District formal investigation hearing held April 16–20, 2012, in Paducah, Kentucky.[4]

Parties to the NTSB investigation were the US Coast Guard, Foss Maritime Company, and the Kentucky Transportation Cabinet, owner of Eggner's Ferry Bridge.

[4] Under 46 *Code of Federal Regulations* (CFR) 4.07, a Coast Guard district commander may authorize a formal investigation hearing into a marine accident or casualty to determine whether measures can be taken to prevent such casualties and promote safety. The *USCG Marine Safety Manual* (COMDTINST M16000.10A, April 2008) details the policies and procedures under which such investigations are conducted.

1.2 Vessel Information

Vessel	M/V *Delta Mariner*
Flag	United States
Port of registry	Falling Waters, West Virginia
Owner/operator	Foss Maritime Company/Foss Atlantic, Inc. (subsidiary)
Type	Roll on/roll off cargo ship
Builder, date	VT Halter Marine, Moss Point, Mississippi Delivered 2000
Classification society	American Bureau of Shipping
International Maritime Organization number	9198501
Construction	Steel
Depth	20 ft. (6 m)
Length overall	286.8 ft. (87.4 m)
Breadth	82 ft. (25 m)
Gross tonnage	8,679 (ITC[a])
Deadweight	3,887.6 long tons (3,950 metric tonnes)
Engine type and power	2 Electro Motive Division diesel 16-710-G7 engines Maximum power: 5,968 kW
Propulsion	2 aft azimuth drives, 2 bow thrusters
On day of departure:	
Draft	9 ft. 6 in. (2.9 m) forward 9 ft. 11 in. (3 m) aft
Cargo	Rocket components
Persons on board	16 bridge team 2 contract pilots 2 representatives of cargo owner

[a] Measured according to International Tonnage Convention.

Foss Maritime is an international provider of a broad range of marine transportation services. In 1988, the company formed Gulf Caribe Maritime, Inc., a wholly owned subsidiary, which operated the *Delta Mariner* until July 1, 2011. At that time, Gulf Caribe was merged with another Foss subsidiary, and the resulting corporate entity became Foss Atlantic, Inc. Foss Atlantic was the operator of the *Delta Mariner* at the time of the accident.

Foss Maritime commissioned construction of the *Delta Mariner* for operation both on the inland waterway system and offshore. The vessel was specifically designed to carry Delta IV rocket components and associated hardware from the Boeing manufacturing facility on the Tennessee River in Decatur, Alabama, to launch facilities at Vandenberg Air Force Base, California, and Cape Canaveral Air Force Station, Florida. In 2006, Boeing and Lockheed

Martin formed ULA as a joint venture to provide space-related services for defense, civil, and commercial industries. When ULA began producing components for Atlas V rockets at its Decatur facility in 2009, the mission of the *Delta Mariner* was modified to include transport of those components as well. At the time of the accident, the *Delta Mariner* was carrying Atlas V rocket components to Cape Canaveral. The cargo area of the *Delta Mariner* is shown in figure 4.

Figure 4. Common booster cores, similar to the cargo carried by the *Delta Mariner* on the accident voyage, are loaded into the *Delta Mariner*'s cargo area. Photo from United Launch Associates video, http://www.spaceflightnow.com, accessed February 7, 2013.

At the time of the accident, the *Delta Mariner* was subject to inspection by the Coast Guard; however, that function was delegated to the vessel's classification society, the American Bureau of Shipping (ABS) under the Alternate Compliance Program.[5] The vessel also operated in international waters and therefore was subject to the requirements of the International Convention for the Safety of Life at Sea (SOLAS) and the International Safety Management (ISM) Code for the Safe Operation of Ships and for Pollution Prevention, generally known as the ISM Code.[6]

[5] Under the Coast Guard's Alternate Compliance Program, the Coast Guard delegates commercial vessel inspection to a recognized classification society for vessels that meet certain requirements (see 46 CFR 8.4). As such a recognized organization, ABS inspected the *Delta Mariner*.

[6] SOLAS, a 1974 treaty managed by the International Maritime Organization (IMO), outlines minimum construction, operation, and equipment standards. The objectives of SOLAS and the ISM Code are to ensure safety at sea, prevent human injury or loss of life, and minimize the risk of environmental or property damage.

1.3 Damage to Vessel and Bridge

1.3.1 *Delta Mariner*

An initial postaccident survey of the *Delta Mariner*, conducted on January 27, 2012, by ABS, identified damage to the bow of the vessel: the bulwark, which normally extends above the upper side of the ship was flattened to the deck; panama chocks (casings used for line handling from one vessel to another or to the dock) were broken; and debris was resting on top of bollards (which secure ship's lines) and deck winches. After the allision, approximately 275 long tons (616,000 lbs.) of the bridge span weight was resting on the vessel. The survey also found two small puncture holes in the forecastle deck, but the vessel's hull remained watertight. Figure 5 shows the bow of the *Delta Mariner* and the section of the highway bridge that was torn away by the allision.

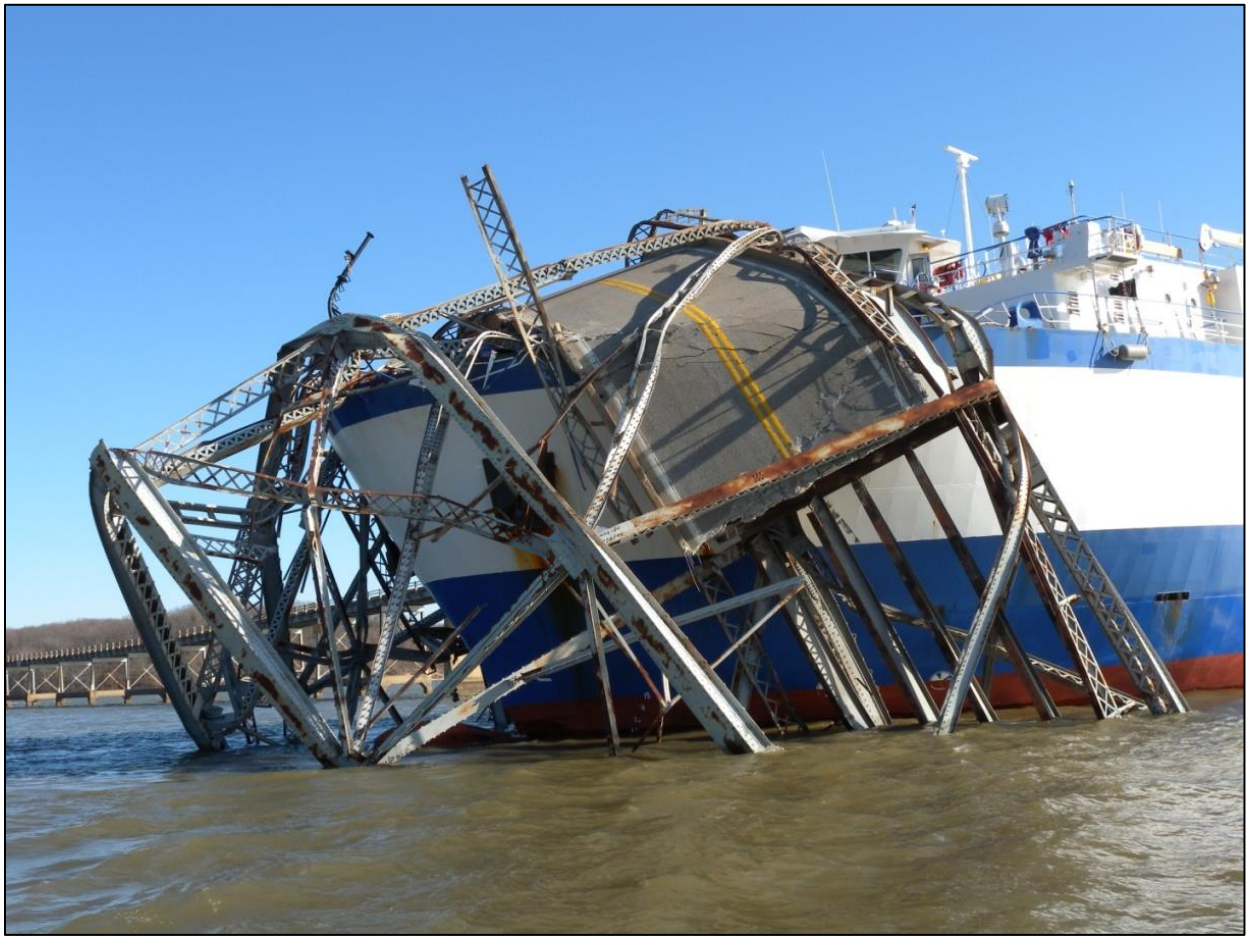

Figure 5. Postaccident photograph showing a portion of Eggner's Ferry Bridge span E and US Highway 68 resting across the bow of the *Delta Mariner*.

A dive survey conducted the next day, January 28, found no indications of damage to the hull below the waterline. The ship was repaired and returned to service on February 12, 2012.

Foss Maritime officials reported the total cost of removing bridge debris from the deck of the *Delta Mariner* and repairing the bow and pilothouse superstructure was $2,583,750.

1.3.2 Eggner's Ferry Bridge and US Highway 68

Eggner's Ferry Bridge was closed for repairs following the allision, and traffic was diverted until the bridge reopened to traffic on May 25, 2012. KYTC reported total costs of about $7.2 million resulting from the accident. Figure 6 is a photo of the *Delta Mariner* and the bridge following the accident.

Figure 6. Eggner's Ferry Bridge with *Delta Mariner* anchored after striking span E. The stern of the vessel is visible between the piers of the downed span E. Photo by www.wired2fish.com.

1.4 Injuries

No injuries were reported either on the *Delta Mariner* or on the bridge.

1.5 Weather and Waterway Conditions

1.5.1 Weather

The weather reporting location nearest the accident site, about 13.5 miles west in Murray, Kentucky, reported the following weather conditions at the time of the accident: winds from 330° at 13 knots, visibility of 10 miles, ceiling broken at 800 feet, overcast at 11,000 feet above ground level, temperature 39°F (4°C), and dew point temperature 37°F (3°C). The automated weather observation system did not record precipitation.

Weather models suggested that at the accident site west-northwesterly winds were prevailing with overcast clouds. Light to heavy continuous rain was present across the region.

Temperatures were in the low to mid-40s F with dew point temperature at or within 2°F of the temperature, indicating saturated conditions.

The moon was a waxing crescent with 15 percent of its visible disk illuminated; however, given the broken to overcast cloud cover over the area, no significant illumination would have been expected.

1.5.2 Tennessee River

The navigation channel of the Tennessee River, the largest tributary of the Ohio River, is 652 miles long. The Tennessee River system is managed through a series of dams and navigation locks owned by the US government and operated by the Tennessee Valley Authority (TVA) and the US Army Corps of Engineers. The TVA Act of 1933 (16 *United States Code* [USC] 831 et seq.) required the TVA to provide a 9-foot-deep navigation channel from Knoxville, Tennessee, to Paducah, Kentucky. A TVA study (TVA 2012) described the cooperative operation of the project:

> The responsibilities of maintaining safe navigation on the Tennessee River are divided among three federal agencies. TVA has custody of and control over the physical structures in the water and releases water to provide sufficient depth for navigation. [The Army Corps of Engineers] operates the locks and is responsible for periodic dredging to maintain channel depth. The US Coast Guard installs and maintains the navigation aids in the main channels.

From its beginning just above Knoxville, the Tennessee River drops a total of 513 feet in elevation before joining the Ohio River. The TVA described its management of this section of the river: "The TVA system of nine main-river dams allows boats to ascend or descend a 'staircase' of quiet, pooled water and controlled current—a continuous series of reservoirs that stretches the entire length of the Tennessee River." (TVA 2013) The nine main and four auxiliary locks allow commercial and recreational vessels to pass from one reservoir to another. "The Tennessee River navigation system provides for a year-round channel with a minimum depth of 11 feet between Knoxville and Paducah and on several tributaries. The 11-foot-deep channel provides the 9-foot navigation depth mandated by the TVA Act plus a 2-foot margin of safety." (TVA 2012)

Kentucky Lake, the largest manmade lake in the eastern United States, was created by the construction of the Kentucky Dam about 19 miles north of Eggner's Ferry Bridge. The dam backed up the Tennessee River for 184 miles and created a lake that stretches south across the western tip of Kentucky. In the vicinity of Eggner's Ferry Bridge, the river was just over a half mile wide. Water depth under the span the *Delta Mariner* transited was about 40 feet. In the vessel passage plan, the crew recorded the river current speed as "fast" in the hours leading up to the accident. The vessel was traveling with the current.

1.6 Eggner's Ferry Bridge

Original construction of Eggner's Ferry Bridge was completed in 1932. Several years later, at the request of TVA, the bridge was raised to provide a vertical clearance of 41 feet from the maximum reservoir water level to the lowest point on the bridge span. In 1942, the bridge

was raised to its present level of 57 feet above the normal water level. The central section of the bridge consists of six spans, A through F from west to east, supported by seven piers. The concrete deck was last repaired and an asphalt overlay provided in 2008.

Clearance under each bridge span varied with the water level, which was largely determined by dam operations. The Army Corps of Engineers measured water elevation of the Tennessee River at Kentucky Dam at approximately 355 feet about 1800 on January 26, approximately 2 hours before the allision. The *Delta Mariner* crew had calculated an air draft of 3.57 feet between the highest point on the vessel—the automatic identification system (AIS) antenna—and span B of Eggner's Ferry Bridge, where the vessel should have transited. Span E provided approximately 11 feet less clearance at its highest point based on field measurements taken after the accident, which was about 7.43 feet less clearance than the *Delta Mariner* needed. Bridge spans B and E are indicated in figure 7.

