



Testimony of

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Board Member  
National Transportation Safety Board

Before the

Committee on Commerce, Science, and Transportation  
United States Senate

— On —

Are We Ready for the Next Hurricane Season?  
Status of Preparation and Response Capabilities for 2018

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*An Independent Federal Agency*

Good morning Chairman Thune, Ranking Member Nelson, and Members of the Committee. Thank you for inviting the National Transportation Safety Board (NTSB) to testify before you today.

The NTSB is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in other modes of transportation—highway, rail, marine, and pipeline. We determine the probable cause of the accidents we investigate and issue safety recommendations aimed at preventing future accidents. In addition, we conduct special transportation safety studies and coordinate the resources of the federal government and other organizations to assist victims and their family members who have been impacted by major transportation disasters.

When we investigate accidents, we try to understand not only the human factors or the mechanical factors involved, but also the environmental factors, including weather. In over 50 years of accident investigations, we have seen the importance of having accurate weather information, adequate training and equipment to understand adverse weather conditions and how to operate in them, and suitable equipment to survive dangerous conditions. All of these issues were raised in our recent investigation into the sinking of the *El Faro*.

### **Investigating the Sinking of *El Faro***

On October 1, 2015, the US-flagged cargo ship *El Faro*, owned by TOTE Maritime Puerto Rico and operated by TOTE Services, Inc., sank in the Atlantic Ocean about 40 nautical miles northeast of Acklins and Crooked Island, Bahamas, during Hurricane Joaquin, claiming the lives of all 33 crew members. Our investigation into the sinking and the subsequent loss of life identified several major safety issues, including the captain's actions, currency of weather information, bridge resource management, company oversight, damage control plans, and survival craft suitability.

We served as the lead investigative agency and worked jointly with the US Coast Guard to investigate *El Faro*'s sinking. Because the sunken vessel could not be physically investigated, recovering *El Faro*'s voyage data recorder (VDR) from over 15,400 feet below the surface of the ocean was critical to determining the probable cause of its sinking. We want to thank the US Coast Guard, the National Oceanic and Atmospheric Administration (NOAA), and all the other organizations who provided tremendous support to recover *El Faro*'s recorder.<sup>1</sup>

We recovered audio of conversations and ambient sounds from the ship's bridge that began at 5:36 a.m. on September 30, two days before the accident, and continued until *El Faro* sank. This data—as well as parametric data from the VDR, such as the ship's heading and speed—provided information about the captain's and crew's conversations and actions throughout the voyage, the weather information available to them, and the ship's performance as it sailed into the storm. On December 12, 2017, following a 26-month investigation, we determined the probable cause of the

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<sup>1</sup> Organizations assisting in the VDR recovery included the Department of the Navy, Supervisor of Salvage and Diving and Military Sealift Command; US Coast Guard; American Bureau of Shipping; National Oceanic and Atmospheric Administration; National Science Foundation; Woods Hole Oceanographic Institution; TOTE Services, Inc.; and University of Rhode Island, Inner Space Center.

sinking and made 53 safety recommendations. The final report and recommendations were published on February 7, 2018.<sup>2</sup>

For the purposes of this testimony, I will focus on the safety issues regarding the weather information available to and used by the crew, as well as the survival craft onboard the ship, and recommendations that we made to address these issues.

### *Currency of Weather Information*

On September 29, 2015, at 9:48 p.m., *El Faro* and its 33 crewmembers departed its homeport in Jacksonville, Florida, on a 1,100-nautical-mile (nm) planned voyage to San Juan, Puerto Rico, slated to arrive in the early morning hours of October 2. However, the ship sailed directly into the path of Hurricane Joaquin, a Category 3 storm that reached Category 4 strength shortly after the sinking, at approximately 8:00 a.m. on October 1.

Approximately 3 hours before *El Faro* set sail on September 29, the National Hurricane Center (NHC) issued the first marine hurricane warning for Joaquin for a large area of the Atlantic east of the Bahamas; however, we determined that the captain's decision to depart Jacksonville was reasonable, considering the number of options he could employ to avoid the storm. As they tracked the storm the next day, the captain and chief mate diverted course slightly to the south to try to distance themselves from the storm. However, as it continued to intensify, Joaquin also tracked further south than originally predicted.

