Collision between Bulk Carrier *Summer Wind* and the *Miss Susan* Tow
Houston Ship Channel, Lower Galveston Bay, Texas
March 22, 2014

Marine Accident Report
NTSB/MAR-15/01
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Notation 8695
Adopted June 9, 2015

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National
Transportation
Safety Board

490 L'Enfant Plaza, SW
Washington, DC 20594

National Transportation Safety Board. 2015. *Collision between Bulk Carrier* Summer Wind *and the* Miss Susan *Tow, Houston Ship Channel, Lower Galveston Bay, Texas, March 22, 2014*. Marine Accident Report NTSB/MAR-15/01. Washington, DC.

Abstract: This report discusses a collision in the Houston Ship Channel in which the towing vessel *Miss Susan*, pushing two tank barges, attempted to cross the channel as the inbound bulk carrier *Summer Wind* was approaching. The collision punctured the lead barge causing a fuel oil spill, and two crewmembers on board the *Miss Susan* sustained inhalation-related injuries.

Safety issues identified in this accident include lack of vessel separation in Houston Ship Channel precautionary areas with intersecting waterways and inadequate oversight and training related to the safety and health of uninspected towing vessel crews responding to hazardous materials releases.

As a result of this investigation, the National Transportation Safety Board makes new recommendations to the United States Coast Guard, Kirby Inland Marine, and the American Waterways Operators.

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Acronyms and Abbreviations

AIS	automatic identification system
CFR	*Code of Federal Regulations*
HAZWOPER	Hazardous Waste Operations and Emergency Response
MSDS	material safety data sheet
NPRM	notice of proposed rulemaking
NTSB	National Transportation Safety Board
NWS	National Weather Service
OSHA	Occupational Safety and Health Administration
PAWSA	Ports and Waterways Safety Assessment
PPE	personal protective equipment
PPU	portable pilot unit
QI	qualified individual
SCBA	self-contained breathing apparatus
SST	Site Specific Targeting (OSHA program)
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
USC	*United States Code*
S-VDR	simplified voyage data recorder
VHF	very high frequency
VTS	vessel traffic service

Executive Summary

On March 22, 2014, about 1235 central daylight time, the 607-foot-long bulk carrier *Summer Wind* with a Houston pilot on board collided with the 670-foot-long *Miss Susan* tow (a 70-foot-long towing vessel and two 300-foot-long tank barges loaded with fuel oil) in the Houston Ship Channel, Lower Galveston Bay, Texas. The visibility was restricted at the time due to fog. The bulk carrier was inbound to Houston, traveling in a north direction. The tow was bound for Port Bolivar on the east side of the Houston Ship Channel, traveling in an east direction.

The collision breached the hull of the forward tank barge in the *Miss Susan* tow, and about 168,000 gallons of fuel oil spilled into the waterway. Two crewmembers on board the *Miss Susan* sustained minor injuries related to inhalation of fuel vapor. The total estimated damage was nearly $1,378,000 (excluding oil response and recovery efforts).

The National Transportation Safety Board (NTSB) determines that the probable cause of the collision was the *Miss Susan* captain's attempt to cross the Houston Ship Channel ahead of the *Summer Wind*, thereby impeding the passage of the bulk carrier, which could transit only within the confines of the channel. Contributing to the accident was the failure of the Houston pilot and the *Summer Wind* master to set a safe speed given the restricted visibility and nearby towing vessel traffic, and the failure of the *Miss Susan* captain and the Houston pilot to establish early radio communication with one another. Also contributing to the accident was the failure of Vessel Traffic Service Houston/Galveston to interact with the two vessels in a developing risk of collision, and the lack of a Coast Guard vessel separation policy for the Bolivar Roads Precautionary Area.

The report identifies the following safety issues:

- **Lack of vessel separation in Houston Ship Channel precautionary areas with intersecting waterways:** The NTSB has previously noted that insufficient distance between vessels when they turn, pass, and overtake one another near intersections can create unsafe situations. This accident once again highlights the need for separation between vessels in such areas of the Houston Ship Channel.

- **Inadequate oversight and training related to the safety and health of uninspected towing vessel crews responding to hazardous materials releases:** In assessing why two *Miss Susan* crewmembers suffered inhalation injuries when responding to the oil spill, the NTSB found that both federal oversight and company training of personnel exposed to hazardous materials were insufficient.

As a result of this investigation, the NTSB makes new recommendations to the Coast Guard, Kirby Inland Marine, and the American Waterways Operators.

1. The Accident

About noon central daylight time on Saturday, March 22, 2014, a pilot from the Houston Pilots Association boarded the Liberia-flag bulk carrier *Summer Wind* (figure 1).[1] The ship had been at Anchorage B at the Bolivar Roads anchorage near Port Bolivar, Texas (figure 2), for about 2.5 days awaiting a berth at the Cargill dock in the Port of Houston, Texas.[2] At Cargill, the ship was to be loaded with grain and then transit to Africa.

Figure 1. Bulk carrier *Summer Wind* after the collision. The vessel's cargo tanks were empty at the time of the accident and in this photo as well.

[1] (a) Unless otherwise noted, all times in this report are central daylight time (coordinated universal time – 5 hours), based on the 24-hour clock. (b) A pilot is retained by the ship to provide local knowledge of the waterway, familiarity with tides and currents in the area, understanding of local procedures, and a thorough knowledge of the topography of the waterway. Pilots usually operate by issuing maneuvering instructions (such as heading, rudder angle orders in degrees to port or starboard, and speed orders) to the crew under the supervision of the master or the officer in charge of the navigation watch, or both. The master is ultimately responsible for ensuring that the instructions and operations of the pilot result in the safe passage of the vessel through the waterway and to or from a berth.

[2] Road (also *roads* or *roadstead*) is a nautical term for a large, partly protected area in which vessels may anchor.

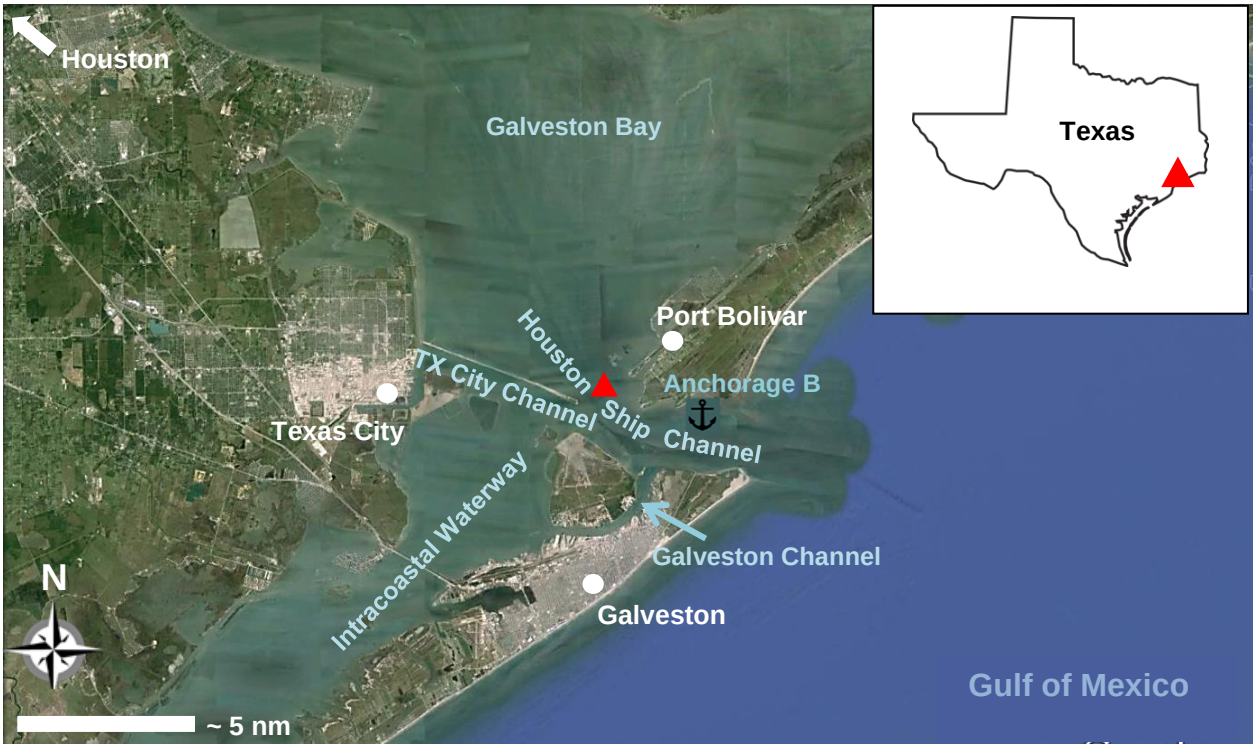

Figure 2. Satellite image of the collision site. (Background by Google Earth)

Throughout that morning, the Houston Ship Channel and nearby waterways had experienced restricted visibility due to fog, and about 0740, the Houston Pilots Association suspended pilot boardings of deep-draft vessels.[3] However, late morning, with the visibility somewhat improved, outbound deep-draft traffic commenced again. Shortly before noon, pilot boardings of inbound deep-draft vessels also resumed, and the *Summer Wind* was to be the first inbound deep-draft vessel.[4] Several tows with various cargo had continued to transit in the area during the morning. The Houston pilot and the *Summer Wind* master conducted the master/pilot exchange regarding vessel particulars and the route ahead.[5] However, the two did not discuss a speed at which to transit in the Houston Ship Channel during restricted visibility. The pilot asked

[3] (a) Ship channels in general are deeper navigational pathways in a waterway. Larger vessels, due to their deep draft requirements, transit within the confines of the ship channels. (b) The term *deep-draft* describes vessels that must transit in the ship channels (unlike smaller vessels, such as towing and fishing vessels, which can operate in the shallower water outside the channels).

[4] Local pilot associations have the right to temporarily suspend pilot boardings of vessels if they deem weather conditions unsatisfactory. The ultimate authority on whether to close a port and nearby waterways resides with the local Coast Guard captain of the port. Complete shutdowns are very rare and usually occur only during a state of emergency.

[5] (a) In the maritime industry, the terms *master* and *captain* both refer to the highest-ranking crewmember on a vessel and the one with overall responsibility for the vessel's operation and safety. In this report, the term *master* is used for the highest-ranking crewmember on the bulk carrier *Summer Wind*; *captain* is used to describe the highest-ranking crewmember on each of the towing vessels in the area, including the *Miss Susan*. (b) An effective master/pilot exchange includes discussion of the vessel's navigational equipment, any limitations of maneuverability, available engine speeds, un-berthing maneuvers, intended course and speed through the waterway, anticipated hazards along the route, weather conditions, composition of the bridge team and deck crew both forward and aft including bow lookout, and so on. For more detail, see for example "Bridge Resource Management for Maritime Pilots, III" by George A. Quick, April 2002.

the master to configure the vessel's radar the way the pilot preferred. The pilot also set up his own portable pilot unit (PPU), a compact laptop computer with electronic navigation and charting software. In discussing vessel traffic with the master, the pilot mentioned that only two ships were outbound in the Houston Ship Channel. He did not mention any of the various tows under way at the time.

The *Summer Wind* was in an area the Coast Guard designates as the "Bolivar Roads Precautionary Area" (figure 3), which includes several intersecting waterways. Title 33 *Code of Federal Regulations* (CFR) 161.2 defines precautionary areas as geographic sectors in which "vessels must navigate with particular caution." Nautical charts for the Houston Ship Channel do not graphically depict the Bolivar Roads Precautionary Area (figure 4).[6]

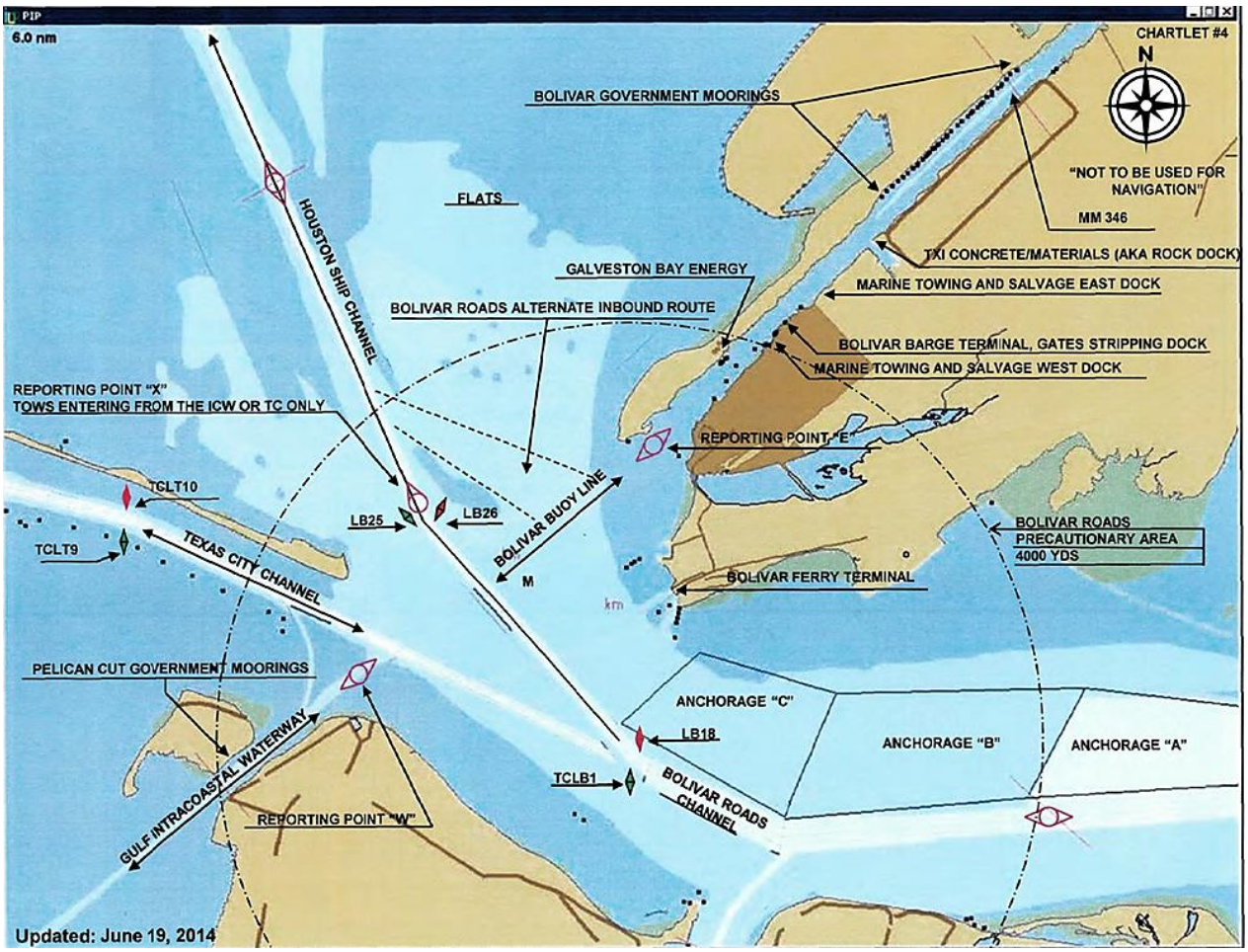

Figure 3. Image of the Bolivar Roads Precautionary Area (circled), including part of the Houston Ship Channel, the Texas City Channel, the Intracoastal Waterway, and, in the lower center of the image, the Galveston Channel. (Image in Vessel Traffic Service Houston/Galveston's Ports and Waterways Safety System Chartlet #4)

[6] US nautical charts are published by the National Oceanographic and Atmospheric Administration, based in part on information provided by the Coast Guard, the US Army Corps of Engineers, and other federal, state, and local government agencies. These charts do not identify Coast Guard-designated precautionary areas. Precautionary areas in the Houston Ship Channel area are listed in 33 CFR 161.35(b) and in the *U.S. Coast Pilot*.