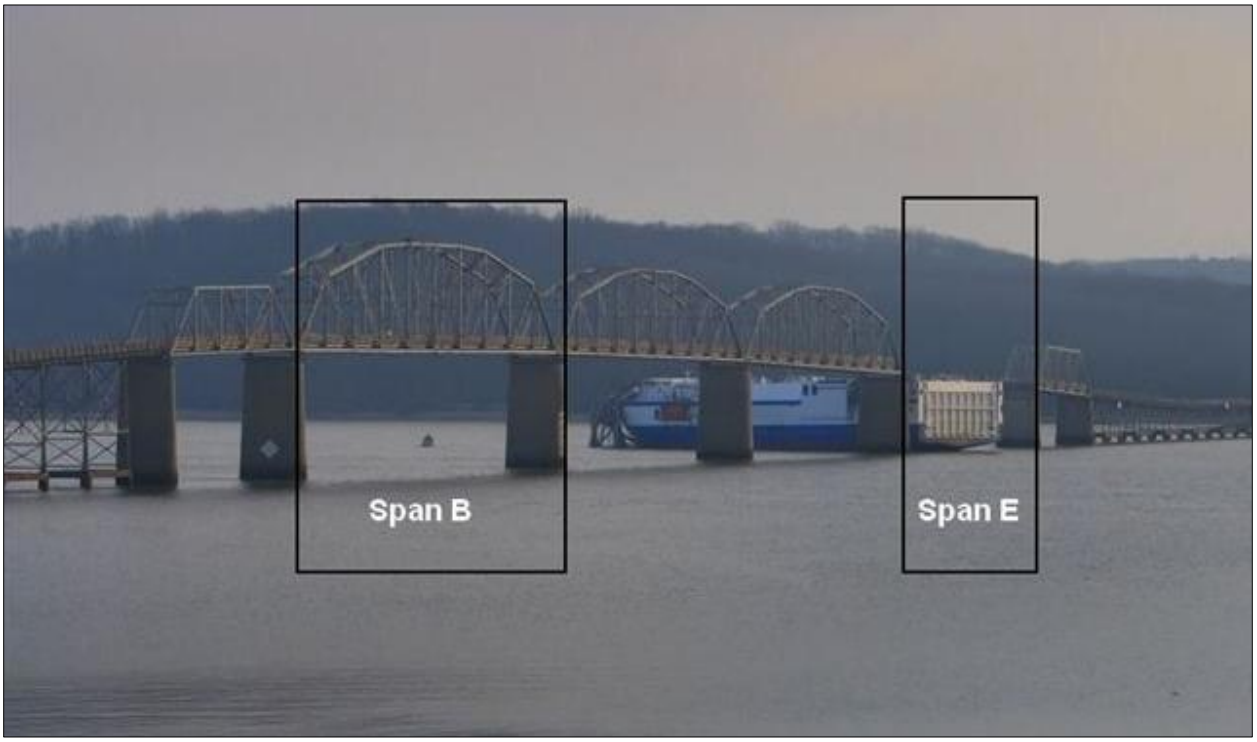

Figure 7. Eggner's Ferry Bridge indicating span B, the main navigation span, and span E, which was struck by the *Delta Mariner*. Photo by www.wired2fish.com.

1.7 Coast Guard Bridge Administration

Eggner's Ferry Bridge fell within the jurisdiction of the Coast Guard's Eighth District Western Rivers Bridge Branch, based in St. Louis, Missouri. A Coast Guard Bridge Branch is located in each Coast Guard district and is responsible for carrying out the Coast Guard Bridge Administration program, which is congressionally mandated to protect the public right of navigation. One of the functions of the bridge administration is to approve navigation lighting plans for bridges crossing navigable waters. Coast Guard lighting specifications for Eggner's Ferry Bridge are illustrated in figure 8.

The initial lighting plan for Eggner's Ferry Bridge was prescribed in a letter from the Coast Guard to KYTC in 1973 and remained unchanged until 1996. At that time a requirement was added for 24-inch-square high-intensity red retroreflective panels on the piers on the upstream side. Such panels direct reflected light back toward a light source, such as a spotlight, rather than in all directions as with diffuse reflection. The 2011 plan required retroreflective panels for both upstream and downstream sides of the bridge.

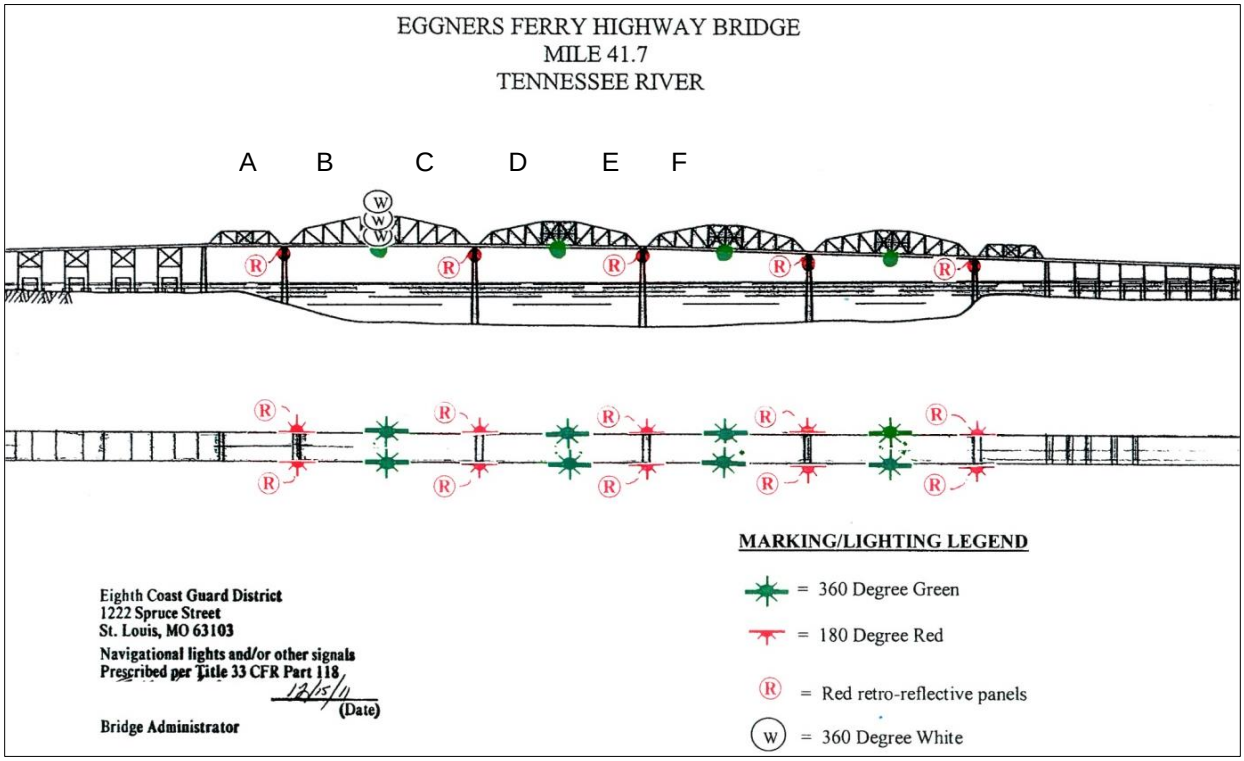

Figure 8. Coast Guard lighting specifications for Eggner's Ferry Bridge, with labels added to identify spans A through F. The lighting scheme is depicted from upstream of the bridge, as it should have appeared to the *Delta Mariner* bridge team the night of the accident. Red lights mark each pier, and green lights mark the center of each span. Span B, the main navigation span, is designated by three white lights arranged vertically at the center of the span above the corresponding green light. The plan also shows an overhead view to illustrate that the lights are affixed on both sides of the bridge. Illustration by the Coast Guard.

The lighting plan for Eggner's Ferry Bridge specified that lights and retroreflective panels were to be "displayed from sunset to sunrise each night of the year and at other times when the visibility is less than one mile."

Federal regulations at 33 CFR 118 authorize the Coast Guard district commander to approve plans for lighting and other required signals before bridge construction and to modify any light and signal requirements as warranted by changes in local conditions.

1.8 Kentucky Bridge Maintenance

1.8.1 Kentucky Transportation Cabinet

The commonwealth of Kentucky is the legal owner of Eggner's Ferry Bridge, which is located in KYTC District 1 under the purview of the Division of Traffic Operations. Coast Guard regulations at 33 CFR 118 require a bridge owner to maintain any required bridge navigation lights or signals. The KYTC Traffic Operations Guidance Manual detailed its responsibilities for maintenance and inspection of Coast Guard–required bridge navigation lights:

> The Cabinet shall be responsible for navigation lighting on bridges when the United States Coast Guard requires such lighting. The Cabinet shall follow all applicable sections of Enclosure 6, COMDTINST M 16590.5A, Bridge Administration Manual of the United Sates Coast Guard, when the lighting is required.
>
> The district shall be responsible for the maintenance of navigation lighting. The district should conduct periodic inspections of navigation lighting and keep records of the inspections.

1.8.2 Coordination with US Coast Guard

The Coast Guard typically received notification about bridge lighting issues from mariners reporting to the Coast Guard Sector Ohio Valley Command Center, but occasionally the Coast Guard Bridge Branch was notified directly. In either case, the Sector Command Center would issue a broadcast notice to mariners (BNM), and the Bridge Office would notify the bridge owner of the problem. The Coast Guard sends BNMs on very high frequency (VHF)-FM, NAVTEX (Navigational Telex), and other maritime frequencies. These navigational warnings contain important information for mariners and typically address short-term or temporary issues. A BNM consists of an initial call-out from the Coast Guard on VHF channel 16, a hailing and distress channel regularly monitored by vessels under way. To minimize broadcast time on this channel, the initial call-out informs mariners an important navigation notice is pending and asks them to switch to channel 22a to hear the actual notice. Channel 22a is used for more extensive Coast Guard communications such as broadcasting the details of the BNM. When lighting issues were reported to the Coast Guard, the Eighth District Bridge Branch coordinated directly with KYTC.

Both the Coast Guard and KYTC were aware that at least some of the lights were not functioning on Eggner's Ferry Bridge on the day of the accident. Coast Guard Sector Ohio Valley was notified that lights were out on Eggner's Ferry Bridge on Saturday, January 21. Beginning that day at 1033, Sector Ohio Valley Command Center issued a BNM twice daily stating that all navigation lights were reported out on Eggner's Ferry Bridge and asking mariners to transit the area with caution. The Bridge Branch notified KYTC on Monday, January 23, that lights were reported out. KYTC began work on the lights on Tuesday, January 24. On the day of the accident the BNM was broadcast at 0400 and 1613. None of the deck officers on the *Delta Mariner* recalled hearing the initial call-out indicating a BNM had been issued. Investigators reviewed the VDR audio and were able to identify the 1613 call-out by the

Coast Guard on channel 16, but the bridge team on the *Delta Mariner* did not switch channels to listen to the content of the BNM.

1.9 Personnel Information

1.9.1 *Delta Mariner* Bridge Team

Master. At the time of the accident, the 60-year-old master had been employed by Foss Atlantic (formerly Gulf Caribe) for over 11 years as a chief mate and as master. He held a Coast Guard license as master of steam or motor vessels of any gross tons on oceans. His license included endorsements as first-class pilot on vessels of any gross tons upon the waters of Prince William Sound from Hinchinbrook Entrance to the Port of Valdez, Alaska. He held a Standards of Training, Certification and Watchkeeping (STCW) certificate as master, meaning he met the minimum safety and competence standards of the STCW code.[7]

The master served in the US Navy from 1970 to 1974 before beginning a 24-year career with Atlantic Richfield, a US oil company operating petroleum tankers. First employed as an ordinary seaman, he progressed to third mate in 1982 and ultimately to master. He left the company in 2000 and joined Gulf Caribe (now Foss Atlantic) as chief mate on the *Delta Mariner*, becoming master later that year. The master had been on watch during 10 transits under Eggner's Ferry Bridge before this accident.

His work rotation was 50 days on, 50 days off, standing watch 0900 to 1500 and 2100 to 0300. The first day of the voyage, the master reported he woke about 0800 and stayed awake that night until going to sleep about 0300 and waking prior to his watch at 0900 on the second day. He slept again from about 1500 to 1900, waking about an hour before the accident. He previously maintained a more regular schedule while in port, going to sleep around 2000 to 2100 and usually waking about 0600.

Chief mate. The chief mate, age 65, was employed by Foss Atlantic for more than 8 years. He held a Coast Guard license as master of steam or motor vessels of any gross tons upon oceans and as master of towing vessels upon oceans and western rivers.

After working offshore on crew boats, tugboats, and supply boats since 1976, he moved to deep-sea vessels, including oceangoing towing vessels and tankers, where he gained most of his experience. He joined the *Delta Mariner* as third mate, progressed to second mate 2 months later in 2003, and became chief mate in 2006. All his river experience was on board the *Delta Mariner*. The chief mate had been on watch during 10 transits under Eggner's Ferry Bridge before this accident.

[7] The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers was the first international agreement to set qualification standards for masters, officers, and watch personnel on seagoing merchant ships. STCW was adopted in 1978 by the International Maritime Organization (IMO) in 1978 and entered into force in 1984. Significant amendments in 1995 created the STCW Code, which set stringent standards for mariners, and required that mariners obtain a certificate of their compliance with those standards.

The night before the accident, the chief mate said he went to sleep about 1900, woke about 0230, and stayed awake through the evening of the allision. He stood watch from 0300 to 0900 and 1500 to 2100 on the day of the accident. His work rotation was 65 days on, 65 days off. In the previous 2 days while in port in Decatur, he reported going to sleep between 1900 and 2200 and waking between 0600 and 0630.

Third mate. The third mate, age 58, was employed for 5 years by Foss Atlantic. He held a Coast Guard license as master of steam or motor vessels of not more than 1,600 gross registered tons (domestic), 3,000 gross tons (international) upon oceans, unlimited radar observer, and third mate of steam or motor vessels of any gross tons upon oceans.

He began his maritime career working on fishing and shrimping boats in 1976 and then worked in the Gulf of Mexico oil field on utility boats, first as a deck hand and engineer and progressing to captain, licensed since 1990. He was captain on a crew boat and on a supply boat, mate and captain on a casino boat, and a contractor on several Navy fleet operations and research vessels for a total of about 13 years. He joined the *Delta Mariner* in Cape Canaveral on January 5, 2012. The third mate had been on watch during four transits under Eggner's Ferry Bridge before this accident.