The crew onboard *El Faro* relied on two primary sources of weather information to remain aware of Joaquin's changing position, forecast intensity, and predicted track: Inmarsat-C SafetyNET (SAT-C) and the Bon Voyage System (BVS). These sources used different methods and formats to deliver weather guidance. SAT-C provided text broadcasts of NHC weather products, which were delivered to the vessel's bridge. This includes near-real-time information on Joaquin's position, forecast intensity, and predicted track, and is issued four times a day for active tropical cyclones.

BVS is a commercially available software program that provides graphic depictions of weather information via e-mail or broadband. BVS weather files were e-mailed to *El Faro*'s captain, who primarily relied on this information for storm location and forecast track. Seven BVS files were e-mailed to *El Faro* during the accident voyage. At the times the BVS weather files were e-mailed, the storm location and forecast track were not current with the information then available through SAT-C; rather, due to a delay in processing and preparing the data for distribution, BVS provided a storm position and forecast track 6 hours behind SAT-C. BVS can also send updates with current forecasts if a user specifically requests them, but during the accident voyage, *El Faro* did not request any.

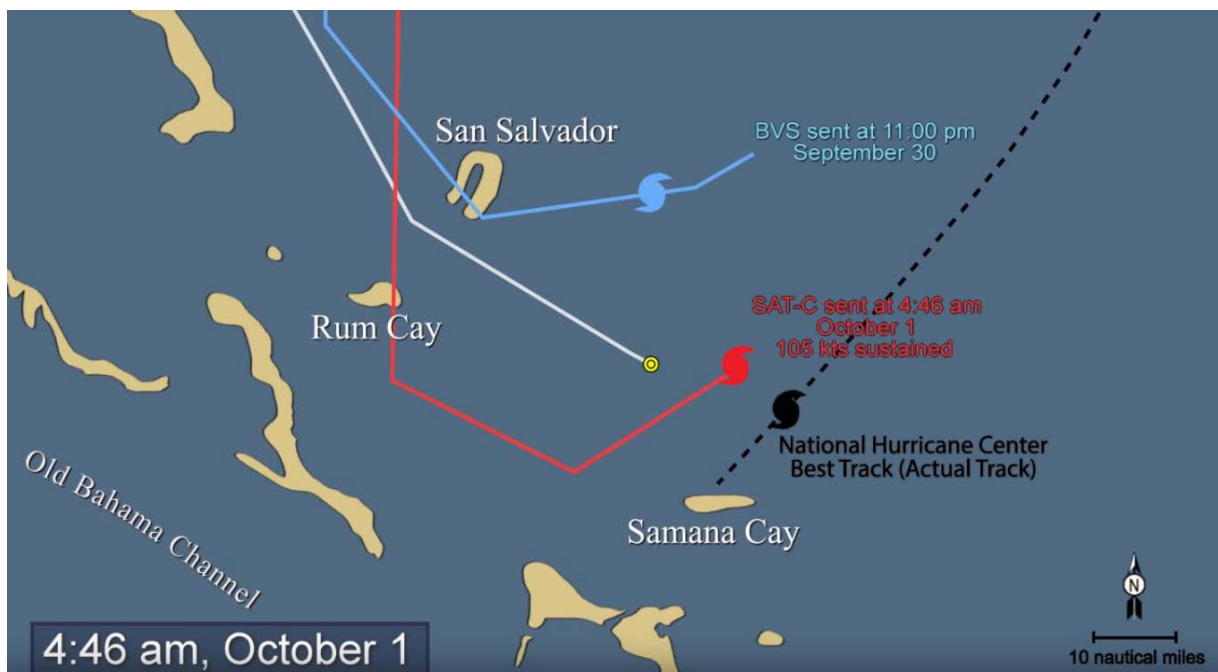
The VDR audio recording from the bridge made clear that the crew had access to other weather information as well, including the Weather Channel, satellite radio, and broadcasts from US Coast Guard aircraft. We found that *El Faro* was receiving sufficient weather information for

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<sup>2</sup> National Transportation Safety Board, [Sinking of US Cargo Vessel SS El Faro, Atlantic Ocean, Northeast of Acklins and Crooked Island, Bahamas October 1, 2015](#), Rpt. No. MAR-17/01 (Washington, DC: NTSB, 2017).

the captain to make educated decisions regarding the vessel's route, but the captain did not use it. Several times throughout the night of September 30 and into the early morning of October 1, the bridge crew noted their concerns about the ship's advancement toward a strengthening storm based on information from SAT-C and other sources; however, the captain may have felt confident about the ship's route and proximity to the storm. However, he was relying on BVS weather information that was many hours older than what the bridge crew was reviewing. Based on the information obtained from the VDR, it seems most likely that the captain did not realize that Sat-C was providing more current information than BVS.