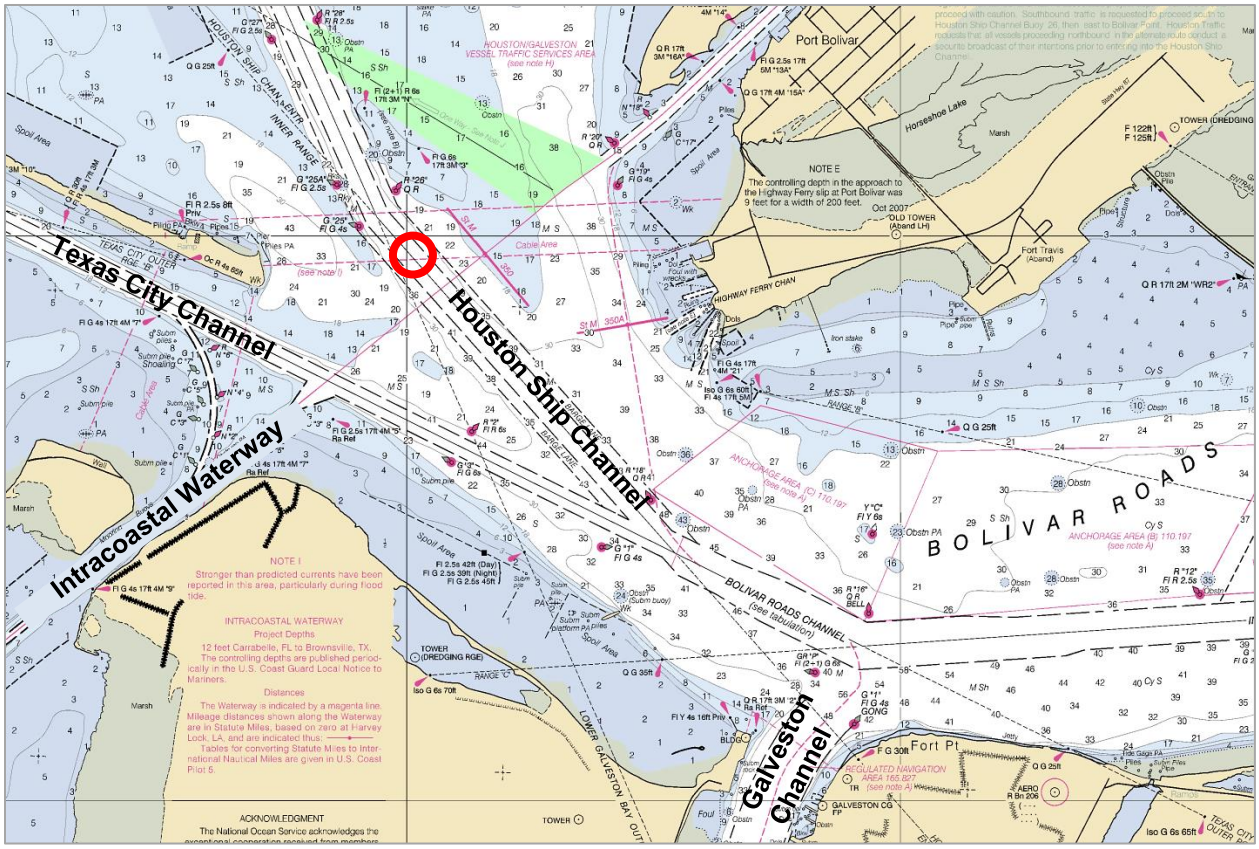

Figure 4. Section of nautical chart 11324, showing portions of the Houston Ship Channel, the Texas City Channel, the Intracoastal Waterway, and the Galveston Channel, with overlaid channel labels. The collision site is overlaid by a red circle. The Coast Guard-designated Bolivar Roads Precautionary Area, which was shown as a large circle in the previous image, is not depicted on this chart.

In addition to the pilot, 22 crewmembers were on board the *Summer Wind*. On the bridge together with the master and the pilot were the mate on watch and a helmsman. At 1205, the pilot announced via very high frequency (VHF) channel 13 that the ship was heaving anchor getting ready to go inbound to Houston. Five minutes later, at 1210, the pilot made another radio call reiterating that the ship was leaving anchorage inbound to Houston. At that time, the vessel was transiting at a speed of dead slow ahead (about 3 knots). The pilot also conveyed visibility information to another vessel, stating that fog was "socked in, all the way to Morgan's Point" (a location about 25 nautical miles to the northwest, near Houston). About 1215, the pilot ordered half-ahead speed on the *Summer Wind*. As a precaution in the fog, the ship's boatswain and the chief mate were stationed on the bow as lookouts and to be prepared to release the anchor, if necessary.

At 1217, the captain on board the towing vessel *Miss Susan* (figure 5) radioed that she was exiting Texas City with two loaded tank barges (the *Kirby 27705* and the *Kirby 27706*) bound for Bolivar (Port Bolivar) on the other side of the Houston Ship Channel. The two tank barges were carrying about 45,621 barrels (1,916,082 gallons) of the heavy marine fuel oil

RMG 380.[7] The *Miss Susan* captain had relieved the vessel's mate and taken the conn (navigational control) about 2 minutes before this radio call.[8] About the same time as this radio call was made, the pilot on the *Summer Wind* was completing a meeting arrangement with the *BBC Indiana*, a 454-foot-long cargo ship that needed to make a wide turn to starboard into the Galveston Channel. The pilot told investigators that he did not hear the *Miss Susan* captain's 1217 announcement.

Figure 5. Postaccident photo of towing vessel *Miss Susan*, pushing barge *Kirby 27705*.

About 1221, the pilot on the *Summer Wind* ordered the bulk carrier's speed increased from the approximately 7 knots at which it was transiting at that time to full ahead (which would gradually increase the speed to about 12 knots). Also about 1221–1222, the *Miss Susan* captain announced a second time that she was exiting Texas City bound for Bolivar with "two loads." The pilot on the *Summer Wind* told investigators that he did not hear this announcement either.

Although the fog had improved to about 1 mile of visibility to the north and south of the intersection between the Texas City and Houston Ship Channels, a thicker patch of fog lingered in that intersection where the *Miss Susan* tow was about to cross, and the captain activated the vessel's fog signal. She told investigators that she could see just beyond the bow of the lead

[7] RMG 380 exhibits a pungent petroleum hydrocarbon odor with the potential to accumulate hazardous vapors in poorly ventilated areas. Inhaling high concentrations of the product irritates the respiratory tract and may cause headache, dizziness, nausea, vomiting, and malaise. Recommended first-aid measures for inhalation are to remove the affected person to fresh air and provide oxygen if breathing is difficult. For more detail, see section "2.7. Policies Regarding Hazardous Materials."

[8] "Mate" is also called "pilot" on this towing vessel.

barge, indicating that the visibility at the time was just over 600 feet. Referencing her vessel's automatic identification system (AIS) about 1225, the *Miss Susan* captain noted the inbound *Summer Wind* about 3 nautical miles away, near buoy 16, at a speed of almost 10 knots.[9] She told investigators that she mentally calculated the bulk carrier's speed and location compared to her own and concluded that she had "plenty of time to cross" the Houston Ship Channel.

In addition to the *Miss Susan*, several other towing vessels were pushing barges in the area. The *Natures Way Commander* and the *Mission* were both southbound in the Houston Ship Channel north of the Intracoastal Waterway, bound for Bolivar. The towing vessel *Buttercup* was south of the Intracoastal Waterway and east of the Houston Ship Channel, also bound for Bolivar. All of the towing vessels were in radio contact with each other, adjusting their speeds to facilitate lining up one after the other on their approach to Bolivar. The mutually agreed-to order of the line-up was to have the *Buttercup* (south of the Intracoastal Waterway) enter Bolivar first, followed by the *Miss Susan* (which was about to cross the Houston Ship Channel), then the *Mission*, and then the *Natures Way Commander*. The entire radio conversation about the vessels' positions and intentions took place over VHF channel 13, which enabled all vessels in the area to hear the discussion.[10] The radio traffic was also audible to and recorded by the Coast Guard's vessel traffic service (VTS) for the Houston/Galveston area.[11]

During the radio conversation among the towing vessel captains, the *Mission* captain radioed the inbound *Summer Wind*, and the pilot responded "inbound ship just cleared [buoy] 16 looking at 18." The *Mission* captain stated his location and intention to proceed to Bolivar, asking the pilot if the *Mission* could meet the *Summer Wind* in a starboard-to-starboard arrangement.[12] The pilot agreed. Shortly thereafter, the captain on the *Natures Way Commander* asked for the same meeting arrangement, to which the pilot also agreed.

Moments later, about 1227, while in radio contact with the *Miss Susan* captain, the *Buttercup* captain requested that the *Miss Susan* slow down to allow the *Buttercup* to enter Bolivar. The *Miss Susan* captain responded that it looked on the AIS like the *Buttercup* was "almost in there" and that her own vessel had not even crossed the Houston Ship Channel yet. Nevertheless, she acknowledged the *Buttercup* captain's request and stated "all right, we'll bring

[9] AIS is a maritime navigation safety communications system. At 2- to 12-second intervals on a moving vessel, the AIS automatically transmits vessel information, including the vessel's name, type, position, course, speed, navigational status, and other safety-related information, to appropriately equipped shore stations, other vessels, and aircraft. The rate at which the AIS information is updated depends on vessel speed and whether the vessel is changing course. AIS also automatically receives information from similarly equipped vessels. AIS is required in waterways governed by vessel traffic control.

[10] Vessels are required to monitor VHF channel 13, which is the main vessel-to-vessel communication channel.

[11] VTS Houston/Galveston is co-located with Coast Guard Sector Houston/Galveston at Ellington Field in Houston, about 23 miles from the accident site. About 70 miles of navigable waterways fall under VTS Houston/Galveston's coverage area, 55 miles of which is the Houston Ship Channel. Per regulations governing VTS operations in the United States, certain vessels transiting the waterways are required to check in with VTS both before entering the area and at designated reporting points once inside. Their crews must provide a sailing plan, position report, sailing plan deviation/amplification report, and final report to VTS (33 CFR 161). For more information, see http://www.uscg.mil/vtshouston/. Also see section "2.3.3 VTS Houston/Galveston" in this report.

[12] Although port-to-port meeting arrangements are the standard, starboard-to-starboard arrangements are not abnormal.

you on in first." In the next sequence of radio calls, the *Mission* captain indicated that he was slowing his vessel to let the *Miss Susan* pass before him.

About 1229, the *Mission* captain radioed the *Miss Susan* captain, saying "Hey you going to be [. . .] beating that inbound ship across the intersection there?" The *Miss Susan* captain replied, "I'm going to be crossing the intersection there in a minute, over." The *Mission* captain replied, "Yeah, that's what I'm saying, you going to beat him across? Are you gonna be across before he gets down here?" The *Miss Susan* captain replied, "Roger." When investigators later asked the *Mission* captain why he questioned the *Miss Susan* captain, he responded that the way things appeared to him at the time, the *Miss Susan* captain was unaware of the inbound *Summer Wind*. Later on during questioning, the *Mission* captain stated that he had just wanted to ensure that the *Miss Susan* could safely cross the channel.

The *Miss Susan* captain told investigators that, about the same time as the *Mission* captain's radio call, she realized by looking at her AIS that the *Summer Wind*'s speed had increased. At this point, the *Miss Susan* was at the tip of the Texas City Dike, on the west side of the Houston Ship Channel (figure 6). The *Miss Susan* captain told investigators that the *Summer Wind*'s speed increase was unexpected; however, she also acknowledged that inbound and outbound deep-draft vessels in the Houston Ship Channel routinely transited at full-ahead speed (12–13 knots), including during restricted visibility. Her own vessel's speed at that point was about 5.4 knots, according to AIS data.[13]

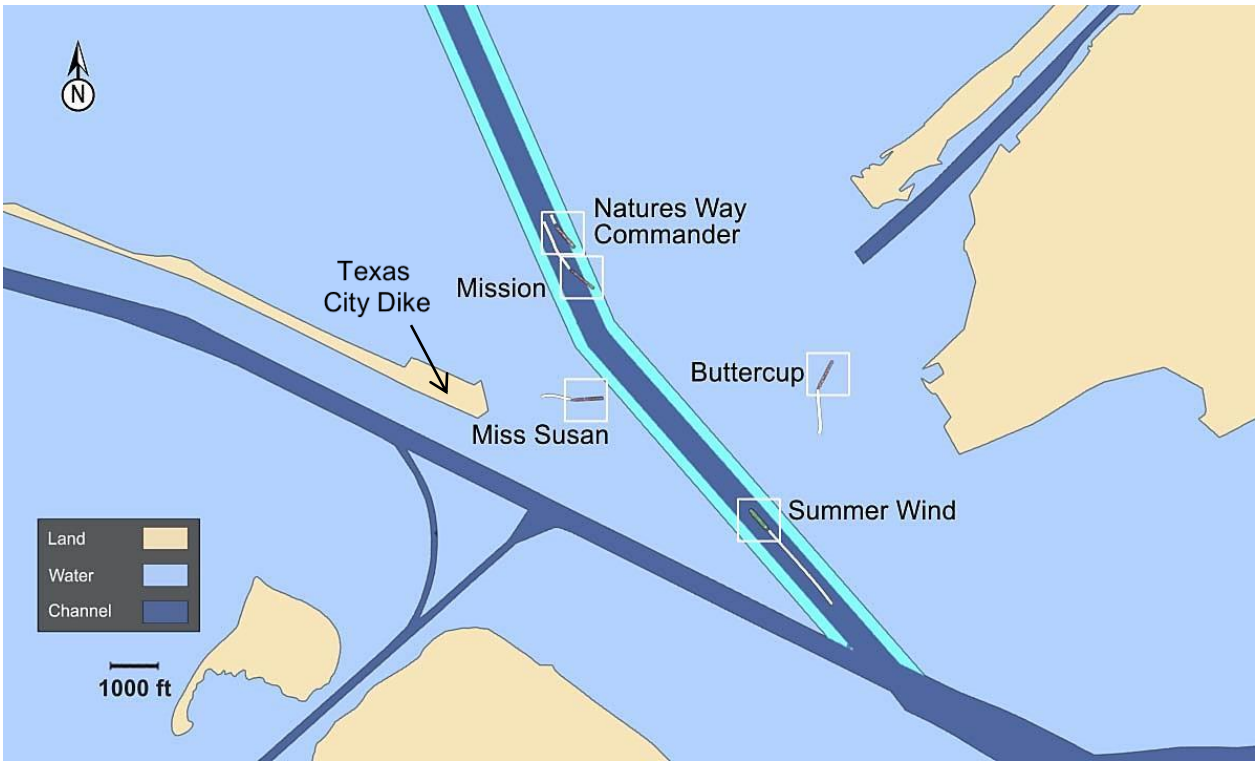

Figure 6. Illustration, based on AIS data, of the various vessels' positions in the waterway about 1232, 3 minutes before the collision.

[13] Around the time of the accident, the current was flooding at "over 1 knot," according to VTS radio broadcasts.