His rotation on the vessel was 60 days on, 60 days off, standing watch 0600 to 1200 and 1800 to 2400. The night preceding the accident, he went to sleep at midnight and woke prior to his 0600 watch. He reported a fairly regular sleep/wake schedule in the preceding three days while in port in Decatur, usually going to sleep between 2100 and 2400 and waking between 0600 and 0700.

Able-bodied seaman. The 58-year-old AB, who was acting as lookout at the time of the accident, had been employed by Foss Atlantic on and off since 2000. He estimated he had been in the maritime industry for about 17 years, spending most of his time on deep-sea tank and freight vessels for various companies. He was first hired by Foss Atlantic as an ordinary seaman, left the company in 2006, and was rehired in 2008 as an AB. He had been on watch during eight transits under Eggner's Ferry Bridge before this accident. His rotation on the *Delta Mariner* was 4 months on the vessel, 1 month off. He stood the 0800 to 1200 and 2000 to 2400 watch each day when under way on the river.

1.9.2 Contract Pilot

The 58-year-old contract pilot worked as an independent contractor for Foss Atlantic since mid-2008. He held a Coast Guard license as master of towing vessels upon Great Lakes, inland waters, and western rivers except waters subject to the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS). His license included a radar observer (unlimited) endorsement.

The contract pilot began working for American Commercial Barge Line, now American Commercial Lines (ACL), as a deckhand on towing vessels in 1972 and had been a towing vessel officer for ACL since 1976. At the time of the accident, he was employed as captain of the *Elizabeth Dewey*, a 165-foot, 7,200-hp towing vessel, working 28 days on, 28 days off. The contract pilot said he was a heavy tow pilot for ACL and routinely operated his vessel with up to 25 loaded barges in all river and weather conditions. Most of his experience was on the Mississippi River between St. Louis and New Orleans. On his days off from his ACL job, he said

he sometimes worked as contract pilot on board the *Delta Mariner*. He could not recall how many trips he had completed on the Tennessee River and could only estimate he made more than 12 transits since he began sailing in 1972, some of which he said could have included transits under Eggner's Ferry Bridge. According to Foss Maritime records, the contract pilot had been on watch on the *Delta Mariner* during four transits under Eggner's Ferry Bridge before this accident.

On the night of January 24, prior to joining the vessel, the contract pilot slept from midnight to 0500. He boarded the vessel on January 25, the day before the accident. That night he reported he again slept from midnight to 0500. He stood his morning watch the day of the accident and went back to sleep from about 1130 to 1600. His scheduled watchstanding periods were from 0600 to 1200 and 1800 to 2400.[8]

The contract pilot had been diagnosed with sleep apnea, considered to be severe by the sleep specialist physician who was treating him. As a result, he was required under the provisions of his Coast Guard–issued waiver to use a continuous positive airway pressure (CPAP) device when sleeping before performing duties as a licensed mariner. The contract pilot told investigators he regularly used the device and brought it with him when on board, and no evidence suggested otherwise. However, accident investigators were unable to determine from the machine his history of CPAP use because of a malfunction in its recording mechanism. The sleep specialist physician treating him, upon examining a CPAP technician's written findings regarding the machine, also was unable to determine whether the pilot had used it and, if so, whether it was functioning properly at the time of the accident.

1.10 Events Following the Accident

After the *Delta Mariner* allided with the bridge, the master ordered the stern anchor dropped. The pilot immediately notified the Coast Guard of the accident by VHF radio and asked for assistance in stopping vehicle traffic on the bridge. Crewmembers turned the spotlight on the bridge to warn drivers of the damage.

At the time of the allision, a truck-tractor-semitrailer combination unit was approaching the bridge from the east side. The unit was on the approach spans when the driver saw the allision and was able to stop several hundred feet back from the missing span of the bridge. An off-duty Kentucky State Police detective arrived and established traffic control and was able to prevent one driver from passing the stopped truck and traveling onto the bridge. On the west side of the bridge, a motorist in a private vehicle had passed span B and was a few hundred feet away from span E when he saw the allision and was able to stop. This motorist and the truck on the other side of the bridge told emergency responders they thought no one had driven off the bridge.

After notification of the accident, the Coast Guard in turn reported it to the county sheriff's office. The sheriff's office contacted the Kentucky State Police, who were already in route in response to earlier notification by the off-duty state police officer on scene. Marked police units from the sheriff's office and the state police were on scene within 15 minutes of the

[8] Off-duty times may appear to overlap with watchstanding periods because a crewmember may be relieved early toward the end of a watch.

allision. In addition, emergency responders from the county deployed a vessel equipped with side-mounted sonar to verify that no vehicles were in the water. The county vessel was in the water within 45 minutes of the allision and confirmed that no vehicles were in the water.

1.11 Toxicological Testing

The contract pilot and all crewmembers on the bridge at the time of the accident were tested for alcohol within 2 hours of the accident and for illegal drugs within 3 hours, and all results were negative.[9] Split samples for the crewmembers and contract pilot were sent for additional testing to the Civil Aerospace Medical Institute laboratory in Oklahoma City, Oklahoma, and again produced negative results. Crewmembers reported taking no prescription medications.

1.12 Previous Allisions at Eggner's Ferry Bridge

Eight marine incidents occurred at Eggner's Ferry Bridge since 1992, most involving towing vessels having minor to serious allisions with the bridge's concrete piers. The most recent allision before the *Delta Mariner* accident involved the towing vessel *Miss Katie*, which struck the lower segment of the span E truss superstructure between piers 5 and 6 on November 15, 2011, about 2 months before the current accident. This was the same span that was struck when the *Delta Mariner* allided with the bridge. The *Miss Katie* allision also occurred at night, and the master and pilot of the vessel indicated span E was lighted and one of the spans to the left was partially lighted. Photographs taken at night after the allision showed that the bridge navigation lights were not visible on two spans and three bridge piers. KYTC and the Coast Guard reported the radar mast and a part of a fiberglass container on the *Miss Katie* contacted the lowest part of the bridge.

Coast Guard Marine Safety Unit Paducah conducted an informal investigation into the *Miss Katie* allision. The investigation identified the missing lighting on the bridge as a potential factor in the accident and notified the Coast Guard Bridge Branch of the issue. The Bridge Branch notified KYTC and requested the bridge lighting be repaired. According to testimony by Bridge Branch personnel during the Coast Guard's formal investigation hearing in April 2012, the lights were reported out on four more occasions following the *Miss Katie* allision and before the *Delta Mariner* accident. As a result of the first two of these reports, both in November 2011, the Bridge Branch sent a letter to KYTC in December citing its obligation as bridge owner to maintain the lighting on the bridge. The letter also contained a copy of the approved lighting plan.

[9] The contract pilot and crewmembers were tested according to federal regulations at 46 CFR 4.06, which require postaccident drug and alcohol testing for "each individual engaged or employed on board the vessel who is directly involved in" a serious marine incident. Alcohol testing must be conducted within 2 hours of a serious marine incident (unless safety concerns related to the incident preclude it, in which case no testing is required beyond 8 hours), and drug-test specimens must be collected within 32 hours. Regulations at 46 CFR 16.113 specify testing for marijuana, cocaine, opiates, phencyclidine, and amphetamines.

2. Investigation and Analysis

The NTSB investigation derived information from several sources:

- Interviews with crewmembers and the contract pilot on board the *Delta Mariner* and personnel from the KYTC Bridge Maintenance Division and the Coast Guard Eighth District.

- Testimony of *Delta Mariner* crewmembers and the contract pilot; management and staff of Foss Atlantic, Inc., and Foss Maritime Company; KYTC staff; and Coast Guard Bridge Branch personnel during the Coast Guard formal investigation held in Paducah, Kentucky, April 16–20, 2011.

- The *Delta Mariner* VDR and ECS.

- Documentation and records from organizations including the Coast Guard, the TVA, the Army Corps of Engineers, Foss Maritime and Foss Atlantic, and ABS as well as relevant US regulations and legislation and international conventions.

Based on the evidence, investigators eliminated several issues as factors in the accident. The negative results from toxicological tests ruled out the use of alcohol and illegal drugs at the time. Investigators also found neither the mechanical condition of the *Delta Mariner* nor its propulsion systems were factors in the accident. No distraction from the use of cell phones or other electronic devices was identified. The NTSB concludes none of the following were found to be factors in the accident: the use of alcohol or illegal drugs, the mechanical condition of the *Delta Mariner* or its propulsion systems, and distraction from the use of cell phones or other electronic devices.

Investigators examined the sleep/wake/work history of the officers on the *Delta Mariner* bridge at the time of the accident. All had maintained regular sleep patterns in the days preceding the accident voyage. In the 1 day the vessel had been under way, except for the AB, all bridge officers maintained a 6-hours-on/6-hours-off watch schedule. Such a schedule can, over time, potentially disrupt circadian rhythms, which can interfere with watchstanders' ability to sleep at times when they are used to being awake and keep them on duty when they would otherwise obtain their deepest sleep. If the *Delta Mariner* bridge officers slept in the times they reported to investigators, the amount of sleep they obtained could have enabled them to avoid being fatigued. Further, the 6-hours-on/6-hours-off schedule was maintained only during the inland rivers portion of the voyage, a period of 4 to 5 days.

The contract pilot, who also was starting a 6-hours-on/6-hours-off watch schedule, had been diagnosed with sleep apnea and was using a CPAP device to treat this condition in accordance with Coast Guard medical requirements. However, the data needed to determine the extent of his use of the device as well as its efficacy could not be obtained. In all cases, the evidence regarding possible fatigue among the bridge officers and contract pilot on board the *Delta Mariner* was insufficient to determine whether they were fatigued at the time of the accident.

2.1 Sequence of Accident Events

The *Delta Mariner*'s voyage was uneventful as the ship transited north, or downbound, on the Tennessee River. According to the vessel's operations manual, two deck watch officers were required on the bridge at all times during river transits, which exceeded Coast Guard watchstanding requirements for the vessel codified in 46 CFR 15. At the time of the accident, the chief mate and third mate were standing the bridge watch. The chief mate was at the helm, and the third mate was standing near the chart table on the starboard aft side of the pilothouse. The officers typically rotated the helmsman position every hour, as required by the vessel's operations manual and the master's supplemental river orders requiring hourly exchange of steering responsibility to avoid excessive strain.[10] An AB was acting as lookout on the starboard side of the pilothouse by the spotlight. The contract pilot was on the port side of the pilothouse near the helm where he could operate the port spotlight.

The chief mate said his watch turnover with the master was routine when the chief mate assumed the watch at 1454, and they discussed upcoming waypoints and the weather. The contract pilot came on watch at 1720, and the off-going contract pilot briefed him on vessels in the area and told him visibility was improving. The third mate relieved the second mate at 1750, and they discussed how they were steering the vessel, weather, and upcoming items on the passage plan. When the AB relieved the previous lookout about 10 minutes before the accident, the only information reported to have passed from the previous lookout was that there was no traffic. All watch turnover times were recorded in the *Delta Mariner* deck log for January 26.

The *Delta Mariner* carried a simplified voyage data recorder (S-VDR), which captured audio data from the pilothouse and a record of time, latitude and longitude, speed through water, heading, rate of turn, depth, and wind speed and direction.

The audio recording revealed that about 1946, 15 minute before the allision, an unidentified voice in the pilothouse called out that the vessel was approaching a bridge (see chart of the accident location in figure 9). At this time, Eggner's Ferry Bridge was approximately 3 miles away. About a minute later, the pilot and chief mate discussed the vessel's heading and navigation aids in the vicinity.

[10] The master created supplemental river orders for each upbound and downbound voyage on the rivers. The purpose of the river orders was to spell out the master's expectation for navigation of the vessel. They were to be reviewed and signed by all deck officers.

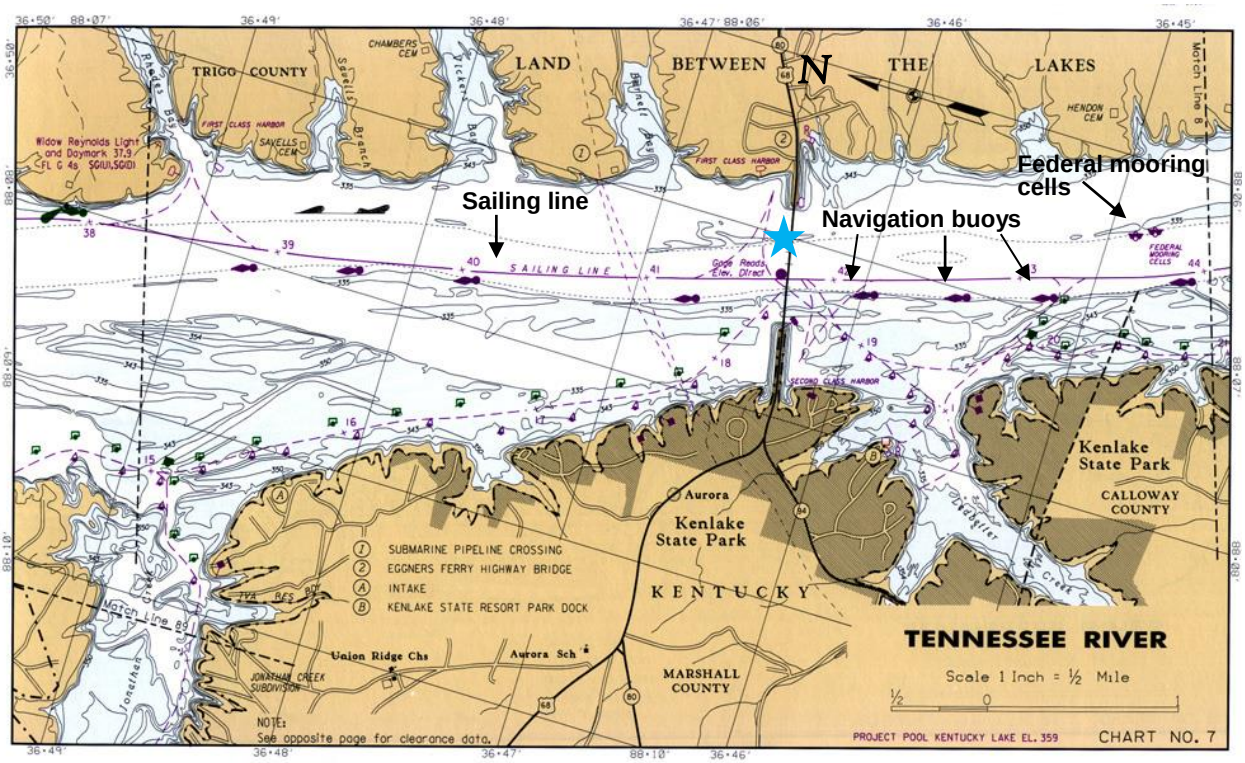

Figure 9. Area of US Army Corps of Engineers chart 7 of the Tennessee River detailing the location of the *Delta Mariner* allision with Eggner's Ferry Bridge, indicated by a blue star. The sailing line is clearly depicted and labeled in purple.