At 4:45 a.m., on October 1, the captain downloaded a BVS weather file that had been sent to him at 11:04 p.m. the night before. Joaquin's position, forecast track, and intensity given in the file were consistent with the data in the advisory that had been delivered to the bridge via SAT-C almost 12 hours before, at 4:54 p.m. the previous afternoon. At 4:46 a.m., *El Faro's* SAT-C terminal received an advisory indicating that *El Faro* was 11 nm northwest of the storm center (**Figure 1**). By that time, the ship was experiencing a starboard list caused by increasing wind on the vessel's port side. As the ship continued to sail into the storm, the crew struggled to deal with a cascading series of events, including flooding and loss of propulsion, any one of which could have endangered the ship on its own.



**Figure 1.** *El Faro's* location in relation to available weather forecasts and poststorm analysis at 4:46 a.m. on October 1.

Once under way on the accident voyage, the captain had opportunities to take other actions to avoid Hurricane Joaquin. There are several possible explanations for the captain's decision to continue on course into the hurricane's direct path, but his training does not appear to have prepared him for the conditions Hurricane Joaquin presented.

*El Faro*'s captain graduated from Maine Maritime Academy in 1988, and he obtained his master's credential in 2001. Mariners who obtained their initial credential before 1998 were not required to take an advanced meteorology training course approved by the US Coast Guard; thus, the captain was not required to have completed the advanced meteorology or advanced shiphandling courses. The same was true for *El Faro*'s chief mate. According to their most recent certificates, none of the bridge officers had attended the advanced meteorology or advanced shiphandling courses. We concluded that training in heavy-weather operations, including advanced meteorology and advanced shiphandling, might have provided the captain with additional information to consider while evaluating options, and may have resulted in a different course of action. We recommended that the US Coast Guard require that all deck officers, at both operational and management levels, take a US Coast Guard-approved advanced meteorology course to close the gap for mariners initially credentialed before 1998.<sup>3</sup> The recommendation is currently classified "Open—Await Response."

We also recommended that the US Coast Guard publish policy guidance to approved maritime training schools offering management-level training in advanced meteorology, to ensure that the curriculum includes the following topics: characteristics of weather systems, including tropical revolving storms; advanced meteorological concepts; importance of sending weather observations; ship maneuvering using advanced simulators in heavy weather; heavy-weather vessel preparations; use of technology to transmit and receive weather forecasts (such as navigational telex or weather-routing providers); ship-routing services (capabilities and limitations); and launching of lifeboats and liferafts in heavy weather.<sup>4</sup> The recommendation is currently classified "Open—Await Response."

We further recommended that the US Coast Guard provide policy guidance to approved maritime training schools offering operational-level training in meteorology to ensure that the curriculum includes the following topics: characteristics of weather systems, weather charting and reporting, importance of sending weather observations, sources of weather information, and interpreting weather forecast products.<sup>5</sup> The recommendation is currently classified "Open—Await Response."

An accurate determination of wind speed and wind direction onboard *El Faro* would have allowed the crew to resolve the conflicting weather reports. *El Faro* was not required to carry an anemometer but did have one installed. The vessel's anemometer displayed wind data on the bridge, which was also recorded by the VDR; however, according to interviews with former crewmembers and crew discussions and wind data obtained from the VDR, the anemometer was not properly functioning. A properly working anemometer would have allowed the ship's crew to compute the true wind direction and speed. With that information, the captain would have had additional tools to use to determine the vessel's position in relation to Hurricane Joaquin. We concluded that TOTE did not ensure that *El Faro* had a properly functioning anemometer, which deprived the captain of a vital tool for understanding his ship's position relative to the storm. To ensure that vessels are equipped with properly functioning weather equipment, we recommended that the US Coast Guard require that vessels in ocean service (500 gross tons or over) be equipped with properly operating

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<sup>3</sup> [Safety Recommendation M-17-33.](#)

<sup>4</sup> [Safety Recommendation M-17-34.](#)

<sup>5</sup> [Safety Recommendation M-17-35.](#)

meteorological instruments, including functioning barometers, barographs, and anemometers.<sup>6</sup> The recommendation is currently classified “Open—Await Response.”