About 1232, the *Miss Susan* captain radioed the *Summer Wind* on VHF channel 13. The following is a transcript of the conversation leading up to the collision.[14]

Time	**Vessel/operator**	**Remarks (VHF 13)**
1231:54	*Miss Susan* captain	Inbound ship ahh I think it's Summer I believe
1232:00	Pilot, *Summer Wind*	Got an inbound ship approaching twenty five six[15]
1232:02	*Miss Susan* captain	Miss Susan I'm looking at um I'm looking at everything I'm fixing to start across the intersection bound for Bolivar, how do I look to you on your plotter over?
1232:14	Pilot, *Summer Wind*	Well if you keep on going I'm gonna get ya unless you're doing about seven or eight knots cause right now I'm less than three quarters of a mile from ya and you ain't got to the channel yet
1232:24	*Miss Susan* captain	All right well s--t I'm glad I called ya here all right we'll see you on we'll try to see you on the one then um unless you want to try and cut em back a little bit[16]
1232:31	Pilot, *Summer Wind*	Cap'n I can cut em back I can put it on dead slow but that still ain't gonna stop cause I'm almost coming up on half a mile on ya
1232:37	*Miss Susan* captain	All right I'll give it a hard rudder and see you on the one okay
1232:39	Pilot, *Summer Wind*	One whistle thank you
1233:02	*Miss Susan* captain	[inaudible] Roger, I got a hard starboard rudder on her now
1233:07	Pilot, *Summer Wind*	You might want to stop and back it cap'n I don't know what to tell you cause man it's close and
1233:12	*Miss Susan* captain	[inaudible] Roger on that I'm looking at two tows too, all right we're backing her down
1233:19	*Mission* captain	Mission Miss Susan that other ship I'm outbound here right at the intersection there I'm giving her some port rudder once I get on past here I'll give you all the room I can there skippers
1233:29	*Miss Susan* captain	I got a [inaudible] wheel on here
1233:32	Pilot, *Summer Wind*	[inaudible] if I can thank you
1234:26	Pilot, *Summer Wind*	Still got her backing full Mission? I'm sorry Miss Susan?

[14] Also see VHF radio transcript in Appendix C, spanning from about 1221 to about 1232.

[15] "Twenty five six" refers to buoys 25 and 26.

[16] "On the one" refers to "one whistle," which is a port-to-port meeting arrangement.

Time	Vessel/operator	Remarks (VHF 13)
1234:32	*Miss Susan* captain	Roger on that, roger on that, I'm backing her hard cap'n
1234:35	Pilot, *Summer Wind*	Yeah keep on doing it skipper keep on doing it how many loads you got?
1234:39	*Miss Susan* captain	Two loads two loads, I'm looking at you now it don't look good
1234:42	Pilot, *Summer Wind*	Yeah it don't look good you need to keep on backing it down hard as you can, I'm gonna shoot her for the red side as much as I can keep her going[17]
1234:50	*Miss Susan* captain	Okay
1234:51	Pilot, *Summer Wind*	Mission I'm coming over by you cap'n
1234:53	*Mission* captain	Hey I'm already clear of the buoys you got all the room here you're gonna get
1234:57	*Natures Way Commander* captain	Natures Way Commander is right behind that Mission I'm gonna head over as close as I can to that red and get out of your way

Starting at 1232:37, the *Miss Susan* captain radioed that she was applying hard starboard rudder. She also radioed at 1233:12 that she was backing her engine. According to the *Summer Wind*'s simplified voyage data recorder (S-VDR), the pilot ordered a speed of dead slow ahead at 1233:12, but, 30 seconds later, he ordered full-ahead speed again.[18] At 1234:10, the pilot ordered a 2-degree heading change to starboard (from 322 degrees to 324 degrees). He and the *Miss Susan* captain told investigators that, about this same time, they visually sighted the other vessel. They were about 800 feet apart at that point.

About 1235, the *Summer Wind*'s bulbous bow struck the *Miss Susan*'s lead barge, *Kirby 27706*, half way down its starboard side (figures 7 and 8). The impact punctured the barge's double hull and released about 4,000 barrels (168,000 gallons) of RMG 380 into the waterway. The collision occurred about 3.2 nautical miles from where the *Summer Wind* had left anchorage some 25 minutes earlier.

[17] "The red side" in this case means the right-hand side of the *Summer Wind* (the east side of the channel, transiting inbound from sea).

[18] Hardly any noticeable speed reduction took place during the pilot's speed change from full ahead to dead slow ahead.

Figure 7. Screen capture from the *Summer Wind*'s port bridge wing video, which began recording automatically from the motion caused by the collision. The image shows the scene immediately after the impact. In the upper left of the image is the *Miss Susan* tow.

The *Miss Susan* captain and mate told investigators that, immediately after the collision, the *Miss Susan* captain sounded her vessel's general alarm to muster the crew of two deckhands, two tankermen, and the mate on deck. About the same time, 1236, the *Mission* captain radioed VTS and requested activation of spill response efforts because he saw oil leaking from the tow and the lead barge was taking on water. The pilot on the *Summer Wind* told investigators that he also saw oil leaking from the lead barge and that, following an unsuccessful attempt to contact the *Miss Susan*, he radioed VTS about the oil spill.

The force of the collision caused the lead barge *Kirby 27706* to separate from the tow and begin to sink. The *Miss Susan* captain instructed the crewmembers to re-attach *Kirby 27706* to the tow, and they proceeded toward the bow of *Kirby 27705*. They did not don respiratory protection before going out on the barges (see section "2.7 Policies Regarding Hazardous Materials").

Figure 8. Photo of the collision scene, taken by the *Natures Way Commander* crew roughly 1,000 feet away, shortly after the accident.

The *Miss Susan* crewmembers managed to capture the leaking *Kirby 27706* and reattach it in its original position forward of *Kirby 27705*.[19] With the concurrence of Kirby Inland Marine and the Coast Guard, the crew pushed *Kirby 27706* onto the closest sandbank to clear the channel and prevent it from possibly sinking (figure 9).

During the process of reattaching *Kirby 27706*, one of the deckhands and one of the tankermen began coughing, vomiting, and experiencing difficulty breathing. Once back on board the *Miss Susan*, the deckhand was given oxygen, and she and the tankerman were transported to the hospital for medical treatment. They were released the following morning.

[19] Capturing and reattaching *Kirby 27706* involved coming alongside the barge and reconnecting the wires that parted in the collision. The wires could be connected to mounted deck fittings on board either *Kirby 27705* or the *Miss Susan*.

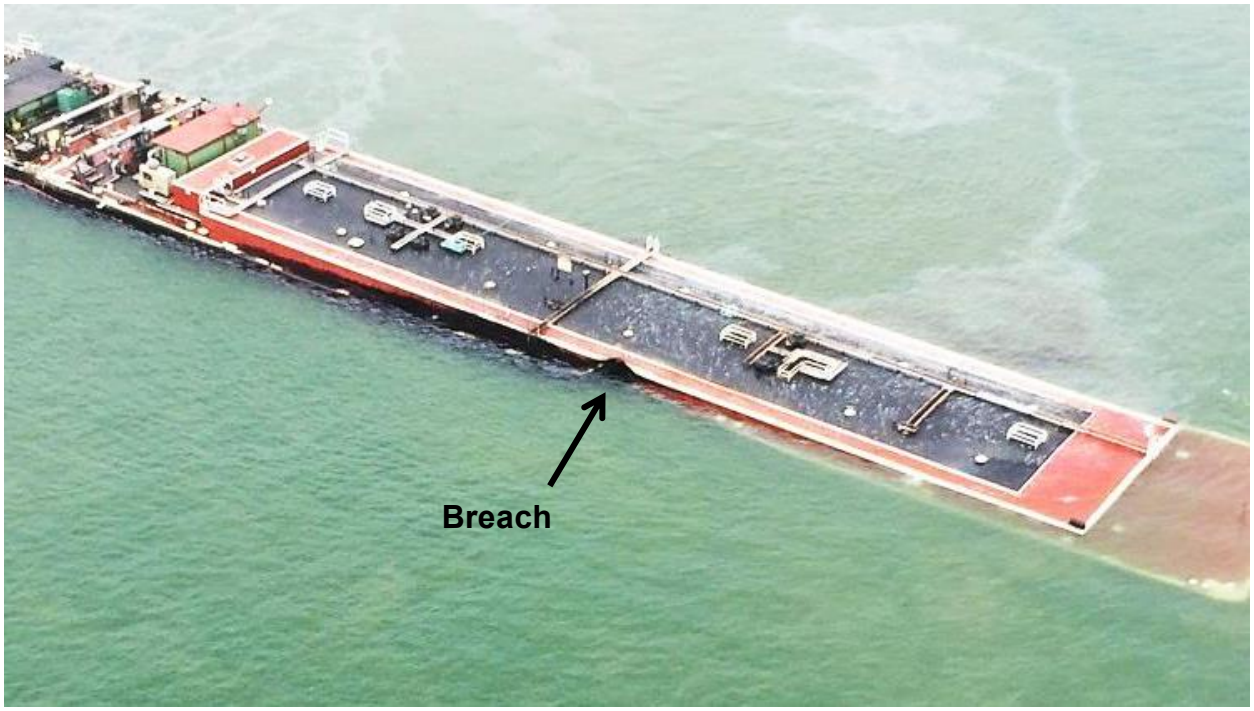

Figure 9. Aerial view of the *Kirby 27706* shortly after the collision, with the point of impact damage marked. Oil sheen from leaking RMG 380 can be seen on the barge's port side. The bow of the barge is submerged in the water. (Photo by the Coast Guard)

The *Miss Susan* crew deployed oil booms that were carried in a storage box near the stern of the towing vessel. An additional oil boom was carried in a drum on each of the barges. However, the combined length of oil booms carried on the *Miss Susan* tow was not sufficient to provide complete containment booming for a 300-foot barge such as the *Kirby 27706*. According to the captain, the oil boom is supplemented with spill pads and granular absorbent material; these resources are intended to contain only small-scale or incidental spills, such as a leak from a transfer hose.[20]

Two crewmembers from the *Mission* launched in a skiff and deployed their vessel's 200 feet of sorbent boom. Initially, more than 600 feet of boom was placed around the damaged barge. However, both the *Miss Susan* captain and the *Mission* captain told investigators that the initial efforts to contain the released oil with sorbent booms had minimal success because of the magnitude of the spill and the currents in the waterway that dragged oil through the booms. By 1420, additional Kirby personnel were on scene with boom and skimmer vessels. Meanwhile, the Coast Guard captain of the port in Houston ordered the Houston Ship Channel closed to prevent wakes of large vessels moving the oil toward the shorelines.

The *Miss Susan* captain initiated emergency response procedures in accordance with the vessel's spill response plan. Per this plan, she contacted the designated qualified individual (QI)

[20] Coast Guard regulations specify discharge removal equipment required for inland oil barges at 33 CFR 155.25. Inland oil barges must have appropriate equipment and supplies ready for immediate use to control and remove on-deck oil cargo spills of at least one barrel, or 42 gallons.

at Kirby Inland Marine in Houston, a vice president of operations.[21] The QI then initiated a major oil response plan, advising the salvage crews to prepare for a worst-case scenario of total cargo loss from the damaged barge, which would have amounted to about 27,000 barrels (1,134,000 gallons) of oil.

At 1455, the industrial hygienist that Kirby was contracted with—the Center for Toxicology and Environmental Health, LLC—was dispatched to sample the air, water, and soil at the accident scene and to ensure that the oil response workers and the surrounding communities were safe. Air monitoring consistently showed no contaminants exceeding permissible exposure levels. Additional assistance from the salvage company T&T Salvage arrived on scene about 4 hours after the accident. This company assessed the damage to *Kirby 27706* and confirmed breach and complete spillage of the starboard-side no. 2 tank, which had been loaded with 4,159 barrels of RMG 380 before the voyage began. The salvage company also observed oil migrating into the common double-bottom void space from the starboard no. 2 tank to the port no. 2 tank, and developed a strategy to deal with the oil spill (figure 10).

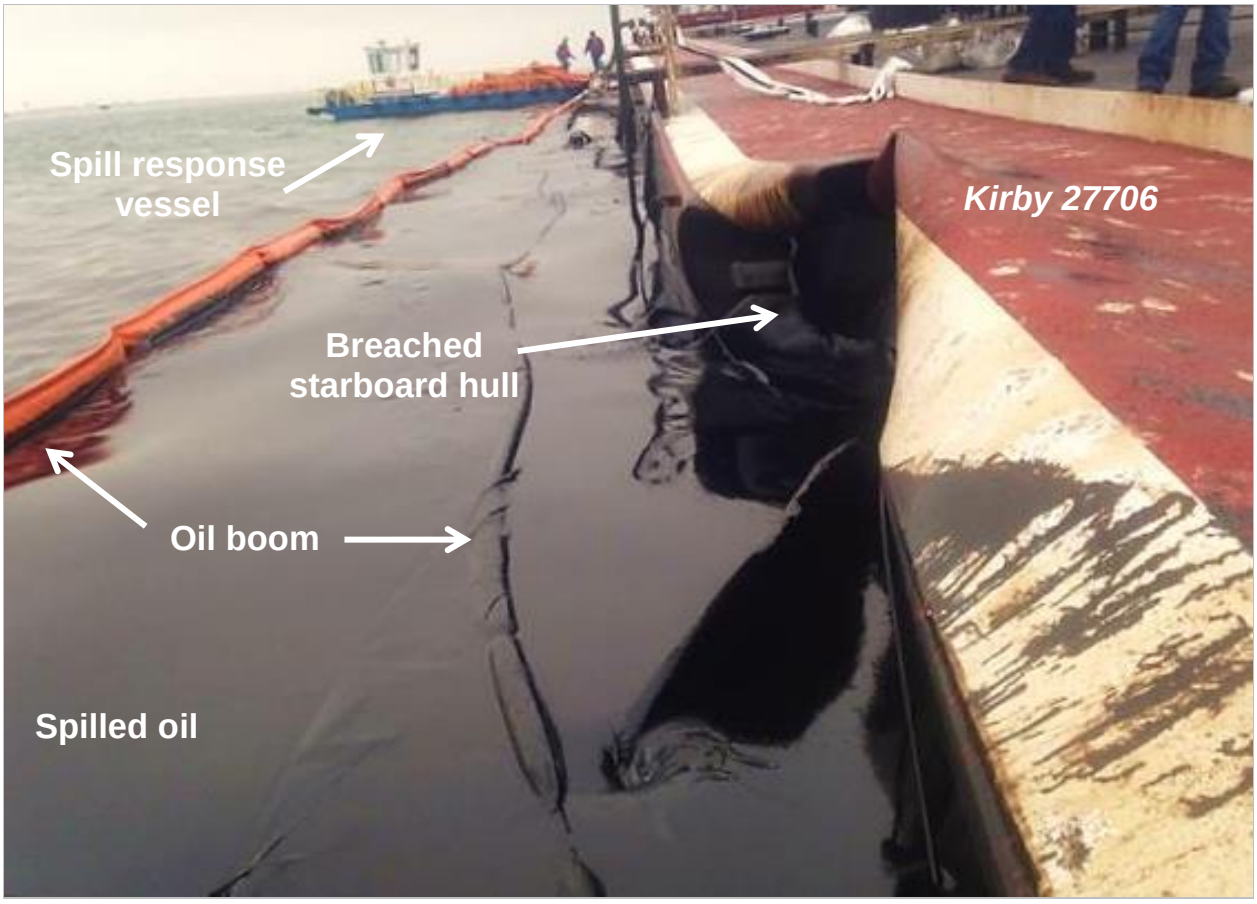

Figure 10. Close-up photo of the point of impact on the *Kirby 27706*'s starboard side. The crew of a nearby oil spill response vessel can be seen deploying boom to contain the oil closer to the barge. (Photo by the Coast Guard)

[21] A qualified individual is a person designated to be notified in the event of an oil spill and who manages the response effort on behalf of the ship owner or operator.