When the *Delta Mariner* was less than 2.6 miles south of the bridge, the vessel passed the towboat *Addi Belle* secured at the federal mooring cells to the east of the sailing line, indicated in figure 9.[11,12] The *Delta Mariner* master's voice was first heard on the VDR a few minutes later at 1951 when he came to the pilothouse for a routine visit. He told investigators he had woken early for his next watch and went up to "see where we were and . . . see how things were going. And then my intent was to make a quick visit, go back down to my room and get ready to go on watch." The chief mate briefed the master on the expected vertical clearance of the upcoming bridge. The *Delta Mariner* was about 1.8 miles from the bridge at this time.

The main navigation span, or span B, and its vertical clearance were indicated in a diagram in the Army Corps of Engineers chart book (see figure 10).[13] The bridge lighting plan was not shown on the paper chart but was available from the vessel's ECS. According to the bridge lighting plan, this span should have been marked by a green light in the center, three

[11] A sailing line is the preferred or recommended route vessels should follow within a navigable channel. It is generally based on a known safe and optimal route used by commercial vessels.

[12] A federal mooring cell is a riverfront structure generally composed of steel piling or a cluster of wooden piles used for securing barges along the bank at loading facilities. The Army Corps of Engineers uses the term to describe the same structures placed up- and downriver from a lock where vessels can tie off while waiting to pass through the lock.

[13] In this report, the term "navigation channel" refers to the deepest part of the Tennessee River. The Army Corps of Engineers is required to dredge the main channel to maintain a depth of at least 9 feet to allow safe passage. "Main navigation span" refers to span B, the highest span of Eggner's Ferry Bridge. The sailing line passes under the main navigation span.

white lights arranged vertically above the green light, and a red light on the pier on each side of the span. Crewmembers in the pilothouse told investigators only three lights were visible on the entire bridge as they approached—two red lights marking bridge piers at each side of the span and one green light in between marking the middle of the span. The lighted span was span E, approximately 800 feet to the right of the sailing line and the center of the main navigation span.

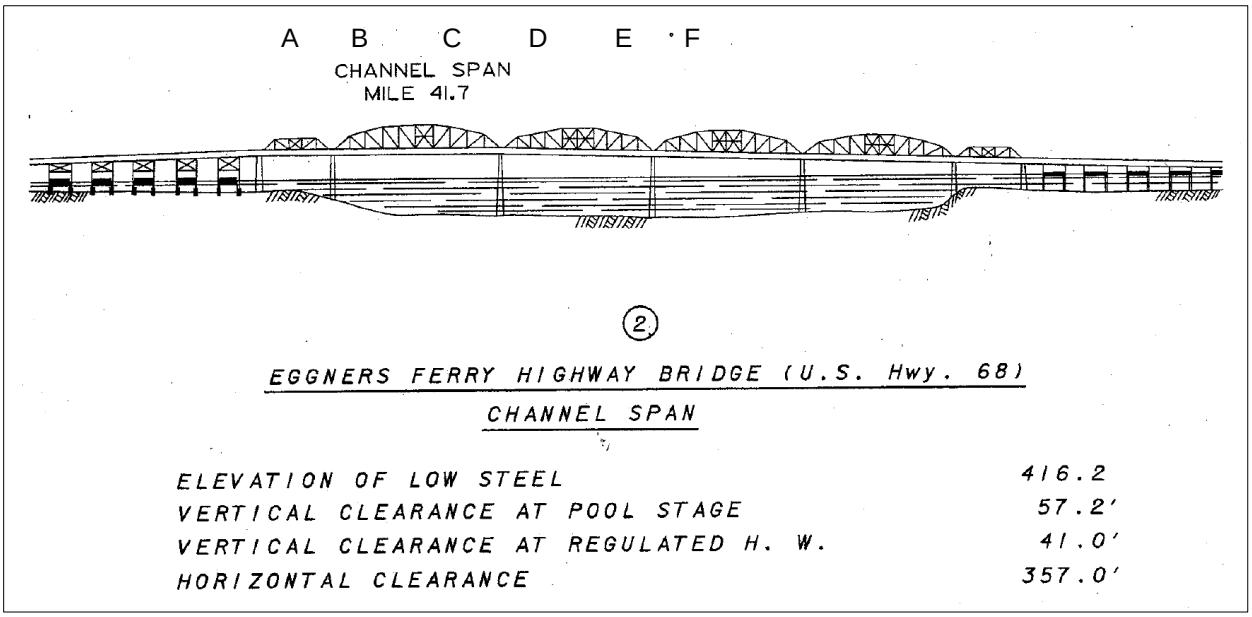

Figure 10. Eggner's Ferry Bridge channel span elevation in the Army Corps of Engineers chart book, with labels added to identify spans A through F. This drawing depicts the bridge as viewed from upstream, the side the *Delta Mariner* was approaching.

At 1957, the contract pilot instructed the chief mate to line up on the green light. Immediately after giving this order, VDR audio indicated the contract pilot said, "I'm thinking the red looks higher." About 26 seconds later, he added, "It is ain't it?" The contract pilot clearly was unsure about the bridge lights he was seeing and what they indicated; less than a minute later, he seemed to realize his mistake, saying "oh [expletive]." The master asked if they should turn the vessel around, but the pilot continued to direct the bridge team toward the wrong span. The vessel was approximately half a mile from the bridge at that point, sufficient distance to slow the vessel or turn around.

About 45 seconds later, the master said, "If you can't slow it down fast enough . . . turn it around." The contract pilot responded, "No no wait listen I think we can go through these," referring to the visible navigation lights. Less than 30 seconds later, and less than half a mile from the bridge, the chief mate asked the contract pilot and bridge team how he should proceed: "What's it gonna be guys?"

The master, contract pilot, and chief mate continued to discuss the lights and the span they were approaching. About a minute later, at 1959, the chief mate again asked how he should proceed. The *Delta Mariner* was then about 500 yards from the bridge. The contract pilot told the chief mate to steer for a spot between the green light and the red light to its left where the bridge appeared to be higher. The pilot of the *Addi Belle* told Coast Guard investigators he thought the *Delta Mariner* was in the wrong position to pass under Eggner's Ferry Bridge and he radioed the *Delta Mariner* to say the navigation lights were out on the bridge. He told

investigators the *Delta Mariner* radioed back, "Well, that is what we're looking at." The master of the *Addi Belle* said he made a second radio call saying, "I don't know how high you are." The contract pilot said he remembered hearing a radio call but could not recall if he responded because his attention was on the bridge.

The *Delta Mariner* maintained its speed of about 11.5 mph without slowing before it struck the bridge about 2001. The chief mate put the engines full astern just before impact.

The contract pilot told investigators he could see Eggner's Ferry Bridge when the ship was about 4 to 5 miles away. He said his normal downbound approach for the bridge was to use the red buoys on the port side as a guide to line up for the main navigation span. On the evening of the accident, he said, the vessel was maneuvered "over to the red buoys and then we shaped up on the red buoys and then pulled on out to the green light." He later questioned whether the red buoys were actually in place that evening; however, the Coast Guard's postaccident survey of aids to navigation found three of the four red buoys on approach to Eggner's Ferry Bridge were in position to guide vessels toward the main navigation span; the fourth was found nearby on shore. These were not lighted buoys.

The contract pilot remembered seeing two bridge piers, each lighted by a red light, with a green light in the middle. He did not see any other lights on the bridge. He told investigators the lighting he saw that evening was not what he expected to see, and he knew additional spans should have been lighted. He did not relay this information to anyone in the pilothouse. He also said he knew the lighted span toward which he was directing the chief mate to steer was not the main navigation span. He believed the vessel was lining up for span C, the next span over from the main navigation span, but he did not share this information with the bridge team. He told investigators he had not taken the *Delta Mariner* through span C before but had been told by other pilots that they had maneuvered vessels under span C, and he felt the *Delta Mariner* could make it safely. He did not recall using any navigational equipment other than radar in the vessel's pilothouse as the *Delta Mariner* approached the bridge. He said he "was concentrating on the bridge. The bridge had my full attention."

2.2 Condition of Eggner's Ferry Bridge Lighting

As described earlier, the Coast Guard–approved lighting plan for Eggner's Ferry Bridge required the upstream and downstream sides of each bridge pier to be marked by a red light and the center of each of the four navigable spans to be marked by a green light. The center of the main navigation span should have been marked by a tier of three white lights arranged in a vertical line directly above the corresponding green light on both the upstream and downstream sides.

As the *Delta Mariner* approached the bridge, personnel in the pilothouse saw only one lighted span (span E). The contract pilot and the bridge team were consistent in describing two red lights marking bridge piers and one green light between them marking the center of the span. No other lights were visible to them. Therefore, the NTSB concludes that at the time of the accident, most of the navigation lights on Eggner's Ferry Bridge were extinguished, including the lights marking the main navigation span, which was the intended route of the vessel.

2.3 Contract Pilot's Performance

The contract pilot told investigators he was familiar with Eggner's Ferry Bridge and its prescribed lighting, but he did not inform the vessel bridge team that more than one span should have been lighted. He said he assumed the lights were out on the main navigation span and the lights he saw were marking the next span over (span C). He told investigators he thought the chief mate/helmsman could more easily steer for the visible green light rather than steer toward an unlit span, and so he directed him to do so, but he did not tell the bridge team he thought the lights were marking a span other than the main navigation span. In his role as contract pilot, he should have shared this information with the bridge team.

The contract pilot was incorrect in his assumption about which span the vessel was approaching. Directing the chief mate to steer for the lighted span took the vessel away from the sailing line and toward the span with the lowest clearance, span E. The contract pilot had several tools at his disposal, including the Army Corps of Engineers chart book and the ECS, which could have provided him with additional information about the vessel's position on approach to the bridge. Instead, he relied on visual cues from the bridge lighting even though he later said he knew the bridge was not lighted as he expected. The NTSB concludes that the contract pilot's exclusive focus on the only bridge navigation lights that were illuminated caused him to direct the vessel toward span E, which had insufficient clearance for the *Delta Mariner.*

2.4 Bridge Team Performance and Vessel Operations

Aspects of bridge team performance examined in this investigation included passage planning, bridge team and contract pilots' roles and responsibilities, and use of available navigation references and monitoring of shipboard equipment.

2.4.1 Passage Planning

Under IMO regulations, the *Delta Mariner*'s crews were required to formulate a passage plan for each voyage.[14] The ship operations manual stated:

> The Passage Plan encompasses the navigation of the vessel from berth to berth taking into consideration all pertinent information. Passage planning should be carried out in accordance with STCW bridge team management guides. The plan

[14] SOLAS Chapter V, Safety of Navigation, Regulation 34, outlines voyage planning to promote safe navigation and avoidance of dangerous situations. IMO also adopted a resolution specifying guidelines for voyage planning.

> shall be entered into the [electronic charting system], printed, and reviewed by the Navigation Officer and the Master prior to sailing.

The purpose of the passage plan was to ensure all members of the navigation team had the same expectations for the voyage. It was to be created in advance to provide a step-by-step description of how a voyage is to proceed and identify hazards and was to be monitored as the vessel progressed along the route.

Passage planning for the *Delta Mariner* differed based on whether the vessel was operating on a river or in open waters. The second mate told investigators, "The passage plan for the river system is an Excel spreadsheet. It is a passage plan but it's not like you have waypoints out in the ocean. There's not a track line on the [ECS] that's . . . got waypoints in it and the [ECS] is telling you [to] steer 5 degrees port or steer 5 degrees starboard, not on the river. You would have to have 10,000 waypoints to get down that river system constantly turning . . . and things of that nature."

Primarily because the *Delta Mariner*'s river transits involved so many turns that would require mention in a passage plan, crewmembers told investigators, it was impractical to attempt to create a passage plan that included all waypoints and courses for the river. Instead, they identified various geographic features such as bridges, river junctions, and locks, and used them to track their voyage as they passed. Also included in the plan were pertinent notices to mariners and a bridge clearance spreadsheet. The passage plan was to be reviewed with the contract pilots prior to each voyage, and this master/pilot exchange was documented using a master/pilot checklist. Investigators reviewed documentation for several voyages prior to the accident voyage and found significant inconsistency in completing the master/pilot checklists. This is discussed in more detail in section 2.5.1, Safety Management System and Practices.

Investigators found the inland rivers passage plan for the *Delta Mariner* was insufficient because it failed to adequately identify potential hazards by including, for instance, information about bridges that posed navigation challenges or difficulties. Crewmembers mentioned, for example, that personnel on vessels approaching the Norfolk Southern Tennessee River Bridge needed to call ahead to have the bridge raised, but this requirement was not stated in the passage plan. Several bridges on the *Delta Mariner*'s route had multiple spans listed as navigable, yet the passage plan provided no information regarding the preferred spans. Eggner's Ferry Bridge had multiple navigable spans, and the passage plan provided vertical clearance information for only one span but did not identify which span it was. Using data from the vessel's ECS, investigators discovered the *Delta Mariner* had transited through span C on January 16, 2012, with a different bridge team and contract pilot. The Army Corps of Engineers publishes vertical clearance only for span B. Vertical clearance for the other spans was not available from any other known source; therefore, the bridge team could not have known the clearance for span C.