During the course of our investigation, the factual information indicated that Joaquin’s track was difficult to forecast because of its moderate wind shear. The forecast errors for Hurricane Joaquin and other tropical cyclones suggest that hurricane forecasting needs to be improved. Further, our investigation revealed that critical tropical cyclone information issued by the National Weather Service (NWS) is not always available to mariners via well-established broadcast methods. The data also suggest that modifying the way the NWS develops certain tropical cyclone forecasts and advisories could help mariners at sea better understand and respond to tropical cyclones. As a result, we adopted a safety recommendation report on June 20, 2017, making ten recommendations to address these safety issues—two addressed to NOAA, seven to the NWS, and one to the US Coast Guard.<sup>7</sup>

Among these, we recommended that NOAA develop and implement a plan specifically designed to emphasize improved model performance in forecasting tropical cyclone track and intensity in moderate-shear environments. We also recommended that NOAA develop and implement technology that would allow NWS forecasters to quickly sort through large numbers of tropical cyclone forecast model ensembles, identify clusters of solutions among ensemble members, and allow correlation of those clusters against a set of standard parameters.<sup>8</sup> Both recommendations are classified “Open—Await Response,” although we recently received information from NOAA that these recommendations aligned with work that is in progress or planned as part of the Hurricane Forecast Improvement Program.

Collecting and disseminating meteorological and oceanographic data in near real-time is vital to supporting global meteorological authorities who aim to produce the best possible weather forecasts and advisories. Although surface-based data collection networks on land are geographically extensive and, in many cases, provide good temporal coverage, no such network exists over the world’s oceans. Satellites retrieve valuable data from the ocean surface; yet, they have limitations. We found that increased reporting and improved transmission of meteorological and oceanographic data from vessels at sea would significantly improve the availability of vital information to enhance weather awareness, forecasting, and advisory services aimed at improving mariner safety.

We recommended that NOAA coordinate with the NWS, vessel operators, automatic identification system (AIS) service providers, and required onboard technology vendors to perform a “proof-of-concept” project to establish whether AIS, or another suitable alternative, can practically deliver, in a single message, meteorological and oceanographic data obtained directly from automated instrumentation and manual observation onboard vessels at sea, vessel position and time of observation, and other important metadata by satellite and land-based receivers to global meteorological authorities via the Global Telecommunication System with

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<sup>6</sup> [Safety Recommendation M-17-36](#).

<sup>7</sup> National Transportation Safety Board, [Tropical Cyclone Information for Mariners](#), Rpt. No. MSR-17/02 (Washington, DC: NTSB, 2017).

<sup>8</sup> Safety Recommendations [M-17-8](#) and [M-17-9](#).

acceptable time delay.<sup>9</sup> On March 15, 2018, the NWS responded that it is establishing a proof-of-concept project under its Office of Observations to evaluate the feasibility of transmitting weather information through AIS. Preliminary discussions have been conducted among the NWS, NOAA, potential contributors to this project, and key stakeholders. This recommendation is classified “Open—Initial Response Received.”

### *Suitability of Survival Craft*

According to data from *El Faro*'s VDR, at 7:27 a.m. on October 1, after struggling to address the flooding and propulsion loss experienced on the vessel, the captain rang the ship's general alarm, and one minute later, the chief mate gave a radio command for the crew to muster on the starboard side of the ship. At 7:29 a.m., the captain ordered abandon ship, and two minutes later, he ordered that inflatable liferafts be thrown overboard and that the crew enter them. The VDR ceased recording at 7:39 a.m., with the captain and able seaman still on the bridge.