The area contingency plan for a major oil spill was activated.[22] Before dark on March 22, more than 3,000 feet of boom was in place to try to prevent the oil from spreading with the tides. However, changing currents, winds, and weather conditions necessitated extension of containment and oil recovery operations into the Gulf of Mexico and south along Galveston Island (figure 11).

Figure 11. Overflight map, produced by Kirby Inland Marine, showing the locations of boom deployment and oil sightings in Galveston Bay on March 26, 2014, 4 days after the accident.

The oil spill reached its greatest extent of impact on April 10, when about 13 miles of shoreline were heavily oiled and about 40 miles were lightly to moderately oiled. The oil spill endangered several environmentally sensitive areas located on or along about 160 miles of coastline. One of the most impacted areas was Matagorda Island, a 38-mile-long barrier island located about 120 miles southwest of Galveston, containing about 26,000 acres of salt marsh and tidal flats. The island is home to the Aransas National Wildlife Refuge and contains sensitive habitat for birds, marine mammals, and various endangered species, including the critically

[22] The area contingency plan was developed by the area committee under the direction of the federal on-scene coordinator. The area committee is a spill preparedness and planning body with federal, state, and local agency representatives. More information can be obtained in Section 4202 of the Oil Pollution Act of 1990.

endangered whooping crane. The oil spill impacted about 25 miles of the Gulf side of the island just as the migratory shorebird season was approaching.

The response efforts were challenged by weather conditions, including storms and high winds. In addition, strong waterway currents, the remoteness and sensitivity of affected coastal areas, and the presence of critically endangered species habitat presented challenges to the response effort.

At the peak of the response in early April, more than 2,200 personnel from 18 federal, state, and local agencies, as well as contractors from about 80 businesses, were working on the salvage, containment, decontamination, and cleanup operations.[23] They also organized and staffed the command center. About 150 volunteers per day helped survey and flag oiled beaches and wildlife to cleanup crews following behind.[24] Between the Galveston and Matagorda area commands, as of April 14, 2014 (about 3 weeks after the spill), deceased wildlife included 32 dolphins, 22 other mammals, 401 birds, 38 reptiles, and 5 sea turtles. Only six oiled birds were able to be successfully treated and released.

The unified command estimated that about 18 percent of the spill was recovered as liquid oil. About 25 percent evaporated or was dispersed in the environment, and the remaining 57 percent was collected from shorelines as solid waste.[25]

The Matagorda Island oil spill response was concluded on April 25, 2014.

1.1 Crew Injuries

The two injured crewmembers on board the *Miss Susan*, a deckhand and a tankerman, were treated for inhaling vapors from the spill. They were admitted to the hospital and released the next morning. (Also see section "2.7 Policies Regarding Hazardous Materials.")

[23] Federal agencies included the Coast Guard, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and the US Fish and Wildlife Service. State agencies included the Texas General Land Office, the Office of the Attorney General of Texas, the Texas National Guard, Texas Parks and Wildlife, the Texas Department of Transportation, the Texas Department of Public Safety, and the Texas Historical Commission. Local agencies included the Office of Emergency Management for the counties of Galveston, Brazoria, Calhoun, and Fort Bend; the Office of the Galveston County Judge; the Office of Emergency Management for Texas City, Galveston, and League City; the Galveston Emergency Management Services and Galveston Park Board; the fire and police departments of Texas City and Port O'Connor; and the Port of Houston Authority.

[24] The Central Texas Coastal Area Committee serves as the spill preparedness planning body responsible for developing the area contingency plan for incidents occurring in navigable waters within or along the Central Texas coasts of Brazoria, Chambers, Galveston, or Harris counties.

[25] Although the amount of recovered liquid oil was quantifiable, the unified command reported that mass balance estimates of the amount of oil dispersed into the environment and collected in variable waste-streams of sediments and debris were based on common rules of thumb for natural and chemical dispersion, evaporation, and recovery efficiency.

Type of Injury	*Miss Susan* (6 crew)	*Summer Wind* (22 crew; 1 pilot)	Total
Fatal	0	0	0
Serious	0	0	0
Minor	2	0	2
None	4	23	27

Title 49 CFR 830.2 defines a fatal injury as any injury that results in death within 30 days of an accident. It defines serious injury as that which requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; results in a fracture of any bone (except simple fractures of fingers, toes, or nose); causes severe hemorrhages, nerve, muscle, or tendon damage; involves any internal organ; or involves second- or third- degree burns, or any burn affecting more than 5 percent of the body surface.

1.2 Toxicological Testing

Drug and alcohol testing was conducted on relevant crewmembers from both vessels, the Houston pilot, and relevant VTS watchstanders. All results were negative.

1.3 Damage

The *Summer Wind* sustained an estimated $350,000 in damage to its bow. *Kirby 27706* sustained $923,748 in damage, and the *Kirby 27705* sustained $103,373 in damage.

1.4 Weather

According to the National Weather Service (NWS) surface chart information from 1300 on March 22, the accident area had cloudy skies, air temperatures in the low- to mid-70s F, light and variable wind of less than 5 knots, fog, and haze. The NWS Storm Prediction Center Constant Pressure Charts depicted abundant low-level moisture in the area of the collision, and no strong weather systems were nearby to help move or dissipate the fog.

1.5 Personnel Information

1.5.1 *Miss Susan* Captain

The *Miss Susan* captain, age 52, had held a merchant mariner credential since 1982 and had advanced through the ranks on the job. She had worked for Kirby Inland Marine for 20 years, the past 3.5 years of which she had been relief captain on board the *Miss Susan*. She was credentialed as master of towing vessels upon near coastal waters and western rivers. She also held a current unlimited radar observer endorsement. She had completed required simulator courses, bridge team management training, and radar renewals. The *Miss Susan* captain told investigators that she was very familiar with the accident area and estimated that she had successfully made the same crossing (between Texas City and Bolivar) more than 200 times.

On April 3, 2014, 12 days after the accident, the *Miss Susan* captain provided investigators her 96-hour work/rest/sleep history (see section “2.5 Operator Work/Rest/Sleep Histories”).

1.5.2 Houston Pilot

The pilot, age 63, had worked in the maritime industry for 47 years, 24 of those years (since 1990) as a pilot. He held a federal credential and state commission as pilot of vessels of any gross tons upon the Houston and Galveston Ship Channels. He also held a merchant mariner credential as master of not more than 500 gross tons upon oceans, with an unlimited radar observer endorsement. He had completed simulator training, bridge resource management courses, and various ship-handling training.

The pilot provided investigators with his 96-hour work/rest/sleep history on August 22, 2014, 5 months after the accident (see section "2.5 Operator Work/Rest/Sleep Histories").

1.5.3 *Summer Wind* Master

The *Summer Wind* master, age 40, had worked in the maritime industry for 22 years. He had been sailing as master for 5 years, the entire time with Cleopatra Shipping Company, the operator of the *Summer Wind*. He was credentialed in Greece as master of any gross tonnage, with radar observer endorsement. Due to the ship's registry, he also held a Liberian endorsement pertaining to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). During a previous, 9-month contract, he had served as master on board the *Summer Wind*. The accident transit was his first trip into Houston as master, but on March 19, 3 days before the accident, he had boarded the bulk carrier in Houston and been in command as master during the outbound trip from the Port of Houston to Anchorage B. He had also transited to Houston previously as junior officer. He had not worked with this pilot before.

The *Summer Wind* master provided investigators with his 96-hour work/rest/sleep history on March 23, 2014, the day after the accident (see section "2.5 Operator Work/Rest/Sleep Histories").

1.5.4 VTS Personnel

Watch Supervisor. The supervisor, age 47, was an active duty Coast Guard operations specialist chief petty officer with 20 years of service, including 2 tours at sea and 3 tours at VTS Houston/Galveston. This was his second tour as watch supervisor at VTS Houston/Galveston.

Watchstander 1. The off-going controller of the southern VTS sector in which the collision occurred, age 46, was a retired Coast Guard operations specialist chief petty officer with 22 years of service, including 10 years at sea and 4 years at VTS Houston/Galveston as an active duty watch supervisor. He had served 2 years in civil service in his current position.

Watchstander 2. The originally scheduled controller of the southern VTS sector, age 31, was an active duty Coast Guard operations specialist first class petty officer with 9 years of service, including 1 tour at sea. He had stood watches as a qualified VTS controller for more than 1 year.

Watchstander 3. The controller of the southern VTS sector, age 47, was a retired Coast Guard operations specialist chief petty officer with 20 years of service, including 4 tours at sea and 2 VTS tours. He spent his last 5 years of active duty as watch supervisor at VTS Houston/Galveston. At the time of the accident, he had served 6 years in civil service in his current position.

2. Investigation and Analysis

2.1 Exclusions

Postaccident examination of both the *Miss Susan* and the *Summer Wind* confirmed that all machinery and bridge equipment functioned properly and that neither vessel had problems with propulsion or steering. The Houston pilot also confirmed that the *Summer Wind* bridge crew had carried out his engine and rudder orders without problem. Further, some crewmembers reported taking various prescribed medications; however, analysis revealed no adverse effects on performance. In addition, results of toxicological testing were negative for the presence of alcohol and illegal drugs. Finally, no evidence indicated use of personal electronic devices that could have caused distraction. The NTSB therefore concludes that vessel propulsion and steering systems, medical conditions and medication use, alcohol and illegal drug use, and distraction from personal electronic devices were not factors in this accident.

2.2 Actions of the Vessel Operators

When the *Miss Susan* captain was questioned during the Coast Guard postaccident hearing as to what navigation rules would apply to the situation in which she and her tow found themselves leading up to the accident, she answered rule 19.[26] She said that navigation rule 19 was a "great equalizer" that made "everyone equal on the playing field." Rule 19 is listed in the Inland Steering and Sailing Rules from the Coast Guard's publication *Navigation Rules in Subpart III – Conduct of Vessels in Restricted Visibility*, and states in paragraph (c): "Every vessel shall have due regard to the prevailing circumstances and condition of restricted visibility when complying with Rules 4 through 10."

However, although the *Miss Susan* captain did not specifically mention navigation rule 9(d), that rule also must be taken into account as it refers specifically to the circumstance in which the captain found herself on the day of the accident. Rule 9(d) states, "A vessel shall not cross a narrow channel or fairway if such crossing impedes the passage of a vessel which can safely navigate only within that channel or fairway." The *Miss Susan* captain knew that the *Summer Wind*, a deep-draft vessel with a pilot on board, was inbound in the Houston Ship Channel. By her own testimony of years of experience working in the area, she knew that the water depth outside of the channel in the collision area was shallow and would not allow for a deep-draft vessel to take evasive maneuvers there. On the other hand, the *Miss Susan* tow, with its relatively shallow draft, could have maneuvered outside of the channel and into the barge lanes that were available to her. By attempting to cross the Houston Ship Channel when she did, and thus impeding the passage of the *Summer Wind*, the *Miss Susan* captain disregarded navigation rule 9(d). The NTSB concludes that the *Miss Susan* captain should not have attempted to cross the Houston Ship Channel ahead of the *Summer Wind*'s passage, especially given the restricted visibility and the bulk carrier's ability to navigate only within the confines of the channel.

[26] Inland Navigation Rules Act of 1980 (Public Law 96–591, 94 Stat. 3415, 33 USC 2001–2038).

The *Summer Wind* had limited maneuvering ability in the channel because of its draft. Too much of a course change to starboard, and the *Summer Wind* would either be aground or possibly collide with either the *Natures Way Commander* tow or the *Mission* tow. Too much of a course change to port, and the *Summer Wind* would again either be aground or possibly collide with the *Miss Susan*. Because of these confines on the *Summer Wind*'s maneuvering ability in the channel, only a slower transit speed would have increased the margin of safety for the bulk carrier.

The Houston pilot told investigators that the full-ahead speed at which he ordered the *Summer Wind* to transit (about 12 knots) was not excessive. He stated that he needed that speed for effective steering ability because of the greater-than-1-knot flood current—which he described as "strong"—pushing the bulk carrier from astern. However, according to the *Summer Wind*'s maneuvering characteristics diagram, the bulk carrier's minimum steering speed in normal ballast conditions was 3.92 knots through water—in other words, a speed of less than 3.92 knots through water would cause the rudder to lose its effectiveness. If accounting for the greater-than-1-knot flood current that was pushing the *Summer Wind* from astern—which would have an adverse effect on steering ability—a speed of about 5 knots over ground could be calculated as necessary for effective steering ability. [27] Therefore, a half-ahead speed of about 9 knots over ground—at which the bulk carrier transited for part of the way from anchorage—would have been more than sufficient for effective steering ability.

Navigation Rule 6 states:

> Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions. In determining a safe speed the following factors shall be among those taken into account
>
> (a) By all vessels: (i) the state of visibility; (ii) the traffic density including concentration of fishing vessels or any other vessels; (iii) the maneuverability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions; (iv) at night, the presence of background light such as from shore lights or from back scatter of her own lights; (v) the state of wind, sea, and current, and the proximity of navigational hazards; (vi) the draft in relation to the available depth of water.

According to the *Summer Wind*'s maneuvering characteristics diagram, the bulk carrier needed 1.28 nautical miles to come to a complete stop when transiting at full sea speed (15 knots; 115 rpm) in deep water. Although the *Summer Wind* was not transiting quite that fast leading up to the collision and its precise stopping distance cannot be determined, investigators estimate that the bulk carrier likely would have needed almost 1 nautical mile to stop in the channel.[28] A slower transit speed would have shortened this stopping distance. A slower speed

[27] Speed over ground is the speed of the vessel relative to the surface of the earth, while speed through water is the speed of the vessel relative to the water. It is possible for the speed through water to be 0 knots while the speed over ground is 5 knots, if for example the vessel is drifting in a 5-knot current. It is also possible for the speed through water to be 5 knots while the speed over ground is 0 knots, if for example the vessel is motoring at 5 knots against a current pushing on the bow at 5 knots. (Examples obtained from www.maretron.com/support/knowledgebase/phpkbv7/article.php?id=174)

[28] For greater detail on the *Summer Wind*'s maneuvering characteristics, see the engineering report in the NTSB's public docket on this accident.

would also have allowed for application of reserve engine power, providing an immediate increase in steering effectiveness, if necessary.

To transit at full-ahead speed in restricted visibility with several towing vessels operating in the area was imprudent because it reduced the pilot's time to react and increased the ship's stopping distance. The NTSB therefore concludes that given the restricted visibility and the towing vessel traffic in the Bolivar Roads Precautionary Area at the time, the pilot on the *Summer Wind* should not have given an order for the bulk carrier to transit at full-ahead speed.

Although the Houston pilot and the *Summer Wind* master discussed vessel information during the master/pilot exchange at anchorage, they did not discuss transit speed. Further, at no point during the voyage did the master question any of the pilot's commands, including the speed increase to full ahead. The master told investigators that he did not question the pilot because he agreed with all of the pilot's commands given the situation at the time.

However, the same factors described earlier that should have prompted the pilot to choose a slower speed should have prompted the master to question the pilot's choice of full-ahead speed. The master had at his reference AIS, radar, VHF radio, and so on, all of which indicated that towing vessel traffic was under way in the area, including on intersecting waterways. He was also familiar with his ship's long stopping distance. Further, the master could clearly observe the restricted visibility during the transit, and, about 1226, he began sounding the fog signal on his own initiative, with the pilot's consent. Still, he never questioned the full-ahead speed despite feeling the need to sound the fog signal. At all times, a vessel's master retains overall command of the vessel and is responsible for its safety. The NTSB therefore concludes that the *Summer Wind* master should have questioned the pilot's decision to transit at full-ahead speed given the restricted visibility and nearby towing vessel traffic.