Foss Atlantic's safety management system (SMS) documents stated, "A passage plan is of no value unless it is utilized by all team members—including the pilot." Investigators found no evidence, however, that the passage plan was reviewed by deck watch officers during the voyage. The second officer included in the passage plan a Coast Guard local notice to mariners advising caution when approaching Eggner's Ferry Bridge due to ongoing core sampling operations. The notice actually had been canceled on the day the vessel departed Decatur and was no longer in effect at the time of the accident; however, the deck officers on the

Delta Mariner were not aware of the cancelation. Despite the notice being in the passage plan, investigators found no evidence the bridge team discussed it as they approached the bridge.

Investigators also discovered an apparent lack of knowledge among *Delta Mariner* deck officers about the inland rivers portion of the route. None of the officers in the pilothouse at the time of the accident were aware, for example, that multiple spans of Eggner's Ferry Bridge should have been lighted. The bridge team should have known this, and as they approached the bridge and saw only one lighted span, their concern should have prompted them to consult additional sources of information. Although the contract pilots were hired to provide local knowledge and guidance, a thorough, detailed passage plan also was essential. In addition to identifying risks such as bridges with low clearances, a complete passage plan could have described such hazards through diagrams or lighting scheme descriptions. The NTSB therefore concludes the passage plan provided inadequate information for safe navigation on the inland waters portion of the intended journey. The NTSB recommends Foss Maritime develop a detailed passage plan for the inland waters portion of the *Delta Mariner*'s voyage to include specific information about all known risks and ensure the plan is understood and effectively used by bridge teams during transits.

2.4.2 Contract Pilot and Bridge Team Responsibilities

In designated areas of inland waterways, federal regulations at 46 CFR 15.812 require ships to carry licensed pilots. The portion of the *Delta Mariner*'s regular route between Decatur, Alabama, and Baton Rouge, Louisiana, was not so designated, and therefore state or federally licensed pilots were not required. To provide additional support to deck watch officers during this portion of the voyage, Foss Maritime hired contract pilots to provide navigation guidance. The *Delta Mariner*'s SMS called for the vessel to carry a pilot or mooring master "whenever the safe navigation of the vessel or regulations [make] it necessary. . . ." According to interviews with company representatives, the contract pilots were hired for their local knowledge to assist the bridge team with general river navigation, radio communications, and passing arrangements.

A senior Foss Maritime official testified he did not "see a difference" between the role of licensed pilots and the role of contract pilots on the vessel. "They're [both] providing invaluable local knowledge and experience at transiting the river system and really adding to the crew with a specialty that would be very hard to maintain on an oceangoing ship." The *Delta Mariner*'s general manager noted that the contract pilots were "Mississippi River pilots. The bulk of their work is on the Mississippi, but everybody that we have used [has] at one time or another had time on the Tennessee River. . . ." He said the vessel master's initial guidance to contract pilots took about 15 minutes and included the following information:

> You are in an advisory capacity and the master always maintains control, command of the vessel. But you're an advisor. And then he would go through the passage plan which has all the bridges. And the guy would probably have most of that knowledge anyway. And then he would just go through parts of the safety manual, who the different people are on the bridge and what their responsibilities are.

The qualifications of contract pilots on board the *Delta Mariner* differed from those of state- or federally licensed pilots in that the contract pilots had not completed the rigorous training process required to obtain pilot licensing.[15] Foss Maritime hired experienced towing vessel masters to provide deck officers guidance. While the contract pilot on duty at the time of the accident had extensive river experience, most of that experience was on the Mississippi River rather than the Tennessee River. Nonetheless, in the case of the *Delta Mariner*—and Foss Maritime policy—these contract pilots appear to have been regarded as equivalent to licensed pilots, and the deck officers relied heavily on their guidance even though they were not necessarily experienced with the Tennessee River portion of the *Delta Mariner*'s route.

The SMS specified underway operational policies and procedures such as passage planning, bridge watch setting duties, bridge team roles and responsibilities, compliance with regulations, use of navigation equipment, and bridge activity record keeping. The SMS described the company's expectations for bridge team management, including maintaining a focused watch, open exchange of information, prevention of distraction, and creation of a team environment. Of particular significance in this accident, the master and duty officers were to "remain alert to the pilot's or mooring master's handling of the vessel and be prepared to intervene when necessary to safeguard personnel, environment, vessel, or cargo."

VDR recordings from the *Delta Mariner* revealed the bridge team's conversation and interaction, navigation decision making, and concerns expressed by the bridge officers and the contract pilot as the vessel approached Eggner's Ferry Bridge. Despite procedures prescribed by the *Delta Mariner*'s SMS, none of the vessel's bridge team countermanded or challenged the contract pilot's direction to steer toward a bridge span no one was sure provided sufficient clearance. As the vessel continued on its course, no attempt was made by the contract pilot or bridge team to verify the vessel's position in relation to the bridge using other than visual means with the aid of two spotlights. The SMS assigned responsibility for obtaining vessel position fixes to the duty watch officer who was not on the helm position, in this case, the third mate. The SMS stated the "helmsman shall have no other duties when assigned to the helm" and "when the deck watch officer is acting as helmsman, a second deck officer and/or the master will be on the bridge to perform all other navigation and watch duties."

Just before the allision with Eggner's Ferry Bridge, however, the third mate on the *Delta Mariner* was entering and exiting the navigation bridge to read exterior weather instruments, record those measurements in vessel logs, and document the temperature and relative humidity measurements in the internal cargo bay as displayed on a navigation bridge computer. He performed no position-fixing functions. In a statement to investigators, the third mate indicated the chief mate, as senior watch officer, was responsible for position fixing of the vessel. The chief mate, however, was manning the helm at the time of the allision.

[15] State piloting authorities generally impose the most stringent requirements for pilot licensing. While in training, an apprentice pilot may undertake hundreds of instructional trips on board progressively larger and more challenging vessels before qualifying for a deputy or full pilot's license. Underway training is often supplemented by classroom and simulated instruction as well as rigorous continuing training and professional development. State authorities regulate pilotage operations, and the Coast Guard exercises oversight through its standards for federal pilot licensing and adherence to federal and international navigational regulations.

VDR and other data further indicated no order, recommendation, or action was issued or taken by the contract pilot, master, chief mate, or third mate to reduce speed or perform an emergency stop as the *Delta Mariner* approached the bridge. The contract pilot testified he did not recall seeing the *Delta Mariner*'s pilot card, which indicated the loaded vessel was capable of maneuvering from full ahead to full stop in less than 1 minute. The contract pilot said he was unfamiliar with the *Delta Mariner*'s maneuvering characteristics and had not been briefed by the bridge team on this aspect because his position was advisory. The chief mate said the contract pilot was directing control of the *Delta Mariner* and was "in charge of giving us adequate information to navigate this river. And rarely have we ever questioned that, and with good reason."

As the vessel approached the bridge, the contract pilot directed the chief mate/helmsman to steer for the visible green light marking the center of span E rather than the main navigation span. Receiving that guidance, the chief mate began steering to starboard, causing the vessel to move away from the sailing line. At this time, no member of the bridge team questioned or remarked on this deviation from the previous course. As the vessel approached the bridge, the contract pilot's expressed confusion about which span they were steering toward still did not prompt active concern by the bridge team.

Although the contract pilot expressed uncertainty about which bridge span the *Delta Mariner* was approaching, the officers on the bridge deferred to the contract pilot's guidance and failed to verify the vessel's position. The chief mate, who was serving as helmsman, and the third mate who was the second watch officer, had both the authority and the responsibility to verify the pilot's actions but did not do so, suggesting a breakdown in team performance which the NTSB has noted in previous marine accidents.[16] In this instance, the bridge team deferred to the contract pilot and did not verify his guidance by consulting readily available information on the vessel's position and the appropriate span to approach. The NTSB therefore concludes the bridge team overly relied on the direction of the contract pilot, despite his apparent uncertainty, which resulted in the bridge team attempting to maneuver the vessel under the incorrect span. The reasons for this breakdown in team performance are discussed in more detail in section 2.5.2.

2.4.3 Use of Navigation Equipment

The bridge of the *Delta Mariner* was outfitted with up-to-date navigation technology, including a Global Positioning System, radar, AIS, and an ECS. (Figure 11 shows a portion of the navigational equipment on the *Delta Mariner*.) The ECS software was installed on a computer on the starboard aft side of the bridge, with a display directly in front of the helmsman's position. The bridge team was using Army Corps of Engineers inland electronic navigation charts for this portion of the voyage. These charts, available free online, display land areas, coastlines, depths, buoys, and other features, and the user can select which of these objects to include on screen. According to the bridge team, at the time of the accident the ECS was on and functioning properly as they approached Eggner's Ferry Bridge.

[16] See, for example, *Grounding of U.S. Passenger Vessel* Empress of the North, *Intersection of Lynn Canal and Icy Strait, Southeast Alaska, May 14, 2007* (NTSB/MAR-08/02) (Washington, DC: National Transportation Safety Board, 2008).

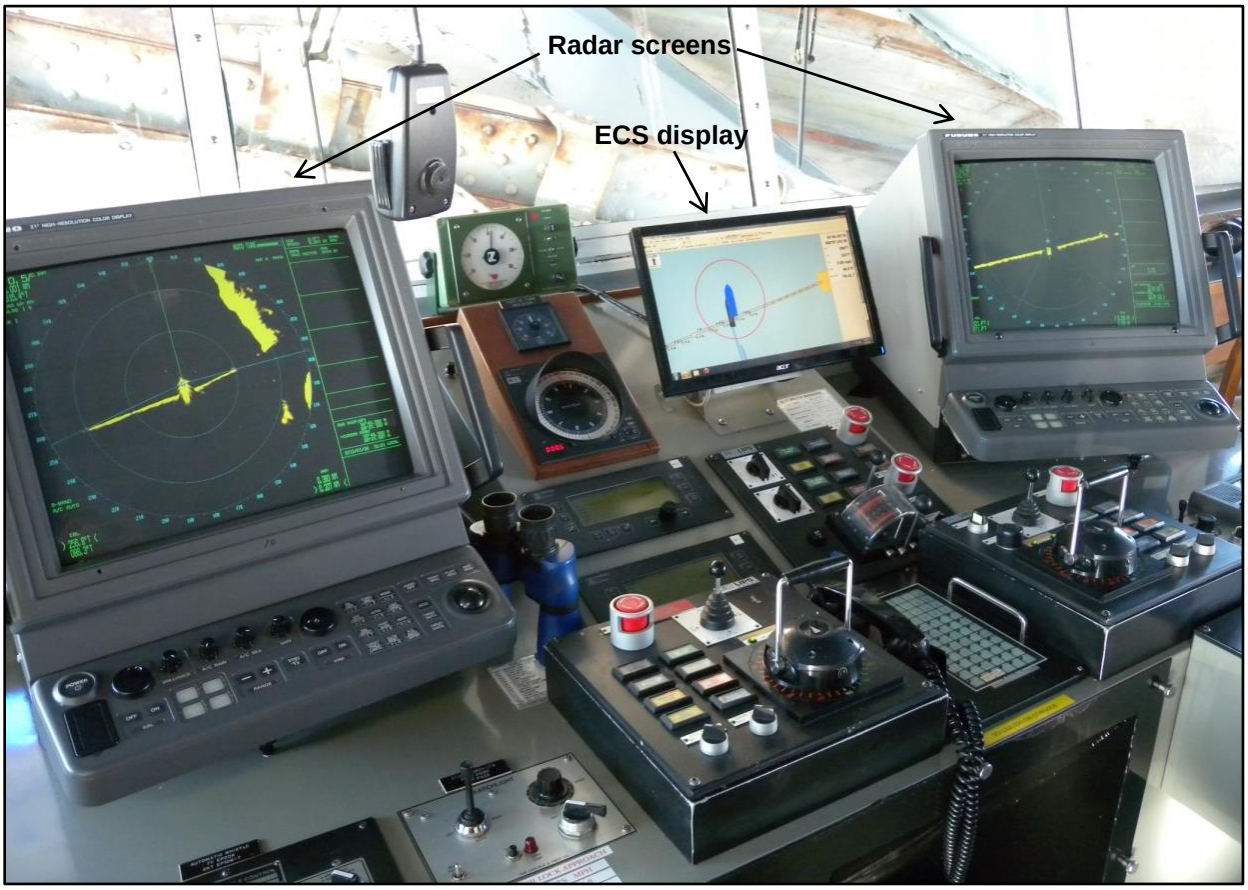

Figure 11. Photo of two radar screens and the ECS display located forward of the *Delta Mariner*'s steering and throttle control station. The chief mate, who was acting as helmsman at the time of the accident, was facing the ECS display.

The second mate told investigators he updated the ECS vector charts "every time we reach a port or I can tie up the Internet long enough to do it." He last updated the ECS on January 24, the day before the *Delta Mariner* departed on the accident voyage. The second mate also told investigators that ECS "has lighting schemes for bridges on it." The lighting scheme for Eggner's Ferry Bridge is shown on the ECS display in figure 12.

The bridge team did not attempt to verify that the lights they observed matched what the ECS displayed. The contract pilot told investigators he could not see the ECS display in front of the helm because a screen was fixed to it to dim the display for night operation. The chief mate said he was focusing on steering the vessel, and when asked how he used the electronic chart display in front of the helm position, he told investigators, "There's no information I need there."