A transmission from *El Faro*'s emergency position indicating radio beacon (EPIRB) was detected by geostationary satellite at 7:36 a.m. and received by the US Coast Guard. The transmission was forwarded as an “unlocated first alert” because *El Faro*'s EPIRB was not GPS-equipped, which would have allowed the unit to transmit its current position. No further communications were received by either the US Coast Guard or TOTE. *El Faro*'s last known position, according to VDR data, was 20 nm north of Samana Cay, about 17 nm north of Joaquin's center.

*El Faro* carried five liferafts: four 25-person liferafts and a 6-person liferaft. In addition, *El Faro* was equipped with two 43-person open lifeboats, which were original equipment from when the ship was built. *El Faro*'s starboard lifeboat was discovered during the search-and-rescue operation, damaged and swamped. The damaged port lifeboat was discovered on the seafloor during the second mission to recover the VDR. There was no indication that the lifeboats had been launched. A partially inflated liferaft was discovered during the search-and-rescue operation and confirmed to be from *El Faro*. None of the remaining five *El Faro* liferafts was recovered, and none was observed in a stowed position on the wreckage.

We found that the captain's decision to muster the crew and abandon ship was late and may have reduced the crew's chances of survival. However, the severe weather, combined with *El Faro*'s list, made it unlikely that the liferafts or lifeboats could be launched manually or boarded by crewmembers once in the water, and they would not have provided adequate protection even if they had been launched. Open lifeboats, such as those *El Faro* carried, are not allowed on newly built vessels. *El Faro*'s lifeboats were inspected and surveyed in accordance with the regulations applicable to its delivery date of January 1975. A vessel is surveyed under the same regulations as long as it is in service or until it undergoes a major modification; in the latter case, the vessel must comply with the requirements current at the time of modification as far as is reasonable and practicable. In 1993, *El Faro*, then named *Northern Lights*, underwent a major modification, but the lifeboats were not required to be upgraded at that time because the lifeboats themselves were not modified in the conversion. The vessel was again substantially modified in 2005–2006 to carry

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<sup>9</sup> [Safety Recommendation M-17-52.](#)

load-on/load-off containers, but the US Coast Guard did not classify this change as a major modification. We concluded that the 2005–2006 conversion should have been designated a major modification, which may have required the vessel to meet newer safety standards for lifeboats.

The average life of international merchant ships is roughly 20 to 30 years. The *El Faro* was 40 years old when it sank, and open lifeboats had been superseded for 30 years. Therefore, considering the average service life of these vessels, we recommended that all lifesaving appliances on inspected vessels, which would include lifeboats and liferafts, be reviewed at a maximum 20-year interval to current standards and be upgraded as required.<sup>10</sup> This recommendation is classified “Open—Await Response.”

Survivability would be enhanced if open lifeboats on all vessels remaining in service were replaced with enclosed lifeboats that adhered to the latest safety standards, and if new cargo vessels were equipped with stern-launched freefall lifeboats where practicable. We recommended that the US Coast Guard require open lifeboats on all US-inspected vessels to be replaced with enclosed lifeboats that meet current regulatory standards and freefall lifeboats, where practicable.<sup>11</sup> This recommendation is classified “Open—Await Response.”

## **Conclusion**

The captain’s insufficient action to avoid Hurricane Joaquin due to his failure to use the most current weather information and the lack of appropriate survival craft for the conditions were critical factors in the probable cause of *El Faro*’s sinking and the loss of 33 lives. Although the ship and its crew should never have found themselves sailing into the storm, many other factors, including ineffective bridge resource management, inadequate company oversight and safety management, flooding, propulsion loss, and the lack of an approved damage control plans also contributed to the sinking, and there are many other lessons to learn.

As with all of our investigations, our aim is to learn from this tragedy to improve safety for current and future generations of mariners. We hope that our investigation into *El Faro*’s sinking will improve mariners’ awareness of and preparation for heavy weather as well as prompt changes to improve weather forecasting and dissemination. These changes, combined with updated technology and equipment requirements, will help future mariners make better decisions in the face of hurricanes and other significant weather events. We appreciate that both the US Coast Guard and NOAA have been responsive to our recommendations and we look forward to continuing to work with them.

Thank you again for the opportunity to testify, and I am happy to take your questions.

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<sup>10</sup> [Safety Recommendation M-17-042.](#)

<sup>11</sup> [Safety Recommendation M-17-043.](#)