The close-quarters situation between the *Miss Susan* and the *Summer Wind* could have been avoided if both operators had communicated with each other earlier. By talking to each other and consulting their onboard equipment, the operators would have quickly determined that a close-quarters situation was developing and would worsen if each vessel continued at current speed and heading. Early action could have been taken to mitigate the situation; a brief radio check with the other vessel as to who should go first and why would have sufficed. Similar communication and agreements were being made via VHF radio by all the other vessel operators in the area that morning. All of the towing vessel captains were talking to each other; the pilot on the *Summer Wind* was talking to the pilot on the *BBC Indiana* (bound for Galveston) to coordinate their vessels' meeting arrangement, and the pilot on the *Summer Wind* also responded immediately to radio communications and meeting arrangement requests initiated from the towing vessels *Mission* and *Natures Way Commander*. The NTSB therefore concludes that sufficient information existed via radar, AIS, and radio communications from both the *Miss Susan* and the *Summer Wind* for the vessel operators to know of each other's intended passages, but despite the availability of this information neither the *Miss Susan* captain nor the pilot on the *Summer Wind* took early action to avoid the collision.

2.3 The Houston Ship Channel

2.3.1 Waterway Information

The Port of Houston is one of the busiest ports in the world in terms of cargo tonnage.[29] The Coast Guard reported that, in 2014, the average daily traffic along the Houston Ship Channel totaled nearly 750 vessel transits (including tankers, freighters, tows, and ferries, among others), with about 75 ships docked in port.[30]

The Houston Ship Channel is about 55 nautical miles in length from the sea buoy offshore from Galveston (where pilots usually board inbound deep-draft vessels) to the turning basin at the Port of Houston. In 2005, the US Army Corps of Engineers completed a major upgrade of the Houston Ship Channel, which included adding dedicated barge lanes for towing vessels and deepening and widening the main channel. The Houston Ship Channel in the area of the collision is about 530 feet wide with a controlling depth of 45 feet. On the sides of the channel are shallower barge lanes, each 235 feet wide. The collision occurred near buoys 25 and 26, at the intersection of the Houston Ship Channel and the Intracoastal Waterway (see figure 4). The area just south of it, in which the Texas City Channel meets the Houston Ship Channel, is commonly referred to as the Texas City Y. The Galveston Channel is located at the south end of the Texas City Y. The aforementioned area falls within the Bolivar Roads Precautionary Area.

The Coast Guard's Waterways Management Division conducted a Ports and Waterways Safety Assessment (PAWSA) for Houston/Galveston in July 2009.[31] The Texas City Y was one of three geographic areas examined. Among the risks identified:

- High traffic volume is an issue at the intersection of the Houston Ship Channel and the Intracoastal Waterway and at the Texas City Y; and

- Heavy seasonal fog is common in the spring and fall. The onset and dissipation of the fog are hard to predict. Fog, of varying degree of intensity, may be localized to specific parts of the channel.

The PAWSA also suggested some risk intervention strategies, including:

- Enhancing the VTS coverage of areas where crossing situations exist and where dissimilar vessel types/speeds are most commonly encountered;

- Splitting the VTS coverage area into three geographic sectors (as opposed to two);

[29] Statistics and rankings are compiled by organizations including port authorities, local and national governments, marine industry groups, and business and economic analysts.

[30] *State of the Waterway 2015*, available at www.uscg.mil/vtshouston/.

[31] The PAWSA risk assessment process attempts to identify major waterway safety hazards, estimate risk levels, evaluate potential mitigation measures, and set the stage for implementation of selected risk reduction measures. The process involves convening a select group of waterway users and stakeholders and conducting a structured workshop to meet these objectives. The risk assessment process is a joint effort involving water users, stakeholders, and agencies responsible for implementing risk mitigation measures.

- Redesignating VTS reporting points to take account of changing traffic patterns, increased traffic congestion, and improved sensor capabilities; and

- Expanding the VTS area and more actively managing vessel traffic to facilitate crossings in the Texas City Y and elsewhere.

In April 2015, VTS Houston/Galveston split the southern sector (formerly "Sector I & II") into two separate sections and added a watchstander. Each of the three VTS sectors (I, II, and III) is now individually monitored by a VTS watchstander.

2.3.2 Recent Collisions in Precautionary Areas with Intersecting Waterways

The NTSB has investigated several recent collisions that occurred in the Houston Ship Channel's precautionary areas with intersecting waterways.

Alliance/Naticina

On August 17, 2011, the tanker *Naticina* was outbound in the Texas City Channel with two Galveston–Texas City pilots on board. The towing vessel *Alliance*, pushing two tank barges, was traveling east in the Intracoastal Waterway. The area was within the Bolivar Roads Precautionary Area. The conning pilot on the *Naticina* and the captain of the *Alliance* agreed to meet at the intersection of the Texas City Channel and the Intracoastal Waterway, where, according to the pilot, the *Alliance* would slow and let the *Naticina* pass before the *Alliance* continued across the Texas City Channel. As the vessels neared one another, the second pilot took over the conn of the *Naticina*. He determined that a risk of collision existed and directed the helmsman to begin altering the *Naticina*'s course to port, but the tanker was unable to leave the channel without running aground. The bow of the lead barge pushed by the *Alliance* struck the *Naticina* and punctured the no. 5 starboard ballast tank of the *Naticina*'s hull.

The NTSB determined that the probable cause of the collision was the encroachment by the master of the *Alliance* and its two barges into the Texas City Channel and into the path of the *Naticina* despite the crossing agreement (NTSB 2012).

Elka Apollon/MSC Nederland

On October 29, 2011, 2 months after the *Alliance*/*Naticina* accident, the tanker *Elka Apollon* was outbound and the container ship *MSC Nederland* was inbound in the Bayport Flare Precautionary Area (located about 17 nautical miles north of the Bolivar Roads Precautionary Area). The Houston pilots on board each ship agreed that the vessels would meet just south of the Houston Ship Channel's intersection with the Bayport Ship Channel in Upper Galveston Bay. The pilot on the *MSC Nederland* planned to let the *Elka Apollon* pass before he turned the *MSC Nederland* to port into the Bayport Ship Channel. As the *Elka Apollon* was transiting past the intersection with the Bayport Ship Channel, a towing vessel, the *Mr. Earl*, exited the Bayport Ship Channel into the Houston Ship Channel, near the *Elka Apollon*. Shortly thereafter, the *Elka Apollon* crossed the centerline of the Houston Ship Channel and subsequently struck the port side of the *MSC Nederland*.

The NTSB determined that the probable cause of the *Elka Apollon*/*MSC Nederland* collision was the failure of the pilot conning the *Elka Apollon* to appropriately respond to changes in bank effect forces as the vessel transited the Bayport flare, causing the vessel to sheer across the channel and collide with the *MSC Nederland*. Contributing to the accident was the combination of the narrow waterway, bank effects at the Bayport flare, and traffic density at the time, which increased the challenges in a waterway with a limited margin for error (NTSB 2012).

The NTSB issued several recommendations following the *Elka Apollon*/*MSC Nederland* accident. (See section "2.3.4 Previous Safety Recommendations Regarding Precautionary Areas.")

Carla Maersk/Conti Peridot

On March 9, 2015, the chemical tanker *Carla Maersk* was outbound and the freighter *Conti Peridot* was inbound in heavy fog in the Morgan's Point Precautionary Area in Upper Galveston Bay. Both vessels had Houston pilots on board. Preliminary information indicates that the *Conti Peridot* crossed the channel and collided with the *Carla Maersk* on its port side. No one was injured. However, the collision breached one of the *Carla Maersk*'s cargo tanks, from which methyl tertiary butyl ether (a motor fuel additive for gasoline) discharged into the waterway. The investigation is ongoing as of the date of this report.

2.3.3 VTS Houston/Galveston

Consistent with nationwide Coast Guard VTS policy, VTS Houston/Galveston's internal operating procedures state that management of vessel traffic in the congested waterway is accomplished through a "safety-in-depth" approach.[32] This approach assumes that competent licensed mariners are following applicable navigation rules while operating properly equipped and maintained vessels in properly marked channels. VTS is able and authorized to assess waterway safety, call attention to particular hazards, recommend that mariners take or avoid certain actions, and direct vessels to perform or not perform certain maneuvers or movements. However, according to these VTS operating procedures, in almost every case, simply sharing and highlighting information with mariners will sufficiently provide for safety because mariners will make prudent decisions about how to navigate their vessels. Nevertheless, the procedures make clear that, should VTS detect that danger is imminent and/or that a mariner has made an unsafe decision, the VTS watch supervisor is directed to promptly implement appropriate traffic management measures to mitigate the immediate danger.

VTS manages vessel traffic through four activities, which it calls *monitor*, *inform*, *recommend*, and *direct*. Of these four activities, VTS monitored and informed the *Miss Susan* leading up to the accident. That is, the crew checked in with VTS, VTS informed the crew of traffic and navigation advisory service at a reporting point, and VTS monitored the tow. For the *Summer Wind* on the day of the accident, VTS provided monitoring.

Four persons were on duty at VTS Houston/Galveston on the day of the accident: A watch supervisor, a radio guard for vessels checking in and out of the VTS coverage area (using

[32] *Internal Operating Procedures*, Concept of VTS Traffic Management, pp. 1-7 to 1-8.

radio channel 5A), a vessel traffic controller for Sector I & II (southern sector), and a vessel traffic controller for Sector III (northern sector) (figure 12).

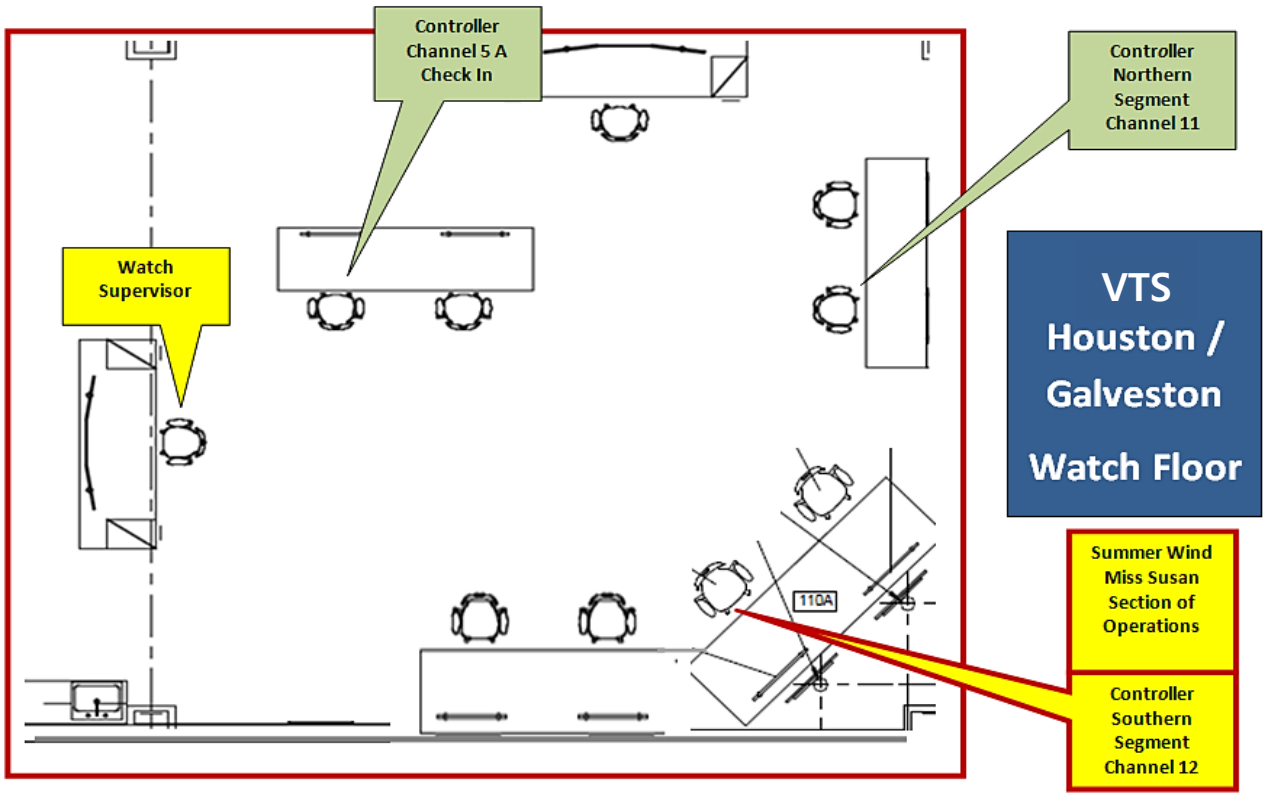

Figure 12. Layout of the vessel traffic control room at VTS Houston/Galveston. (Image by the Coast Guard)

According to internal operating procedures, VTS Houston/Galveston watchstanders were required to "guard" four radio channels; that is, listen and be ready to transmit. The radio channels that required guarding were 5A (for vessel check-in and checkout), 11 (northern Sector III's working frequency to communicate with vessels), 12 (southern Sector I & II's working frequency to communicate with vessels), and 13 (the primary radio channel used by mariners in the waterway to communicate vessel-to-vessel). However, despite the requirement to guard channel 13, none of the watchstanders did so. According to the VTS director and as confirmed by NTSB investigators, channel 13 was being broadcast on speaker in the vessel traffic control room. However, the three watchstanders were wearing headphones and listening to the other three channels. It was by way of channel 13 that the various towing vessel captains were arranging their approaches into Bolivar, and on which the *Mission* captain questioned the *Miss Susan* captain as to whether her tow would have enough time to cross the Houston Ship Channel before the *Summer Wind*'s passage. It was also on channel 13 that the *Miss Susan* captain and the pilot on the *Summer Wind* were communicating about the developing close-quarters situation between their two vessels and the evasive maneuvers they were making in the final couple of minutes to try to resolve it. Despite these audible radio communications, VTS watchstanders never interacted with the vessels, which indicates that they were not guarding channel 13. In fact, one of the watchstanders told investigators that VTS was unaware of the accident until the *Mission* captain reported it. The NTSB therefore concludes that VTS Houston/Galveston did not effectively follow its own internal operating procedures to guard channel 13.

In addition, during an 8-minute time span leading up to the collision, VTS Sector I & II (in which the accident occurred) changed watchstanders three times. About 1227, the watchstander who had been monitoring that sector for the past 2 hours ended his shift. He told investigators that he had a brief exchange with his replacement watchstander ("watchstander 2") before leaving the building. Watchstander 2 began monitoring the sector and did so for about the next 3 minutes. It was during this time that the *Mission* captain radioed the *Miss Susan* captain on channel 13 asking whether she would make it across the Houston Ship Channel before the *Summer Wind*'s passage. Watchstander 2 told investigators that he did not like monitoring Sector I & II because it had eight computer screens that needed monitoring while Sector III (the northern sector) had only four (figure 13).[33] The watchstander who was monitoring Sector III at the time ("watchstander 3") explained to investigators that, in addition to the challenge of monitoring vessel traffic on eight screens, vessel traffic in the southern sector was expected to increase as the fog was gradually dissipating. Watchstander 3, who was more experienced, therefore offered to switch stations with watchstander 2, and they did so about 1230. The exchange between the two watchstanders during this turnover lasted only 2 seconds according to watchstander 2. He also told investigators that the VTS supervisor was occupied on the telephone at the time, so watchstanders 2 and 3 did not inform him of the station switch, nor were they required to do so.