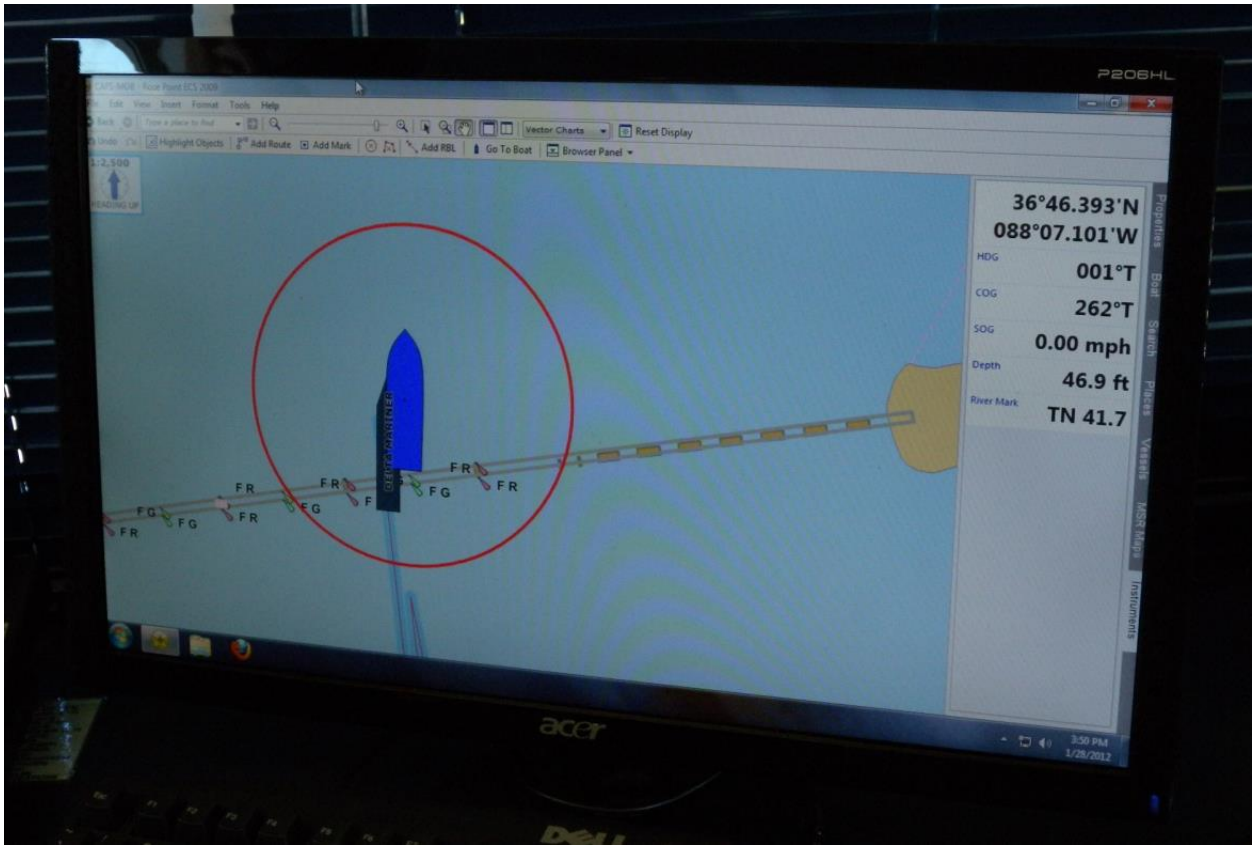

Figure 12. ECS display on the aft chart table taken postaccident. The *Delta Mariner* can be seen anchored in position in the middle of bridge span E, and the bridge lighting scheme is visible.

All such navigating tools are vital to responsible vessel operation and should be used in concert as appropriate rather than individually to the exclusion of other navigation equipment. With the development of electronic navigation equipment, concern was expressed that deck officers might rely too heavily on such tools rather than their own knowledge and observations. In a 1997 accident report, the NTSB determined that the grounding of the passenger ship *Royal Majesty* was due in part to the watch officers' overreliance on the ship's automated systems. (NTSB 1997)

In the case of the *Delta Mariner*, however, the opposite was true. The bridge team and contract pilot focused almost exclusively on Eggner's Ferry Bridge as they approached it, discussing the span's height and the visible lights. While focusing on the visual aspects they ignored electronic tools, particularly the ECS, which could have provided ample information about the bridge and the vessel's position in the waterway. The ECS was displayed on the helm directly in front of the chief mate; had he looked at that screen, he could have recognized that the vessel had traveled a significant distance from the sailing line, which marked the path under the main navigation span. The ECS also was capable of displaying the correct lighting scheme for the bridge, which the bridge officers could have checked against what they were actually seeing. At a minimum, the ECS could have provided enough information to warrant the bridge team slowing the vessel to assess its approach. Because they did not access such resources, the NTSB concludes the contract pilot and the bridge team failed to effectively utilize all navigation tools, such as the electronic charting system and radar, as they approached Eggner's Ferry Bridge.

2.5 Role of Foss Maritime Company

2.5.1 Safety Management System and Practices

Under the ISM Code, Foss Atlantic was required to develop, implement, and maintain a functional SMS, and the master of the *Delta Mariner* was responsible for supporting those safety policies and motivating the crew to ensure each individual's personal commitment to safety. He was required to be sufficiently familiar with the procedures and instructions contained within the SMS to ensure he and the crew applied those measures as appropriate. Commitment from both the company and the master was essential to realizing the full potential of SMS safeguards developed for the *Delta Mariner*.

The *Delta Mariner* SMS defined roles and responsibilities of all personnel (crewmembers and contract pilots), provided safe ship operation and navigation practices, and established safeguards against specific risks. The SMS was available both in electronic file format and in print as three manuals and two contingency plans. The three manuals were the ISM Code Policy Manual, Company Procedures Manual, and Ship Operations Manual, and the two contingency plans were the Shipboard Contingency Plan and Shore-Based Contingency Plan. The master, chief mate, and chief engineer all held copies of these printed manuals.

ISM Code functional requirements for an SMS included shoreside management reviews and onboard reviews of the SMS by each vessel master. On board the *Delta Mariner*, the masters held monthly safety meetings, and crew attendance was mandatory at these meetings unless excluded by the master for cause. Minutes of these safety meetings were captured on a company form and forwarded along with other vessel records to the company office in Mobile, Alabama, for management review. Annually, the master was also required to review onboard activity to ensure the SMS was in place and functional and report his findings to Foss Atlantic management.

Shoreside, Foss Atlantic held quarterly safety committee meetings to review and address the vessel safety meeting reports and analyze reported nonconformities, accidents, hazardous occurrences, and recommendations to improve the SMS. In addition, management met each October to evaluate the results of internal and external (third party) audits, the adequacy of training methods, and any needs for organizational change. These quarterly safety meetings and the annual management review meetings were chaired by the Foss Atlantic general manager, who also served as the designated person ashore (DPA).

Under the ISM Code, the company was required to appoint a DPA, in part to allow crewmembers to express safety-related concerns to an individual who could convey these concerns to the highest levels of company management. In 2009, due to downsizing directed by Foss Maritime, owner of the *Delta Mariner,* Foss Atlantic's general manager assumed the DPA function. The ISM Code does not designate the position within a company the DPA should hold and does not prohibit senior management from also serving as DPA. However, this combination of senior management responsibilities with the DPA function as liaison between crewmembers and company officials regarding safety-related concerns could present a conflict. For instance, even though an internal audit reported the chief engineer of the *Delta Mariner* felt an ombudsman was needed to address concerns of the crew, Foss Maritime did not act upon this indication that the communication link normally provided by the DPA between senior management and the vessel crew might not have been functioning as required. NTSB

investigators could find no record of follow up or monitoring by Foss Maritime to ensure the chief engineer's communication concerns were resolved.

The ISM Code also required crew training and familiarization to ensure new personnel and those in new assignments related to safety and environmental protection are properly familiarized with their duties. On board the *Delta Mariner*, the company's SMS procedure written to fulfill this requirement detailed the expectations of each mariner by position and required the completion of an orientation and ship familiarization checklist within 7 days of joining the vessel. All senior mariners were required to undertake familiarization with the company SMS before joining the ship and thereafter to perform annual familiarization reviews.

In addition, the ISM Code required that the company maintain current SMS documentation on board the vessel, including any changes to the ISM Code itself. Although the ISM Code had been revised and updated by four separate IMO amendments since its mandatory implementation date, Foss Atlantic was using an outdated photocopy of the 1997 version of the code as the basis for its ISM Code policy manual. Although this version of the ISM Code was obsolete, an ABS representative indicated in October 2012 that the ABS auditor's checklist used in performing all ISM audits reflected the latest ISM Code revisions, and the actual content, text, and provisions of the SMS manuals had been updated to reflect these changes. Nonetheless, circulating an obsolete version of the ISM Code indicates a problem with the company's documentation control procedures and a lack of continued commitment by those tasked with ISM Code implementation.

While compliance with the ISM Code can be achieved through successful development and implementation of an SMS, the underlying objective to create an organizational culture in which safety principles are a conscious practice must be encouraged and reinforced both on board a vessel and among company management. An SMS is a tool for promoting risk mitigation behaviors and safety-oriented attitudes. An effective SMS depends greatly upon the commitment, motivation, and competence of all those involved with the system.

The lack of such commitment and motivation was illustrated by the master's failure to properly execute the company's written safety procedures and SMS processes and was not isolated to this voyage. In June 2000, the master, then serving as chief mate, demonstrated a lack of adherence to fundamental SMS concepts by signing off on his own checklist as performing his own training during the orientation and familiarization process. He signed off as both the employee and the department head, essentially attesting that he had been trained for his position and tested for knowledge retention and all responsibilities were understood. According to this SMS procedure, other crewmembers should have conducted the chief mate's training, and management or a senior crewmember should have initialed the checklist.

In September 2011, when the second mate joined the vessel, the master again allowed this training, orientation, and familiarization procedure to be circumvented. In that instance, the second mate's checklist was acknowledged in writing by the third mate, a junior crewmember, who improperly signed as the department head. The master then signed off on the checklist, indicating the second mate had been tested for knowledge retention and was familiar with his assignments. However, the second mate subsequently acknowledged he had never seen the written expectations contained in the company's SMS guidelines that governed his responsibility for development of the passage plan, a function that directly impacted the safe movement of the vessel. Further, all training checklist items were initialed on the day the second mate came on

board. Given the depth of tasking and familiarization with company procedures and shipboard processes outlined in that checklist, it is doubtful the second mate's training was effectively completed in 1 day.

Significantly, in multiple instances, individual crewmembers serving in safety-sensitive positions failed to demonstrate familiarity with or properly execute their responsibilities outlined in the SMS. For example, bridge team members and the contract pilot held substantially different views regarding their underway navigational safety responsibilities and overall roles in vessel safety.

The SMS requires a bridge team/pilot exchange prior to each voyage which should be documented by a signed master/pilot exchange card. Investigators reviewed the completed voyage packages provided by Foss Maritime for the previous five voyages (10 trips, each voyage consisting of a downbound and upbound trip) and identified 12 instances in which no bridge team/pilot exchange was documented for one of the two contract pilots.

NTSB investigators found the lack of an effectively implemented SMS was linked to top company management, the master of the *Delta Mariner*, and several senior crewmembers, and was evident during a span of time that included not only the accident voyage but also a significant period well before the accident. These multiple failures over time and across levels of the organization indicate the objectives of the ISM Code to ensure safety at sea and avoid damage to property were not achieved. Therefore, the NTSB concludes the *Delta Mariner*'s safety management system was not effectively implemented on board the vessel at the time of the accident.

Following the *Delta Mariner* allision, Foss Maritime conducted an internal investigation into the accident and undertook corrective actions to address identified shortcomings. The company required all navigational crewmembers to complete refresher training on bridge resource management, including simulator training. The company also shifted the DPA function from the Foss Atlantic general manger to the individual who serves as DPA in the much larger Foss Maritime towing vessel fleet. In addition, sections of the SMS were revised to include procedures related to watch officer duties, responsibilities of contract pilots, bridge team oversight of contract pilots, and the development and implementation of a guideline for safe passage under highway bridges or other overhead obstructions. Foss Maritime began a comprehensive review of the SMS scheduled to be completed in the second quarter of 2013. Hands-on training on the propulsion system and handling characteristics of the *Delta Mariner* was implemented for all crewmembers who serve in the helmsman position, and this training will be continuing.

2.5.2 Foss Maritime Safety Oversight

Foss Maritime exceeded regulatory requirements by providing contract pilots to the bridge team when none were required and by posting two licensed deck officers on the bridge during inland operations, which also was not required. Such efforts typically indicate proactive measures to enhance the safety of a company's operations. Given Foss Maritime's apparent safety-conscious approach to vessel operations, investigators sought to determine what role the company may have played in events leading to this accident.

Although the company hired contract pilots to assist the *Delta Mariner*'s bridge team, evidence suggests Foss Maritime did not fully define the role of these pilots on the vessel. The

intent of the company, according to interviews and testimony of its management personnel, was to augment the ability of *Delta Mariner* crewmembers, who were primarily oceangoing mariners with little inland waterway experience or expertise, in navigating and communicating with other vessels.

However, the implementation of that decision was flawed in several critical respects:

- The only apparent requirement for serving as a contract pilot was inland waters experience, with no further expertise specified relevant to the *Delta Mariner*'s route.

- Hiring decisions were based on the recommendation of a former contract pilot, and candidates were not vetted by management.

- The mariners serving as contract pilots had little experience working in multiperson bridge team operations.

- The company provided the contract pilots little to no guidance regarding their duties and responsibilities, oversight once on the vessels, feedback on the quality of their performance, or training on working with bridge teams.

- The company provided little to no guidance to the vessel's crew regarding the experience, duties, and responsibilities of the contract pilots assigned to the vessel or on interacting with the contract pilots, their role on the vessel, or the expertise they were expected to provide while navigating on inland waterways.

As the VDR recording revealed, vessel crewmembers fully deferred to the contract pilot. This deference was inappropriate, particularly considering this crew likely possessed more experience navigating under Eggner's Ferry Bridge than did the contract pilot. On the night of the accident, the bridge team's mistaken beliefs about the extent of the contract pilot's knowledge put the safety of the vessel at risk.