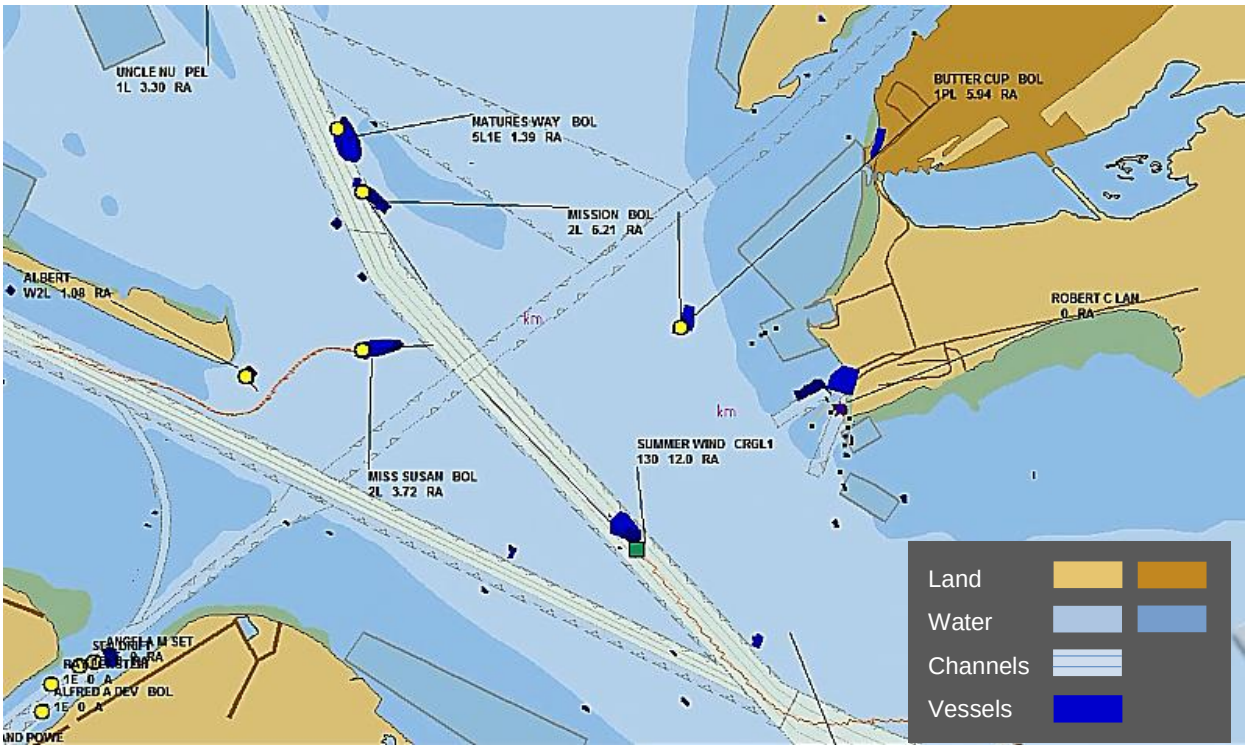

Figure 13. Screen capture of a Sector I & II computer display at VTS Houston/Galveston 3 minutes before the collision. The vessels' completed paths are shown as red lines; their vectors, or projected course over ground at that moment, are shown as straight black lines. The vector time period is 2 minutes. About the time of this screen capture, 1232, the *Miss Susan* captain and the pilot on the *Summer Wind* began communicating directly with one another about their close-quarters situation, but none of the VTS watchstanders recognized the developing emergency at the time.

[33] As noted in section "2.3.1 Waterway Information" in this report, VTS Houston/Galveston has since the accident divided its southern monitoring sector in two, with an individual watchstander for each.

To gain situation awareness of the traffic environment in the Houston Ship Channel, VTS watchstanders would have had to first become aware of the weather and waterway conditions, the positions of all the vessels in their watch sector, and the vessels' direction of movement, speed, and destination. Most important, VTS watchstanders needed to be able to estimate the vessels' proximity to potential hazards in the waterway, including obstructions and other vessels. Given the limited exchange of information that took place between the watchstanders when they relieved each other during this 8-minute period, the brief amount of time each watchstander spent at the station was insufficient to gain situation awareness. VTS could not, therefore, have effectively fulfilled its mission leading up to the accident. The NTSB therefore concludes that in the minutes leading up to the collision, VTS Houston/Galveston did not maintain an effective watch, diminishing its ability to recognize a developing risk of collision and to interact with the vessel operators.

2.3.4 Previous Safety Recommendations Regarding Precautionary Areas

As previously noted, the collision occurred in the Bolivar Roads Precautionary Area, a high-density vessel traffic area in which the Intracoastal Waterway, the Texas City Channel, and the Galveston Channel intersect the Houston Ship Channel.

In 2012, after investigating the collision between the tanker *Elka Apollon* and the container ship *MSC Nederland*, the NTSB concluded that because precautionary areas in the Houston Ship Channel were not identified on nautical charts, mariners might have been unaware of the existence and location of these areas. The NTSB also concluded that a Coast Guard policy to mitigate traffic congestion in precautionary areas of the channel would enhance safety. Further, one of the safety issues identified in the *Elka Apollon*/*MSC Nederland* investigation was insufficient vessel separation near intersecting waterways. Accordingly, the NTSB issued the following two recommendations to the Coast Guard:

> Develop and implement a policy to ensure adequate separation between vessels operating in the Bayport Channel and Bolivar Roads Precautionary Areas and any other similarly configured precautionary areas in the Houston Ship Channel. (M-12-6)

> Graphically delineate precautionary areas on appropriate Houston Ship Channel nautical charts so they are readily identifiable to mariners. (M-12-7)

The Coast Guard initially responded that it was considering actions to take in response to Safety Recommendations M-12-6 and -7. As a result, the NTSB classified them "Open—Acceptable Response" in May 2014. However, as of the date of this report, the Coast Guard has not implemented either of the recommendations. The NTSB therefore reclassifies Safety Recommendation M-12-6 "Open—Unacceptable Response" and also reiterates the recommendation, asking the Coast Guard to develop and implement a policy to ensure adequate separation between vessels operating in the Bayport Channel and Bolivar Roads Precautionary Areas and any other similarly configured precautionary areas in the Houston Ship Channel. In addition, the NTSB reclassifies Safety Recommendation M-12-7 "Open—Unacceptable Response" and also reiterates the recommendation, asking the Coast Guard to graphically delineate precautionary areas on appropriate Houston Ship Channel nautical charts so they are readily identifiable to mariners.

Given the circumstances illustrated in the *Miss Susan*/*Summer Wind* accident, the NTSB concludes that, with several intersecting waterways, high-density vessel traffic, and diverse types of vessels with differing speeds and maneuvering characteristics, the Bolivar Roads Precautionary Area is a high-risk section in VTS Houston/Galveston's area of responsibility, and the Coast Guard's failure to develop and implement a vessel separation policy for this section contributed to the collision.

2.4 Entering Complete Information into AIS

During postaccident interviews, the pilot on the *Summer Wind* stated that he could see only the *Miss Susan* towing vessel itself on the PPU, not the length of the entire tow including the two tank barges being pushed, and that he therefore was uncertain of the tow's length. However, he stated that he did hear the *Miss Susan* captain say that she was pushing "two loads." The pilot said that, in his experience, most towing vessel operators in the waterway do not enter into AIS the entire length of their tows, only the length of the vessel itself. The *Miss Susan* captain stated in the postaccident hearing that she had in fact entered the entire length of the tow into AIS. However, no AIS evidence shows that the *Miss Susan* tow was depicted any greater than the length of the vessel, which was 70 feet, when the tow actually totaled about 670 feet in length.[34] In fact, investigators found no evidence that any of the tows working in the area that day depicted the complete dimensions of their configurations in AIS. In accordance with 33 CFR 164.46(b), "accurate input and upkeep of AIS data fields" is mandatory.[35]

With the exception of draft, the dimensions of deep-draft vessels rarely change and therefore need to be entered only once into AIS. However, towing vessels' tow dimensions can vary with each transit, depending on the type and quantity of product being transported. Altering the input into AIS each time requires minimal effort, and doing so is in the best interest of operators and marine safety. AIS is only as useful and accurate a tool as the information entered into it. Although incomplete AIS input was not a factor in this accident as other vessel-related information was available to the operators, the NTSB concludes that consistently entering the complete dimensions of tow configurations for individual transits into AIS would alleviate misinterpretation and possible confusion from inaccurate information, and thus enhance safety.

2.5 Operator Work/Rest/Sleep Histories

Investigators analyzed the three 96-hour work/rest/sleep histories that the *Miss Susan* captain, the Houston pilot, and the *Summer Wind* master provided after the accident. The *Summer Wind* master's history, which he provided the day after the collision, indicated that he had kept a regular schedule. He told investigators that he had slept about 8 hours the night before the accident and also during the two previous nights when the bulk carrier was at anchorage. He said that this amount of nightly sleep was common for him.

[34] If the length of the two barges had been added to the *Miss Susan*'s AIS information, the tow icon would graphically represent a 670-foot-long object as opposed to a 70-foot-long one; as a digital readout, the information would list the length of the tow numerically.

[35] Uninspected towing vessels of 26 feet or more in length and more than 600 horsepower must have AIS when operating in VTS waterways or in a vessel movement reporting system (33 CFR 161.12(c)).

The *Miss Susan* captain's history was submitted April 3, 2014, and the Houston pilot's on August 22, 2014. The *Miss Susan* captain reported having slept between about 8.5 hours and 11 hours, usually in two segments, in each of the four 24-hour periods before the accident. The pilot reported having slept between about 7 hours and 11.5 hours, also usually in two segments, in each 24-hour period during the same timeframe. Both operators reported having maintained an irregular schedule, working and sleeping at varying times of day, which research has stated diminishes optimum performance (Van Dongen 2005; Åkerstedt 2007). However, the evidence was overall inconclusive as to whether the *Miss Susan* captain and the pilot on the *Summer Wind* were appreciably fatigued at the time of the accident and whether this may have adversely affected their performance. In addition, the delay in providing the histories—particularly on the pilot's part—decreased the reliability of the data.

2.6 Emergency Response

In accordance with the Kirby Inland Marine vessel response plan, the *Miss Susan* crew communicated with the Kirby QI and the Coast Guard, and grounded the damaged barge to clear the channel and prevent it from possibly sinking. The *Miss Susan* crew also communicated with the nearby Kirby vessel *Mission* to request initial oil spill response assistance with its skiff and onboard oil boom equipment. Kirby dispatched its oil spill response organizations with instructions to install containment boom around the affected vessels. The first response organization arrived on scene with spill containment equipment within 2 hours of the collision. The NTSB therefore concludes that, in response to the oil spill, effective communications and coordination were established and maintained between the responsible parties, the Coast Guard, local and state response agencies, and oil spill removal organizations.

Given the size of the barge hull breach, the waterway conditions, and the time required to stabilize the damaged barge, the released oil could not be effectively contained near the accident scene. Sound strategies employed in this response were deflection of the oil away from critical resources and the use of mechanical and manual removal methods to recover the majority of the oil where stranded. The cleanup of this oil spill was accomplished in roughly the same time (about 5 weeks) as envisioned in a similar Houston Ship Channel scenario contained in the Central Texas Coastal Area Contingency Plan. Contracted resources that were brought to the accident scene significantly exceeded the response capability planning criteria of 33 CFR Part 155 Subpart D and Kirby's vessel response plan. The unified command's incident event log indicates that 8.5 hours after the accident, three of the four oil spill response organizations listed in Kirby's vessel response plan, along with two other contractors, were on scene in advance of the 12-hour Coast Guard Tier 1 response planning criteria. All of these five organizations were Coast Guard-rated oil spill removal organizations capable of responding to worst-case discharges. The incident status summaries also reflect that substantial surplus response resources (including personnel, oil booms, oil skimmers, vessels, and barges) were staged on scene throughout the response. The NTSB therefore concludes that the actions taken to recover spilled oil to minimize further environmental damage were timely and appropriate.

2.7 Policies Regarding Hazardous Materials

2.7.1 Evaluation of Hazardous Work Conditions by the *Miss Susan* Crew

Occupational Safety and Health Administration (OSHA) regulations at 29 CFR 1910.120 require that a scene involving an uncontrolled release of hazardous substances be evaluated to identify specific hazards and to determine appropriate safety and health controls needed to protect employees. All suspected conditions that may pose inhalation hazards shall be identified during a preliminary survey with direct-reading instruments.

The *Miss Susan* crew had direct-reading instruments to confirm that no hydrogen sulfide was present (they wore life vests equipped with hydrogen sulfide monitors), and they smelled no odor indicative of hydrogen sulfide.[36] However, they did not have instrumentation to measure atmospheric concentrations of volatile organic compounds that could have exceeded permissible exposure levels and caused the symptoms exhibited by the two injured crewmembers. As a result, the crew could not thoroughly evaluate all of the potential chemical hazards on scene before starting recovery operations. In accordance with OSHA standards, such testing devices should have been available to the crew.

The *Miss Susan* captain told investigators that the oil spill had an "overwhelmingly strong" petroleum odor. She attributed the intensity of the odor both to the fact that the air was very still and dense with fog that day and that the RMG 380 was transported at elevated temperature.[37] When she saw one of the deckhands vomit as the deckhand was returning from the barge, the captain instructed the other crewmembers to abandon the attempt to recapture the damaged barge until the presence or absence of hydrogen sulfide could be definitively confirmed.[38] Together with the mate, the *Miss Susan* captain confirmed via the onboard material safety data sheet (MSDS) that the cargo did not contain hydrogen sulfide.[39] Based on this information and the lack of detection by the life vest monitors, the *Miss Susan* captain had her remaining crewmembers proceed in capturing the leaking *Kirby 27706* and placing it back in its original lead position to maintain distance from the vessel.

The *Miss Susan* captain, the mate, and the uninjured tankerman told investigators that they often transported RMG 380 and that the product required no special precautions other than for the crew to carry hydrogen sulfide monitors. The captain was aware that RMG 380, described as "black oil," was not supposed to contain hydrogen sulfide. It had been loaded onto the barges at the Texas City dock with "open hatch"—that is, no vapor recovery was required—and without the personnel using respiratory protection. They told investigators that they had not experienced any

[36] The odor indicating hydrogen sulfide presence is often described as "rotten eggs."

[37] RMG 380 fuel oil is routinely heated to about 130°F to reduce its viscosity for ease of pumping.

[38] Exposure to high concentrations of hydrogen sulfide can cause headache, dizziness, internal bleeding, suffocation, brain damage, coma, and death.

[39] The MSDS for RMG 380 that Kirby carried on board the barges was generic, covering a wide range of low-sulfur intermediate fuel oils and petroleum distillates. The MSDS stated that the product has the potential to accumulate hazardous vapors in poorly ventilated areas and that inhaling high concentrations irritates the respiratory tract and may cause headache, dizziness, nausea, vomiting, and malaise. The MSDS recommended ventilating confined spaces and areas near vapor sources. When threshold limits are kept below maximum allowable concentrations, no respiratory protection was recommended.

adverse, short-term health effects. The *Miss Susan* crew told investigators that, whenever the cargo contained hydrogen sulfide or benzene, Kirby policy required crews to wear respiratory protection.