The bridge team's misconception regarding the expertise of the contract pilots and the lack of training they received on the role contract pilots were to play on the vessel can be attributed to Foss Maritime's inattention to the safety of *Delta Mariner* operations after the company placed contract pilots and two licensed mariners on the bridge of the vessel. The evidence suggests the company's position was that as long as the vessel operated in accordance with contractual obligations—that is, picking up rocket components, delivering them on schedule, and meeting its SMS audit requirements—then sufficient attention had been devoted to operational safety. This suggestion was confirmed by the president of Foss Maritime, who told investigators:

> The *Delta Mariner* has never been on my radar as a problem area. The one [Foss Atlantic operation] that was running really smooth and really good was the *Delta Mariner*, at least from what we could see, what we were monitoring in our policy, practice, and our continuing improvement. The two probably most well-trained, skilled, educated, practiced, licensed masters in the entire fleet . . . that's the two best captains we have. So perhaps we didn't give it—the guys are doing a good job. Maybe we didn't pay enough attention.

After years of safe operations without adverse regulatory or safety reports, company attention to operational safety can decrease. Further, the company's internal audits of the *Delta Mariner*'s SMS found no nonconformities.

By contrast, evidence from the VDR indicated noncompliance with SMS procedures at the time of the accident. If the company's internal audits had provided such information, action could have been taken to alter vessel operation procedures and optimize bridge team communication. By not collecting critical safety-related information during its internal SMS audits, the company missed an opportunity to address shortcomings in vessel operations and thus enhance safety.

The *Delta Mariner*'s SMS, including oversight such as regular internal audits, did not provide an effective margin of safety as implemented. As researchers have observed:

> The standard of an organization's safety management system as it exists on paper does not necessarily reflect the way it is carried out in practice. This is where the concept of safety culture comes into the picture. It is the safety culture of the organization that will influence the deployment and effectiveness of the safety management resources, policies, practices and procedures as they represent the work environment and underlying perceptions, attitudes, and habitual practices of employees at all levels. . . . (Choudry, Fang, Mohammed 2007)

Although the term "safety culture" is not easily defined,[17] the IMO relates it to doing "the right thing at the right time in response to normal and emergency situations." (IMO 2013) The IMO highlighted the following as key to achieving safety culture: recognizing that accidents are preventable through following correct procedures and established best practice, constantly thinking safety, and seeking continuous improvement. Although Foss Maritime should be lauded for its willingness to enhance safety on the *Delta Mariner* by taking proactive measures when vessel operations began, its failure to oversee and examine the implementation of those actions led company personnel to believe that no further safety-related action was needed. Such beliefs are unjustified, however, in complex transportation systems where ongoing oversight must be provided to ensure that adequate safety levels continue. If anything, providing contract pilots with little to no procedures, training, and oversight, and requiring two licensed deck officers to stand watch, provided the company and its personnel with the false belief that the system was safer than it actually was. Licensed bridge officers deferring navigational responsibilities to a contract pilot, as occurred in this accident, detracts from rather than enhances safety. In sum, the evidence indicates that Foss Maritime's oversight of *Delta Mariner* operations was insufficient to ensure an adequate level of safety. Therefore, the NTSB concludes that Foss Maritime Company provided ineffective oversight of the safety of *Delta Mariner* operations.

[17] See, for example, definitions discussed by A. I. Glendon and N. A. Stanton, Perspectives on safety culture, *Safety Science, 34,* 193–214 (2000); F.W. Guldenmund, The nature of safety culture: A review of theory and research, *Safety Science, 34,* 215–257 (2000); F.W. Guldenmund, (Mis)understanding safety culture and its relationship to safety management, *Risk Analysis, 30,* 1466–1480 (2010); and S.S. Silbey, Taming Prometheus: Talk about safety and culture, *Annual Review of Sociology, 35,* 341–369 (2009).

Since the accident, Foss Maritime modified required pre-voyage sailing meetings to include a discussion of the contract pilot's role and watch officer responsibilities and instituted quarterly general navigation audits to assess the vessel's operations. During these audits, an "experienced master mariner rides for the entire upbound or downbound voyage to observe all operations related to the safe navigation of the ship [with] particular attention to bridge team interaction, navigation of the ship and general watch standing." (Foss Maritime Company 2012) The company performed an audit on July 6, 2012, for an upbound voyage and on November 4, 2012, on a downbound voyage. Foss indicated that the frequency of the audits would be reevaluated after a year. In addition, Foss Maritime sent the *Delta Mariner* deck officers to additional bridge resource management training, which their senior vice president for operations attended.

Although many of the actions Foss Maritime undertook after this accident addressed safety concerns identified in this investigation, shortcomings remain regarding Foss Maritime's use of contract pilots. For example, the investigation found contract pilots were not required to possess unique expertise on the inland waterway sections of the vessel route, neither vessel deck officers nor the contract pilots were given specific information on the duties and responsibilities of the contract pilots, and no mechanism existed to provide feedback to contract pilots on how well they performed their duties and responsibilities on the vessels. Absent changes in the expertise expected of contract pilots, it is incumbent on Foss Maritime to clarify to both the contract pilots and the vessel crews:

- The extent of the contract pilots' expertise on the inland waters route.
- How the deck officers are to use the contract pilots' expertise.
- The duties and responsibilities of the contract pilots.
- The duties and responsibilities of the deck officers regarding the contract pilots.

Until these shortcomings in Foss Maritime's oversight of the safety of *Delta Mariner* operations are addressed, the potential remains for the navigation and crew errors that were displayed in this accident. As a result, the NTSB concludes the expertise, duties, and responsibilities of the *Delta Mariner* contract pilots were inadequately defined. Therefore, the NTSB recommends Foss Maritime clearly define the route expertise expected of *Delta Mariner* contract pilots and provide them and deck officers with specific guidance regarding the contract pilots' duties and responsibilities and the type of guidance expected of them while serving on the bridge of a vessel.

2.6 Kentucky Bridge Lighting and Maintenance

NTSB investigators examined highway plans, specifications for the Eggner's Ferry Bridge structure and dimensions, bridge design and construction plans, the history of bridge accidents and allisions, and the bridge navigation lighting plan prescribed by 33 CFR 118, among other documentation. The team also reviewed the Coast Guard Bridge Administration Manual, KYTC manuals and files, and electrical contracting agreements and interviewed the KYTC supervisor for traffic and permits, a KYTC transportation engineer and traffic technicians, and electrical contractors.

2.6.1 Eggner's Ferry Bridge Lighting Maintenance and Repair

KYTC was responsible for maintaining lighting on Eggner's Ferry Bridge—red lights marking each pier, a green light marking the center of each span, and three white lights marking the main navigation span. At the time of the allision, all lights on the bridge were extinguished except the navigation lights on span E—two red lights and one green light.

The official Coast Guard bridge file for Eggner's Ferry Bridge contained about 26 notices sent to the KYTC between 1994 and 2011 to report navigation lights on the bridge were extinguished. Coast Guard personnel explained that inoperative lights were most often reported by mariners transiting under the bridge. The Coast Guard would then notify KYTC by telephone and issue a BNM, which would be canceled upon KYTC notification that bridge repairs were completed. Repairs typically took 2 days to 2 weeks depending on weather, scheduling, and repair time required. For instance, because Eggner's Ferry Bridge is relatively narrow, repairs can require lane closures to accomplish the work. The logistics of managing traffic disruption can increase the time needed to complete repairs. In addition, bridge lighting was only one aspect of the workload in District 1 of the KYTC Division of Traffic Operations; that unit was also responsible for traffic signals, highway lighting, and dynamic message board lighting in a 12-county area around Paducah.

Interviews with four KYTC employees—the supervisor of the District 1 traffic division and three traffic technicians—indicated the following:

- None of the personnel interviewed knew the purpose of the three white lights on both the upbound and downbound sides of the main navigation span of Eggner's Ferry Bridge, and none had ever worked on or repaired the white lights.

- The traffic division supervisor, responsible for traffic light maintenance in 12 counties within KYTC District 1, had been in his position for 1 year prior to the accident. One employee had been with the traffic section for 10 years, another for 1 year.

- No written KYTC policies or operational procedures described how to inspect, troubleshoot, or correct electrical problems with the navigation lights on any bridges in District 1. These procedures were passed down over the years by word of mouth between the technicians and electricians.

- Several conditions led to nonfunctioning lights on the bridge:

    - Steel conduits can cause chafing if the wire is damaged.

    - Bridge light wiring was old and often damaged due to the operating environment, including bridge movement caused by wind, traffic loads, and moisture.

    - No wiring plan was available.

    - The total of 48 bulbs required to light the bridge to specification were operated by a single photocell, and different wattage bulbs were used over time.

    - Lights could be extinguished when bulbs burned out or breakers tripped due to electrical shorts in the system.

At the time of the accident, lighting repairs at Eggner's Ferry Bridge had been started but were incomplete. On the previous Monday, the Coast Guard had informed KYTC that the bridge lighting needed repair. On Tuesday, 2 days before the accident, the KYTC engineer supervising lighting repair reported the green and red lights on the spans and piers on the upstream side of Eggner's Ferry Bridge were repaired and operable. Downstream repairs were delayed due to rain and rescheduled for later in the week. The condition of the white lights was not noted at that time. Two days later, when the *Delta Mariner* approached the upstream side of the bridge, reports indicate all but three of the red and green lights on the upstream side were out again.

Between 2008 and 2009, requests were submitted and tentatively approved for a $200,000 allocation to replace the navigation light wiring systems on Eggner's Ferry Bridge and two other bridges in District 1. The proposed repairs received lower priority, however, because several traffic signals needed rebuilding.

In an 8-year period between 2004 and 2012, 47 entries in the KYTC Daily Electrical Record showed repairs and inspection of the navigation lights and wiring on Eggner's Ferry Bridge. During this time, approximately 147 lamp bulbs were replaced, the wiring was maintained several times, and on several occasions light assembly carriages were reattached. Notations indicated when green span bulbs and red pier bulbs were replaced, but no entries reported changing the white three-tiered main navigation span marker lamps.

A separate document in the KYTC files, titled "Bridge Night Inspection Reports," was maintained from 1998 to 2004. These reports detailed monthly and bimonthly navigation light conditions of the 12 to 15 bridges in KYTC District 1. An inspection and repair record for August 2003 was the last recorded repair to the Eggner's Ferry Bridge white lights that mark the main navigation span. All other light repairs through 2012 described work on red pier or green span lights. Approximately 40 entries in the monthly or bimonthly night inspection records for this 1998–2004 period indicated one or more of the bottom, middle, or top white lights were extinguished.

The KYTC bridge file also contained records of required inspections, fracture critical inspections, and underwater inspections conducted every 2 years from 2000 to 2012. These inspections were performed by certified bridge inspectors who checked the structural condition of the bridge, including the superstructure, deck, and substructure.

Inspections conducted in 2003, 2005, 2006, and 2008 recorded coded deficiencies and rated the navigation lighting as 5 on a 1-to-8 scale with 1 being the poorest rating and 8 the highest. The same deficiencies were noted on reports for all 4 years and indicated some pier lights were missing and others were held on by ropes or wire and needed attachment by permanent anchors. None of the deficiencies pertained to the white navigation lights.

The most recent repair by electrical contractors on Eggner's Ferry Bridge navigation lights occurred on October 10, 2011, under a KYTC master contract when an electrician and a technician replaced all navigation lamps with new bulbs. According to testimony, the state required replacement of the bulbs in the green span lights and the red pier lights. The state contractor said he had never seen the Coast Guard lighting plan and the KYTC never told him to repair the white navigation lights.

A previous state contract electrician, who held the master electrical contract for about 7 years, said he had at some point changed the white light bulbs on Eggner's Ferry Bridge. The electrician said he was never given specific instructions to change the white lights, but when KYTC requested lighting maintenance he would energize all the bridge lights and replace the white lights if they were out. Invoices indicate the navigation light bulbs were changed in February 2009.

On January 31, 2012, when repairing lighting on Eggner's Ferry Bridge after the accident, technicians discovered all six bulbs were burned out in the three white main navigation span lights on the downstream (north) side of the bridge (each white light required two bulbs). The outages were determined by energizing the lights directly to eliminate shorts as the cause of the malfunction. On the upstream (south) side of the main navigation span, both bulbs of the upper and middle white lights were burned out, and one of the lower light bulbs was burned out. The other lower bulb could be illuminated but was dimmer than usual.

Despite the importance of the white navigation lights marking the center of the main navigation span, those responsible for their maintenance were not aware of their function or of the need to maintain them. As a result, the white lights were ignored during regular visits to the bridge to repair any red or green lights reported out. None of the KYTC personnel responsible for maintenance could remember working on the white lights in the previous year, and the most recent documentation of the white lights being changed was from 2009. In addition, the employee responsible for conducting night-time inspections of Eggner's Ferry Bridge lighting stated that in the preceding year he had never seen the white lights illuminated on the bridge. Photographs taken after the previous allision in November 2011 indicated only one white light on the upstream side was illuminated. As a result, the NTSB concludes the majority of the white lights marking the center of the main navigation span had been extinguished for at least a year prior to the accident and likely for several years.

2.6.2 KYTC Bridge Lighting Maintenance Practices

Over the preceding decade, several electricians, repair technicians, and supervisors were assigned to KYTC Traffic Division District 1. Review of the older inspection and repair records revealed they were more detailed than later records and mentioned faults and repairs made to the three-tiered white light assemblies. A 2006 inspection was found with the lighting plan attached. As technicians retired or moved on to other positions, key knowledge about procedures to maintain bridge lighting was lost because no written operating guidelines were established to guide incoming staff.

Newer employees who conducted bridge inspections were unaware of the importance of the three-tiered white light assemblies. When they received a general complaint about nonfunctional navigation lights on the bridge, they would check only the red pier or green span assemblies.

The record clearly shows that in most cases the Traffic Division of District 1 responded promptly to Coast Guard complaints about routine extinguished lights on the bridge. Most often bulbs were replaced or breakers were reset. At times, however, wiring problems prevented resetting the breakers or caused the problems to reappear several times after initial repairs.

The Federal Highway Administration developed National Bridge Inspection Standards (NBIS) regulations under the requirements of the Federal-Aid Highway Act of 1968.[18] Under these standards, most bridges are inspected at least every 2 years. Biennial NBIS records for Eggner's Ferry Bridge indicated the same complaints continued over multiple 2-year periods. For instance, KYTC bridge inspectors found assemblies came loose from their welded permanent attachments and were found dangling by wires, and such serious defects were allowed to remain unrepaired for at least 2 years.

Delayed repairs also were evident following the November 15, 2011, allision of the towing vessel *Miss Katie*. That accident left a fractured green span E light assembly mounting bracket hanging by wires until it was replaced just 2 days before the *Delta Mariner* allision.

Given such examples, combined with evidence from interviews and documentation indicating the lack of repair to the three-tiered white lights, the NTSB concludes that the Kentucky Transportation Cabinet failed to effectively maintain proper navigation lighting on Eggner's Ferry Bridge as required and resolve recurring lighting problems and their causes.

Three engineering supervisors have overseen the District 1 traffic division in the past decade. The engineering supervisor at the time of the allision had been in this position for 1 year, as had the supervising engineer who preceded him. Both indicated no documents existed to provide guidance about procedures for inspecting and repairing bridge navigation lighting or about the records required to document inspections. Moreover, no formal guidance was available from the executive level about allocating funding to various projects within the district. While both supervisors said they considered bridge navigation lighting a priority, the utilization of funds for major repairs reveals highway traffic signals and highway lighting tended to receive more attention than bridge navigation lighting. The NTSB therefore concludes a lack of specific inspection procedures and attention to navigation light maintenance led to the ineffective oversight of bridge navigation lighting maintenance in District 1 of the Kentucky Transportation Cabinet.

This accident illustrates the necessity for timely and effective navigation lighting maintenance and awareness that recurring lighting failures may require particular attention to avoid repeated instances of extinguished lighting. Because bridge lighting can be critical to the ability of mariners to safely navigate inland waterways, the NTSB recommends the Federal Highway Administration alert state department of transportation bridge maintenance divisions to the circumstances of this allision and their responsibility to maintain bridge navigation lighting in accordance with US Coast Guard regulations.

2.6.3 Previous NTSB Recommendations and KYTC Postaccident Actions

During the early stages of the NTSB's participation in the Coast Guard's formal investigation of this accident, the NTSB issued the following recommendations to the governor of the commonwealth of Kentucky:

[18] The NBIS sets national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151, and the regulations apply to all publicly owned highway bridges longer than 20 feet located on public roads. The language of 23 U.S.C. 151 clearly establishes a state's ultimately responsibility for the inspection of all public highway bridges within the state. See sec. 26, Public Law 90-495, 82 Stat. 815, at 829.

> Verify the status and proper operation of navigation lighting on all Kentucky bridges over navigable waters in accordance with US Coast Guard–approved lighting plans. (M-12-4)
>
> Develop inspection and maintenance procedures so that bridge lighting functions reliably and is maintained in accordance with US Coast Guard–approved lighting plans. Train Kentucky Transportation Cabinet personnel in these procedures. (M-12-5)

Immediately following the accident, KYTC leadership recognized inspection, training, and maintenance of navigation lighting could be more effective and began taking steps to improve those programs. First, the KYTC secretary directed all permitted bridges in Kentucky be inspected to ensure they complied with Coast Guard–required lighting plans. The KYTC then conducted training on implementation of correct policies and procedures. Finally, maintenance was either performed or scheduled to correct deficiencies. According to KYTC, all of these remedial actions were completed by July 12, 2012.

The KYTC responded to NTSB recommendations on September 12, 2012, reporting that the department inspected lighting on all bridges over navigable waters in Kentucky, verified the lighting plans, and developed a training presentation plan for all traffic operations engineers responsible for maintaining navigation lighting. On November 20, 2012, the NTSB considered this response sufficient and classified both recommendations "Closed—Acceptable Action."

2.6.4 Coast Guard Bridge Administration

The bridge administrator for the Coast Guard Eighth District Western Rivers Bridge Branch told investigators that once the Coast Guard notified a bridge owner such as KYTC about a lighting issue, the Coast Guard waited for a report that the lighting problem had been repaired. Bridge Branch personnel typically did not verify, visually or otherwise, that the repairs had actually been completed properly. In the case of Eggner's Ferry Bridge, the KYTC maintenance division repaired the red and green lights when they were extinguished but was unaware that the white lights marking the center of the main navigation span needed to be maintained as well. Therefore, when KYTC reported to the Coast Guard all lights on the bridge were working, that assessment did not include white lights on the main navigation span. Because the Coast Guard did not verify KYTC's report, nonfunctioning white lights went unnoticed.

Prior to the *Delta Mariner* accident, the Coast Guard Eighth District was alerted to repeated lighting issues on Eggner's Ferry Bridge. Inadequate lighting may have played a role in the previous allision in November 2011, and after that allision, lights were reported out on several more occasions, including the days immediately before this accident. In each case, the Eighth District Bridge Branch notified KYTC that the lights were reported out and asked that repairs be made. Due to the numerous reports of lighting outages, the Coast Guard sent a letter to KYTC on December 15, 2011, reminding the department of its responsibility as bridge owner for maintaining the lighting. The letter contained a copy of the approved bridge lighting plan. Although this letter is evidence the Coast Guard was taking steps to ensure the lighting was maintained properly, instructing KYTC to fix the lights each time they went out failed to address the underlying chronic, long-term problem with the lighting on Eggner's Ferry Bridge.

Because the three-tiered white lights marking the channel span had been inoperative for over a year, the NTSB believes the Coast Guard did not effectively ensure the bridge navigation lights were maintained in accordance with the bridge navigation lighting plan. As a result, the NTSB concludes the Coast Guard's oversight for Eggner's Ferry Bridge failed to identify recurring problems with the bridge lighting system as well as the inaccuracy of the Kentucky Transportation Cabinet's reports that lighting problems had been repaired.

The NTSB is concerned about the apparent absence of a clear national Coast Guard policy for ensuring that bridge owners maintain navigation lighting on bridges per approved lighting plans. Although the Coast Guard has the authority to inspect bridge lighting, it does not exercise that authority. Instead, the Coast Guard relies on notifications from mariners or other entities to learn about bridge lighting issues or outages. The NTSB believes the Coast Guard should use its authority to verify bridge lighting deficiencies are addressed and ensure they are repaired appropriately and in accordance with regulatory requirements. This includes recognizing when underlying functional reliability issues cause repeated outages. The NTSB recommends the Coast Guard develop procedures to identify bridges having chronic navigation lighting problems and work with the states that own those bridges to rectify underlying problems in a timely manner.

At the time of the accident the Coast Guard was aware that navigation lighting on Eggner's Ferry Bridge was not working properly. A twice-daily BNM was in effect to alert mariners to the problem. An initial broadcast went out approximately 4 hours prior to the accident, but the bridge team on the *Delta Mariner* said they did not hear it. Had they heard it, switched channels, and listened to the full BNM, they likely would have approached Eggner's Ferry Bridge with more caution and the accident might not have occurred. VDR audio confirmed the initial call-out by the Coast Guard was picked up by the *Delta Mariner*'s bridge radios. Bridge team members were unable to explain why they did not hear the initial broadcast.

The NTSB is concerned about the Coast Guard's reliance on BNMs as its primary means for disseminating navigational warnings about problems such as bridge lighting outages as the broadcasts may not be the most effective means for communicating with mariners. BNMs are issued infrequently and rely on the mariner first hearing the initial call and then taking additional action to switch channels and listen to the actual broadcast. A mariner may be busy with navigation tasks or otherwise occupied and not hear the initial Coast Guard call-out, which would result in the mariner missing important navigation information.

Although BNMs are not intended to replace good seamanship and competent watchstanding practices, they do provide timely information about hazards. As such, the Coast Guard could work to ensure that the messages are effectively delivered and more easily received by those who need the information. Prudent practice would suggest important navigation information should be broadcast more often than twice a day. Further, many vessels now have Internet access while under way, and wireless technology provides mariners greater communications capability than ever before. Therefore, the NTSB concludes traditional broadcast notices to mariners carried out over VHF radio may not be the most effective means for disseminating important navigation information. The NTSB therefore recommends the Coast Guard review the process and means of delivering broadcast notices to mariners and identify and implement methods for providing timely and easily accessible navigation information to mariners.

3 Conclusions

3.1 Findings

1. None of the following were found to be factors in the accident: the use of alcohol or illegal drugs, the mechanical condition of the *Delta Mariner* or its propulsion systems, and distraction from the use of cell phones or other electronic devices.

2. At the time of the accident, most of the navigation lights on Eggner's Ferry Bridge were extinguished, including the lights marking the main navigation span, which was the intended route of the vessel.

3. The majority of the white lights marking the center of the main navigation span had been extinguished for at least a year prior to the accident and likely for several years.

4. The Kentucky Transportation Cabinet failed to effectively maintain proper navigation lighting on Eggner's Ferry Bridge as required and resolve recurring lighting problems and their causes.

5. The contract pilot's exclusive focus on the only bridge navigation lights that were illuminated caused him to direct the vessel toward span E, which had insufficient clearance for the *Delta Mariner*.

6. The passage plan provided inadequate information for safe navigation on the inland waters portion of the intended journey.

7. The bridge team overly relied on the direction of the contract pilot, despite his apparent uncertainty, which resulted in the bridge team attempting to maneuver the vessel under the incorrect span.

8. The contract pilot and the bridge team failed to effectively utilize all navigation tools, such as the electronic charting system and radar, as they approached Eggner's Ferry Bridge.

9. The *Delta Mariner*'s safety management system was not effectively implemented on board the vessel at the time of the accident.

10. Foss Maritime Company provided ineffective oversight of the safety of *Delta Mariner* operations.

11. The expertise, duties, and responsibilities of the *Delta Mariner* contract pilots were inadequately defined.

12. A lack of specific inspection procedures and attention to navigation light maintenance led to the ineffective oversight of bridge navigation lighting maintenance in District 1 of the Kentucky Transportation Cabinet.

13. The Coast Guard's oversight for Eggner's Ferry Bridge failed to identify recurring problems with the bridge lighting system as well as the inaccuracy of the Kentucky Transportation Cabinet's reports that lighting problems had been repaired.

14. Traditional broadcast notices to mariners carried out over VHF radio may not be the most effective means for disseminating important navigation information.

3.2 Probable Cause

The National Transportation Safety Board determines the probable cause of the allision of the M/V *Delta Mariner* with Eggner's Ferry Bridge was the bridge team's exclusive reliance on the contract pilot's incorrect navigational direction as the vessel approached the bridge and their failure to use all available navigation tools to verify the safety of the vessel's course. Contributing to the accident was Foss Maritime Company's failure to exercise effective safety oversight of the *Delta Mariner*'s operations and the failure of the Kentucky Transportation Cabinet to effectively maintain bridge navigation lighting.

4. Recommendations

New Recommendations

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

To the US Coast Guard:

Develop procedures to identify bridges having chronic navigation lighting problems and work with the states that own those bridges to rectify underlying problems in a timely manner. (M-13-07)

Review the process and means of delivering broadcast notices to mariners and identify and implement methods for providing timely and easily accessible navigation information to mariners. (M-13-08)

To the Federal Highway Administration:

Alert state department of transportation bridge maintenance divisions to the circumstances of this allision and their responsibility to maintain bridge navigation lighting in accordance with US Coast Guard regulations. (M-13-09)

To Foss Maritime Company:

Develop a detailed passage plan for the inland waters portion of the *Delta Mariner*'s voyage to include specific information about all known risks and ensure the plan is understood and effectively used by bridge teams during transits. (M-13-10)

Clearly define the route expertise expected of *Delta Mariner* contract pilots and provide them and deck officers with specific guidance regarding the contract pilots' duties and responsibilities and the type of guidance expected of them while serving on the bridge of a vessel. (M-13-11)

Previously Issued Recommendations Resulting from This Accident Investigation

Earlier in the investigation, the NTSB issued two recommendations to the commonwealth of Kentucky. Based on the response received from the Kentucky Transportation Cabinet, these recommendations were classified "Closed—Acceptable Action" on November 20, 2012:

To the commonwealth of Kentucky:

Verify the status and proper operation of navigation lighting on all Kentucky bridges over navigable waters in accordance with US Coast Guard–approved lighting plans. (M-12-4)

Develop inspection and maintenance procedures so that bridge lighting functions reliably and is maintained in accordance with US Coast Guard–approved lighting plans. Train Kentucky Transportation Cabinet personnel in these procedures. (M-12-5)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

DEBORAH A.P. HERSMAN
Chairman

ROBERT L. SUMWALT
Member

CHRISTOPHER A. HART
Vice Chairman

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

Adopted: May 14, 2013

Member Weener filed the following concurring statement on May 24, 2013. He was joined by Chairman Hersman, Vice Chairman Hart, and Members Sumwalt and Rosekind.

Member Weener, Concurring:

I support the accident report concerning the allision of the cargo vessel M/V *Delta Mariner* with the Eggner's Ferry Bridge. I believe it is important, though, to add to the record two important points discussed at the Board meeting. The first point concerns bridge resource management, and the second concerns safety management systems.

Bridge resource management (BRM) is an important set of safety skills that can, when well trained and executed, enhance the safety of vessel operations. It is based on a team concept, and so dependent on all members knowing their respective roles and responsibilities. In this accident, however, it was evident the crewmembers on the bridge at the time of the accident, both contract and permanent, were not working as a team. As discussed at the Board meeting, the integration of a contract pilot who had not received BRM training, into a crew environment consisting of BRM trained crewmembers, poses an interesting challenge. Additionally, there were crewmembers who did not appear to understand their respective roles. Finally, there was also the complexity of employing a contract pilot for the purpose of guiding the vessel during its inland route even though the contract pilot's primary experience was on the Mississippi River. Although these facts were noted in the report I believe they are worth highlighting for further discussion, in the interest of promoting effective BRM.

As well, I want to reiterate that safety management systems (SMS) can only be effective through effective implementation. Establishing policies and procedures, and including the title of safety in the organizational structure, does not automatically result in an effective SMS. In addition to these tools, a successful SMS involves pro-active identification, analysis and management of risks; monitoring to ensure risk mitigations are effective and feedback to improve the process; and most importantly, a culture of "buy in" from all the employees, from the top management down to the line employees. When this type of safety culture exists, the importance of executing the operation <u>safely</u> becomes as important as executing the operation itself.

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