Although cartridge respirators and self-contained breathing apparatus (SCBA) were available, the *Miss Susan* mate and the uninjured tankerman who completed the securing of the barges did not use this protective equipment. They reported no adverse reaction to the RMG 380 vapors. The mate told investigators that the vapors were also there during loading, and he thought that the postaccident exposure was no more than what the crew normally experienced, just that the smell from the leak was overpowering. The remaining deckhand told investigators that he experienced a minor, passing headache, which he thought was insignificant.[40]

The *Mission* captain, whose vessel responded to the accident, told investigators that he and his crew ascertained from the *Miss Susan* crew that the RMG 380 did not contain hydrogen sulfide. During the pre-task safety briefing, the *Mission* captain and crew determined that respiratory protection was not necessary. Nevertheless, as a precaution, two responding *Mission* crewmembers wore hydrogen sulfide monitors; no alarm was noted. They worked in close proximity to the released oil for about 2 hours, and neither reported any discomfort or adverse health effects.

Kirby standard operating procedure C1.060 establishes minimum requirements for PPE.[41] According to the procedure, Kirby should maintain sufficient respirators and chemical resistant clothing for the number of crew, plus two. The procedure states that respiratory protection is used when inhalation hazards are expected to exceed the OSHA permissible exposure level, and, at a minimum, full-face respirators are required during cargo transfer operations. The procedure also states that employees must receive fit testing and training on respirator use.

The *Miss Susan* mate told NTSB investigators that Kirby had issued full-face respirators to each crewmember. The mate was aware that cartridge-type respirators do not provide adequate protection from hydrogen sulfide exposure; however, he said that the *Miss Susan* was one of the few Kirby towing vessels that also carried SCBA equipment on board. If the crewmembers were contracted to handle a product known to contain hydrogen sulfide, then the loading facility would provide shoreside air-supplied respirators.

The NTSB is concerned that the crewmembers universally believed that because the released material was "black oil," which was routinely loaded without the use of respiratory protection, the released material presented no exposure hazards and, therefore, no respiratory protection was required. The crewmembers' assumption was also based on their familiarity with transporting this cargo, including loading it "open hatch" without wearing respiratory protection. It may also have been based on their incomplete assessment of the MSDS, which covered a wide

[40] Kirby provided investigators with its OSHA Form 300 log, documenting work-related injuries and illnesses for 2014. The log noted the injuries to the *Miss Susan* deckhand and tankerman as respiratory conditions from "cargo vapor exposure; emergency response due to cargo spill." The log indicated that the deckhand was placed on job transfer or restriction for 4 days, while the tankerman was away from work for 2 days and placed on job transfer or restriction for 178 days. The log included a total of 46 injuries and two respiratory conditions of inland tank barge crews for 2014. The two respiratory conditions were the only injuries related to cargo handling.

[41] Kirby Inland Marine Safety Manual, revision 07, issued November 20, 2013.

range of products that "may or may not" release hazardous constituents in excess of OSHA permissible exposure levels.

The NTSB concludes that, because of the *Miss Susan* crewmembers' incomplete assessment of the MSDS, lack of being provided required direct-reading testing equipment, and their assumptions about the nature of the cargo, the *Miss Susan* crewmembers did not fully assess the need for respiratory protection during their emergency response following the collision. The NTSB therefore recommends that Kirby provide direct-reading air monitoring equipment and applicable training to its towing vessel crews that transport hazardous materials, so that crews can identify combustible or explosive atmospheres, oxygen deficiency, and toxic substances that may present risk of serious injury.

The NTSB further recommends that the American Waterways Operators inform its members of the circumstances of this accident and the need for towing vessels that transport hazardous materials to carry direct-reading air monitoring equipment, so that crews can identify combustible or explosive atmospheres, oxygen deficiency, and toxic substances that may present risk of serious injury.

In its most recent inspection plan as of the date of this report, published on March 6, 2014, OSHA includes the towing vessel industry in its Site Specific Targeting (SST) program. This program uses injury and illness data from various industries to direct enforcement resources to the industries with the highest injury rates. OSHA conducts about 35,000 inspections in total each year, of which about 3,000 are SST inspections covering all potential workplace hazards. Although the specific organizations to be inspected in accordance with OSHA's SST program are not made public, appearance of an industry in the SST program increases the likelihood of inspection.

2.7.2 Crew Training

OSHA has published guidance for HAZWOPER training that employers should provide to their marine oil spill response workers.[42] The guidance suggests that the highest level of training should be given to match expected job functions, exposures, and responsibilities during an emergency response.[43] For example, vessel crews who attempt to control an oil spill early in an incident require more training than workers who are expected only to warn others and notify appropriate authorities. The guidance suggests that employees with the highest risk of exposure (such as those who work close to volatile fuel during an initial spill, or those whose exposures may equal or exceed published permissible exposure levels) receive 24 hours of initial emergency response training and annual refresher training. The training should include competency in several areas, including:

- Understanding the hazards of oil and the risks of a spill
- Determining the presence of oil and hazardous materials in an emergency

[42] HAZWOPER (Hazardous Waste Operations and Emergency Response) is a standard produced and maintained by OSHA to protect workers in contact with hazardous material. See CFR 29 1910.120.

[43] HAZWOPER Training for Marine Oil Spill Response Workers, Revised Draft, US Department of Labor, OSHA, March 1999.

- Basic hazard and risk assessment techniques
- Selection and use of personal protective equipment (PPE)
- Basic control, containment, and/or confinement operations
- Signs and symptoms of overexposure to hazardous materials, and
- Proper use of field survey instruments.

The OSHA standard at 29 CFR 1910.120(q)(6) requires that training be based on the duties and functions that are to be performed by each emergency responder, such as the *Miss Susan* crewmembers who were actively involved in responding to and mitigating the spill. First responders are required to be trained in these skills and acquire this knowledge before being permitted to take part in actual emergency operations.

Kirby's corporate safety manager told NTSB investigators that Kirby trains its inland tank barge vessel crews to the HAZWOPER first responder operations level.[44] However, according to Kirby records, the *Miss Susan* captain, the injured deckhand, and the uninjured tankerman had not completed their first responder operations-level training. All of the six crewmembers had completed online HAZWOPER refresher training.[45] The *Miss Susan* captain told investigators that the crew also conducted monthly and quarterly drills, in which scenarios such as fire and cargo release are studied.

Although Kirby's training program covered a range of subjects such as HAZWOPER, respiratory protection, hydrogen sulfide and benzene safety, PPE overview, and hazard communications, the majority of it was online, not hands-on, training. Hands-on training allows employees to practice and apply the skills learned, and enables qualified trainers to assess how effectively the employees have mastered the techniques. For example, properly donning respiratory protection is an important safety skill that many employers want their workers to practice. Although OSHA does not approve or endorse training programs, it does encourage the use of hands-on training even in refresher courses because it is more effective in assessing worker performance of safety-related skills.

The NTSB concludes that the *Miss Susan* crewmember training did not adequately prepare them to safely respond to the hazardous materials release. The NTSB therefore recommends that Kirby revise its initial and refresher HAZWOPER training to include demonstration of competence, and ensure that crewmembers complete this training before serving on vessels that transport hazardous materials.

[44] OSHA regulations at 29 CFR 1910.120(q)(6)(ii) describe first responders at the operations level as those individuals who respond to hazardous substances releases and take action to prevent their spread and prevent exposures. First responders at the operations level must have received at least 8 hours of training or have sufficient experience to objectively demonstrate competency in several areas.

[45] Refresher training must be of sufficient content and duration for employees to maintain their competencies or demonstrate competency at least annually.

2.7.3 Proposed Coast Guard Authority over Uninspected Towing Vessels

Although a memorandum of understanding between OSHA and the Coast Guard delineates the agencies' authority over inspected vessels, this memorandum does not pertain to uninspected vessels, such as the towing vessel *Miss Susan*.

OSHA conducted 65 inspections pertaining to towing vessels over the past 10 years.[46] These included 34 planned inspections, 8 complaint investigations, 12 accident investigations, and 8 other activities. OSHA cited 90 violations; however, none of these included citations of the HAZWOPER standard.

One week after the accident, the Coast Guard Marine Safety Unit Texas City boarded the *Miss Susan* and completed an Uninspected Towing Vessel Examination report that focused on several areas, including credentials, documents, and records. The Coast Guard inspection also covered navigation safety equipment; lifesaving equipment; towline and terminal gear equipment; pollution prevention equipment such as spill containment systems at hose connections; firefighting and prevention equipment; and a general check for conditions that may pose a hazard to the vessel, crew, or the environment. The inspection report did not specifically address the availability of PPE such as air purifying respirators, nor did it include any issues related to industrial hygiene or hazardous material exposures. Furthermore, the report did not address crewmember hazardous materials training.

On February 22, 2010, OSHA issued directive no. CPL-02-01-047 to reiterate policy, information, and guidance with respect to its authority over persons working on vessels and facilities on or adjacent to US navigable waters and the Outer Continental Shelf. The guidance makes clear that the Coast Guard regulates the working conditions of seamen on board Coast Guard-inspected vessels. Therefore, OSHA continues to maintain that it will not enforce the OSH Act (except for regulations dealing with the recording and reporting of occupational injuries and illnesses) with respect to any working conditions of seamen on board Coast Guard-inspected vessels. OSHA refers all such safety and health complaints to the Coast Guard for its consideration to determine whether circumstances constitute hazardous conditions.

The Coast Guard and Maritime Transportation Act of 2004 gave the Coast Guard authority to regulate towing vessels as inspected vessels under 46 USC 3301.[47] As a general rule, towing vessels such as the *Miss Susan* have been classified as uninspected vessels. As of the date of this report, the Coast Guard has not exercised this authority; thus, many towing vessels remain uninspected and their crews are not subject to as many Coast Guard health and safety regulations as crews are on inspected vessels.[48] The OSHA directive states that, until the Coast Guard has promulgated regulations requiring all towing vessels to be inspected, these vessels continue to be classified as uninspected. The OSHA directive states that it will continue to provide safety and health coverage of employees on uninspected towing vessels until the Coast Guard issues applicable regulations.

[46] For more detail, see www.osha.gov/oshstats/ (visited April 14, 2015).

[47] Public Law 108–293, August 9, 2004.

[48] Exceptions would be steam-powered towing vessels and tugboats, as well as seagoing towing vessels and tugboats of 300 gross tons or more (the *Miss Susan* was 131 gross tons), which are classified as inspected vessels.

On August 11, 2011, the Coast Guard published a notice of proposed rulemaking (NPRM) titled "Inspection of Towing Vessels." Among the requirements in the proposed rule is a new 46 CFR Part 140 Subpart E, Safety and Health, that would require the towing vessel operator to implement a health and safety plan no later than 3 years after the effective date of the final rule. The general requirements in proposed section 140.505 include the following:

(d) Personal Protective Equipment.

(1) Appropriate PPE must be made available and on hand for all personnel engaged in an activity that requires the use of PPE.

(2) PPE must be suitable for the vessel's intended service; meet the standards of 29 CFR 1910 subpart I; and be used, cleaned and maintained and repaired in accordance with the manufacturer's requirements.

(3) All individuals must wear PPE appropriate to the activity being performed.

(4) All personnel engaged in activity must be trained in the proper use, limitations, and care of the PPE specified by this subpart.

Among the provisions of proposed section 140.515, Training Requirements, are the following:

> (a) All crewmembers must be provided with health and safety information and training that includes:
>
> > . . . (3) Proper selection and use of PPE;
> >
> > . . . (5) Hazard communication and cargo knowledge;
> >
> > . . . (8) Respiratory protection;
>
> . . . (d) Refresher training must be repeated annually and may be conducted over time in modules covering specific topics…

The preamble to the proposed rule states that although Part 140 would allow 3 years after the effective date to implement a health and safety plan, compliance with the regulations on which that plan would be based—that is, making appropriate PPE available to all personnel engaged in an activity that requires the use of PPE—would be required as soon as the rule became effective. The preamble also states that once an inspection of towing vessels final rule becomes effective, vessels subject to it would become "inspected" under the Coast Guard/OSHA memorandum of understanding, and Coast Guard regulations would apply.

According to the US Office of Information and Regulatory Affairs, the issuance date of the proposed rule has yet to be determined.[49]

[49] The Office of Information and Regulatory Affairs is part of the Office of Management and Budget and performs various functions within the Executive Office of the President of the United States.

The failure of the Coast Guard to finalize towing vessel inspection regulations more than 3 years after publishing the NPRM "Inspection of Towing Vessels" has delayed the oversight of PPE and respiratory protection programs for towing vessel mariners. The delay has also placed the burden of regulation on OSHA, which has limited resources to oversee health and safety in the marine environment. It does not operate a fleet of patrol vessels, nor does it routinely board and inspect vessels for compliance with its regulations. The Coast Guard does have these resources, however, and is the best-positioned federal agency to enforce provisions for on-water health and safety of merchant mariners.

The NTSB therefore concludes that the inadequate federal oversight of mariner work safety on board uninspected towing vessels places crewmembers at greater risk of injury from exposure to hazardous materials and other safety hazards.

2.7.4 Previous Safety Recommendations Regarding Uninspected Towing Vessels

The NTSB issued several safety recommendations following the October 12, 2006, accident involving the uninspected towing vessel *Miss Megan* in West Cote Blanche Bay, Louisiana, in which an anchoring spud from the barge *Athena 106* dropped into the water and struck and ignited a buried natural gas pipeline. Five crewmembers on the *Miss Megan* died in the ensuing fire and explosions. The NTSB found that workplace safety on uninspected vessels should be more closely observed and that the memorandum of understanding between the Coast Guard and OSHA should reflect the new regulatory scheme, address all aspects of workplace and navigational safety, and encourage communication between the two agencies and industry. The NTSB issued the following safety recommendations:

To OSHA:

> Review and update your memorandum of understanding with the U.S. Coast Guard to specifically address your respective oversight roles on vessels that are not subject to Coast Guard inspection. (M-07-4; "Closed—Acceptable Action")
>
> Direct the Maritime Advisory Committee for Occupational Safety and Health to issue the following documents to the maritime industry: (1) a fact sheet regarding the accident, and (2) a guidance document regarding the need to secure the gear on barges, including spud pins, before the barges are moved, and detailing any changes to its memorandum of understanding with the Coast Guard. (M-07-5; "Closed—Acceptable Action")

To the Coast Guard:

> Finalize and implement the new towing vessel inspection regulations and require the establishment of safety management systems appropriate for the characteristics, methods of operation, and nature of service of towing vessels. (M-07-6; "Open—Unacceptable Response")
>
> Review and update your memorandum of understanding with the Occupational Safety and Health Administration to specifically address your respective oversight

roles on vessels that are not subject to Coast Guard inspection. (M-07-7; "Closed—Acceptable Action")

In correspondence dated May 13, 2014, the NTSB informed the Coast Guard of its disappointment in the Coast Guard's lack of action to implement Safety Recommendation M-07-6, by which the Coast Guard would have finalized new towing vessel inspection regulations and required safety management systems. The NTSB noted that no significant progress had been made on this issue since August 2012, and, given the 7 years since the recommendation was issued, urged expedited action to implement the recommended actions. The NTSB classified Safety Recommendation M-07-6 "Open—Unacceptable Response." The NTSB hereby reiterates M-07-6 in this report, asking the Coast Guard to finalize and implement the new towing vessel inspection regulations and require the establishment of safety management systems appropriate for the characteristics, methods of operation, and nature of service of towing vessels.

Because Safety Recommendation M-07-6 does not specifically address new regulations governing the health and safety of mariners serving on uninspected towing vessels, which the NTSB considers a critical component, the NTSB recommends that the Coast Guard include in its new towing vessel inspection regulations requirements for (1) availability and use of personal protective equipment, (2) hazardous materials training, and (3) identification and mitigation of health and safety hazards posed by exposure to hazardous materials.

3. Conclusions

3.1 Findings

1. Vessel propulsion and steering systems, medical conditions and medication use, alcohol and illegal drug use, and distraction from personal electronic devices were not factors in this accident.

2. The *Miss Susan* captain should not have attempted to cross the Houston Ship Channel ahead of the *Summer Wind*'s passage, especially given the restricted visibility and the bulk carrier's ability to navigate only within the confines of the channel.

3. Given the restricted visibility and the towing vessel traffic in the Bolivar Roads Precautionary Area at the time, the pilot on the *Summer Wind* should not have given an order for the bulk carrier to transit at full-ahead speed.

4. The *Summer Wind* master should have questioned the pilot's decision to transit at full-ahead speed given the restricted visibility and nearby towing vessel traffic.

5. Sufficient information existed via radar, automatic identification system, and radio communications from both the *Miss Susan* and the *Summer Wind* for the vessel operators to know of each other's intended passages, but despite the availability of this information neither the *Miss Susan* captain nor the pilot on the *Summer Wind* took early action to avoid the collision.

6. Vessel Traffic Service Houston/Galveston did not effectively follow its own internal operating procedures to guard channel 13.

7. In the minutes leading up to the collision, Vessel Traffic Service Houston/Galveston did not maintain an effective watch, diminishing its ability to recognize a developing risk of collision and to interact with the vessel operators.

8. With several intersecting waterways, high-density vessel traffic, and diverse types of vessels with differing speeds and maneuvering characteristics, the Bolivar Roads Precautionary Area is a high-risk section in Vessel Traffic Service Houston/Galveston's area of responsibility, and the Coast Guard's failure to develop and implement a vessel separation policy for this section contributed to the collision.

9. Consistently entering the complete dimensions of tow configurations for individual transits into automatic identification systems would alleviate misinterpretation and possible confusion from inaccurate information, and thus enhance safety.

10. In response to the oil spill, effective communications and coordination were established and maintained between the responsible parties, the Coast Guard, local and state response agencies, and oil spill removal organizations.

11. The actions taken to recover spilled oil to minimize further environmental damage were timely and appropriate.

12. Because of the *Miss Susan* crewmembers' incomplete assessment of the material safety data sheet, lack of being provided required direct-reading testing equipment, and their assumptions about the nature of the cargo, the *Miss Susan* crewmembers did not fully assess the need for respiratory protection during their emergency response following the collision.

13. The *Miss Susan* crewmember training did not adequately prepare them to safely respond to the hazardous materials release.

14. The inadequate federal oversight of mariner work safety on board uninspected towing vessels places crewmembers at greater risk of injury from exposure to hazardous materials and other safety hazards.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the collision was the *Miss Susan* captain's attempt to cross the Houston Ship Channel ahead of the *Summer Wind*, thereby impeding the passage of the bulk carrier, which could transit only within the confines of the channel. Contributing to the accident was the failure of the Houston pilot and the *Summer Wind* master to set a safe speed given the restricted visibility and nearby towing vessel traffic, and the failure of the *Miss Susan* captain and the Houston pilot to establish early radio communication with one another. Also contributing to the accident was the failure of Vessel Traffic Service Houston/Galveston to interact with the two vessels in a developing risk of collision, and the lack of a Coast Guard vessel separation policy for the Bolivar Roads Precautionary Area.

4. Recommendations

4.1 New Recommendations

To the United States Coast Guard:

1. Include in your new towing vessel inspection regulations requirements for (1) availability and use of personal protective equipment, (2) hazardous materials training, and (3) identification and mitigation of health and safety hazards posed by exposure to hazardous materials. (M-15-1)

To Kirby Inland Marine:

2. Provide direct-reading air monitoring equipment and applicable training to your towing vessel crews that transport hazardous materials, so that crews can identify combustible or explosive atmospheres, oxygen deficiency, and toxic substances that may present risk of serious injury. (M-15-2)

3. Revise your initial and refresher Hazardous Waste Operations and Emergency Response training to include demonstration of competence, and ensure that crewmembers complete this training before serving on vessels that transport hazardous materials. (M-15-3)

To the American Waterways Operators:

4. Inform your members of the circumstances of this accident and the need for towing vessels that transport hazardous materials to carry direct-reading air monitoring equipment, so that crews can identify combustible or explosive atmospheres, oxygen deficiency, and toxic substances that may present risk of serious injury. (M-15-4)

4.2 Previously Issued Recommendation Reiterated in this Report

As a result of this accident investigation, the National Transportation Safety Board reiterates the following previously issued safety recommendation:

To the United States Coast Guard:

Finalize and implement the new towing vessel inspection regulations and require the establishment of safety management systems appropriate for the characteristics, methods of operation, and nature of service of towing vessels. (M-07-6)

4.3 Previously Issued Recommendations Reiterated and Reclassified in this Report

As a result of this accident investigation, the National Transportation Safety Board reiterates and reclassifies from "Open—Acceptable Response" to "Open—Unacceptable Response" the following two safety recommendations:

To the United States Coast Guard:

Develop and implement a policy to ensure adequate separation between vessels operating in the Bayport Channel and Bolivar Roads Precautionary Areas and any other similarly configured precautionary areas in the Houston Ship Channel. (M-12-6)

Graphically delineate precautionary areas on appropriate Houston Ship Channel nautical charts so they are readily identifiable to mariners. (M-12-7)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Chairman

ROBERT L. SUMWALT
Member

T. BELLA DINH-ZARR
Vice Chairman

EARL F. WEENER
Member

Adopted: June 9, 2015

Appendixes

Appendix A – Launch Information

The NTSB launched two marine investigators to the accident scene on March 23–24, 2014. Two additional marine investigators joined the NTSB onsite team on March 27, 2014. The Coast Guard was the lead investigative agency. While on scene, investigators interviewed crewmembers from both vessels, as well as crew from other vessels who had witnessed the collision. Investigators also interviewed watchstanders and supervisors from VTS Houston/Galveston. In addition, investigators retrieved and reviewed the S-VDR information from the *Summer Wind* as well as recorded data from VTS Houston/Galveston's command center.

Appendix B – Vessel Information

Vessels	*Summer Wind*	*Miss Susan*	***Kirby 27705* and *Kirby 27706***
Owner	Sea Galaxy Marine, Liberia	Kirby Inland Marine	Kirby Inland Marine
Operator	Cleopatra Shipping Agency, Greece	Kirby Inland Marine	Kirby Inland Marine
Port of registry	Monrovia, Liberia	Houston, Texas	Wilmington, Delaware
Flag	Liberia	United States	United States
Type	Bulk carrier	Towing vessel	Tank barge
Year built	1995	1995	2001
Official number (US)	N/A	1026248	1116752 and 1116758
IMO number	9114139	N/A	N/A
Construction	Steel	Steel	Steel
Length	607 ft (185 m)	70 ft (21.3 m)	300 ft (91.4 m)
Draft	22 ft (6.7 m)	9 ft (2.7 m)	10 ft (3.04 m)
Beam/width	100 ft (30.5 m)	28 ft (8.5 m)	54 ft (16.4 m)
Tonnage	25,503 ITC tons*	131 gross tons	1,632 gross tons
Engine power; manufacturer	Diesel direct main engine, Hyundai – MAN B&W 6S50MC 8,990 hp (metric) (6,612.1 kW)	Diesel main engine, 1,800 hp (metric) (1,323.9 kW)	N/A
Persons on board	22 crew; 1 Houston pilot	6	0

* International Tonnage Convention

Appendix C

Transcript of radio communications on VHF channel 13 from about 1221 to about 1232 on the day of the accident.

Time	Vessel/operator	Remarks (VHF 13)
1220:51	Pilot, *BBC Indiana*	You gonna leave that sixteen buoy to your starboard [. . .]?
1220:53	Pilot, *Summer Wind*	I was, but I'm gonna go ahead and put it on my port side, I'm gonna turn it over right now
1220:58	Pilot, *BBC Indiana*	Yeah I was going to try and swing this wide because of the flood current
1221:01	Pilot, *Summer Wind*	Yeah go ahead go ahead that's the reason I'm doing, I'm gonna put it on my port side
1221:04	Pilot, *BBC Indiana*	Ahh, thank you [. . .]
1221:27	*Miss Susan* captain	Miss Susan coming out of Texas City bound for Bolivar, Miss Susan
1222:09	*Natures Way Commander* captain	Natures Way Commander, Miss Susan
1222:15	*Natures Way Commander* captain	What you got in tow?
1222:16	*Miss Susan* captain	Two loads [over or oil]
1222:20	*Natures Way Commander* captain	Loads you running, ahh running straight through or stopping in Bolivar?
1222:24	*Miss Susan* captain	Stopping in Bolivar on the moorings
1222:27	*Natures Way Commander* captain	All right, come on with it. If I have to I'll pull it back get you across there first
1222:34	*Miss Susan* captain	K, appreciate it, thank you
1222:51	Pilot, *Summer Wind*	Inbound ship going to Houston buoy sixteen
1222:55	*Buttercup* captain	Buttercup's inbound I mean inbound be turning for Bolivar, Buttercup standing by for any uh eastbound westbound traffic and inbound and outbound traffic

1223:09	*Natures Way Commander* captain	Natures Way Commander Buttercup uh, coming down on twenty six, the Miss Susan is coming across from Texas City, she's gonna be heading in there and then I'm gonna be following em in there I got [inaudible] and I believe she's got two loads
1223:23	*Buttercup* captain	I got one bunker barge capt I got the tide riding on me there I could try help you out there anyway I can let me know
1223:31	*Natures Way Commander* captain	All right, ah, looks like you'll probably beat me down there too, I'll pull em back make sure you get down in there
1223:48	*Buttercup* captain	Roger roger thank you appreciate it we'll return the favor
1223:51	*Natures Way Commander* captain	Not a problem, throw a couple more squirrels on that conveyor belt down there
1223:54	*Mission* captain	Mission, Natures Way Commander
1223:56	*Natures Way Commander* captain	Natures Way Commander back
1223:59	*Mission* captain	Yes sir, let me know what you want me to do, I'm creeping up behind you there, making about eight, pull em back, want to work something out inside Bolivar, or want me to try and get by you right quick before we make the turn inside there, your choice cap'n ah skipper
1224:15	*Natures Way Commander* captain	Come on come on come on down I'm gonna pull em back get you around me instead of having to deal with you inside that [inaudible] cut there
1224:24	*Mission* captain	All right man that'll work I'll I got her charging on it there I'll come by you on that one
1224:29	*Natures Way Commander* captain	All right sounds good
1224:31	*Buttercup* captain	Buttercup checking for any ah, Bolivar westbound traffic, Buttercup
1225:31	*Mission* captain	Mission to the inbound ship, be up to the intersection there shortly
1225:35	Pilot, *Summer Wind*	Inbound ship just cleared sixteen looking at eighteen[50]

[50] "Sixteen" and "eighteen" refer to buoys 16 and 18.

1225:38	*Mission* captain	Yes sir I'm outbound cleared thirty one thirty two already be overtaking this Natures Way Commander I'll be on that red [inaudible] ah right side for you be on the two[51]
1225:49	Pilot, *Summer Wind*	See me on the two thank you, who's this
1225:52	*Mission* captain	This is the Mission I'm uh, coming up on the Natures Way Commander once I get clear I'll be your first outbound tow
1225:59	Pilot, *Summer Wind*	Got you fine, see you on two, cap'n
1226:02	*Natures Way Commander* captain	Natures Way Commander be behind that Mission I'll also see you on the uh two whistle there I'm on the red side
1226:09	Pilot, *Summer Wind*	You'll also see me on two sounds great cap'n thank you
1226:23	Unknown	On the inbound ship Galveston harbor Bolivar bell [inaudible]
1226:56	*Miss Susan* captain	Miss Susan Buttercup go ahead cap'n
1226:59	*Buttercup* captain	Yes sir we're uh we're right here fixing to be making our turn inbound uh eastbound for ah Bolivar there, we're running in a parking lot there all right to see if I can get you to slow down just a little bit?
1227:10	*Miss Susan* captain	I'm watching you on this AIS cap'n it looks like you're almost in there aren't ya
1227:15	*Buttercup* captain	Ah almost roger roger
1227:17	*Miss Susan* captain	I didn't even cross this ship channel yet, all right, we'll bring you on in first
1227:20	*Buttercup* captain	Thank you cap'n we appreciate you working with us
1228:13	*Mission* captain	Mission is outbound overtaking the Natures Way Commander down at twenty five twenty six here shortly making my turn for Bolivar I'll be following that Miss Susan into Bolivar, Mission
1228:45	*Mission* captain	Mission, Miss Susan
1228:48	*Miss Susan* captain	Go ahead Mission
1228:50	*Mission* captain	Hey you going to be meeting that or beating that inbound ship across the intersection there?
1228:55	*Miss Susan* captain	I'm going to be crossing the intersection there in a minute, over

[51] "On the two" refers to "two whistles," which is a starboard-to-starboard meeting arrangement.

1228:58	*Mission* captain	Yeah, that's what I'm saying, you going to beat him across? Are you gonna be across before he gets down here?
1229:03	*Miss Susan* captain	Roger
1229:05	*Mission* captain	All right
1231:12	*Mission* captain	All clear of you there Natures Way
1231:14	*Natures Way Commander* captain	Not a problem, not a problem. Was it you that was gonna stop at the moorings in there or you going straight on through?
1231:19	*Mission* captain	I'm going straight on through there cap'n
1231:21	*Natures Way Commander* captain	All right
1231:28	*Mission* captain	I'm just gonna pull em back just a tiny bit make sure that Miss Susan get uh gets on in front of me there
1231:33	*Natures Way Commander* captain	Not a problem I'm just coasting
1231:36	*Mission* captain	I'll make sure I saw you're making five earlier I'll try and turn for that

Appendix D – Vessel Traffic Service Information

The Port of Liverpool, England, is generally credited with being the first port to use shore-side radar to manage ship movements, having used it as early as 1949. In the United States, the Coast Guard instituted the concept in the San Francisco Bay area in 1968 as a research and development project, called the Harbor Advisory Radar Project, or HARP. Participation in this initial system was voluntary, and not all vessels transiting the San Francisco Bay participated. The January 18, 1971, collision between the tankers *Arizona Standard* and *Oregon Standard* under the Golden Gate Bridge (Department of Transportation, 1971) spurred the development and implementation of two federal laws designed to enhance overall maritime safety.[52] The first law, the Bridge to Bridge Radiotelephone Act of 1971 (33 *United States Code* Chapter 24), required positive means by which the operators of approaching vessels could communicate their intentions to one another through voice radio. The second law, called the Port and Waterways Safety Act of 1972 or PWSA (33 *United States Code* Chapter 25), was signed on July 10, 1972, authorizing the Coast Guard to construct, maintain, and operate VTSs in US waters. Shortly after Congress passed the PWSA in 1972, the Coast Guard established both VTS San Francisco and VTS Puget Sound. The Coast Guard currently operates or participates in 12 VTS locations.[53]

[52] See US Department of Transportation, *Marine Casualty Report: Collision Involving the SS* Arizona Standard *and SS* Oregon Standard *at the Entrance to San Francisco Bay on January 18, 1971* (Washington, DC: DOT, 1971).

[53] VTSs are currently in operation at Valdez, Alaska; Seattle, Washington; San Francisco, California; Los Angeles, California; Houston, Texas; Port Arthur, Texas; Morgan City, Louisiana; New Orleans, Louisiana; Tampa, Florida; Louisville, Kentucky; Sault Ste. Marie, Michigan; and New York, New York.

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