



# National Transportation Safety Board

## Marine Accident Brief

### Collision of *Dixie Vandal* Tow with Moored *Trinity* and Tow

<b>Accident type</b>	Collision	<b>No.</b> DCA19FM026
<b>Vessel names</b>	<i>Dixie Vandal</i> , <i>Trinity</i>	
<b>Location</b>	Houston Ship Channel, mile 44, Kinder Morgan Pasadena Liquids Terminal; Pasadena, Texas 29°44.09' N, 95°12.28' W	
<b>Date</b>	March 15, 2019	
<b>Time</b>	0408 central daylight time (coordinated universal time – 5 hours)	
<b>Injuries</b>	None	
<b>Property damage</b>	\$630,230 (facility: \$519,700; barges: \$110,530)	
<b>Environmental damage</b>	About half-gallon of jet fuel discharged	
<b>Weather</b>	Visibility 10 miles, no precipitation, winds north about 25 mph, air temperature 60°F <sup>1</sup>	
<b>Waterway information</b>	The Kinder Morgan Pasadena Liquids Terminal is located south of Crown Bend in the Houston Ship Channel. The width of the channel is about 300 feet, and the depth is about 40 feet; the depth at the terminal is about 42 feet.	

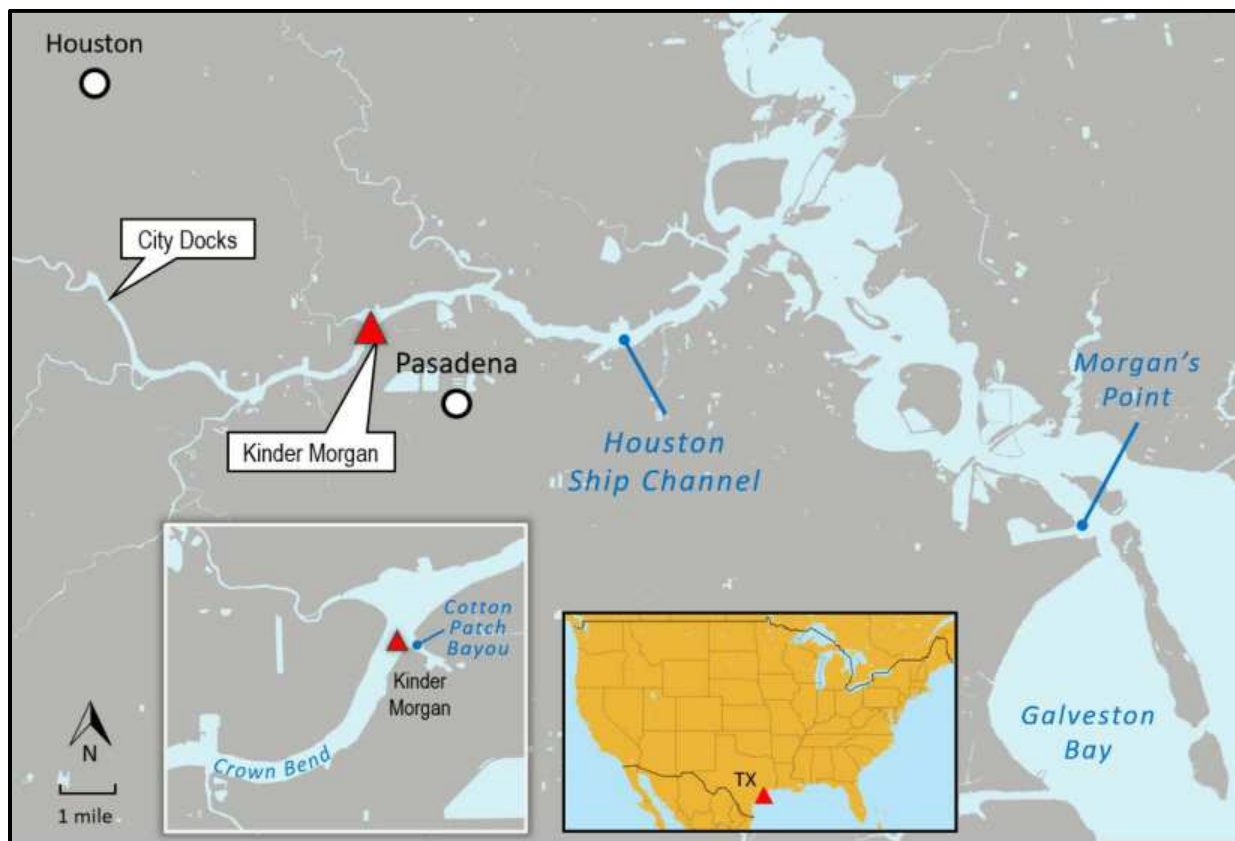
At 0408 local time on March 15, 2019, the towing vessel *Dixie Vandal*, pushing a partially loaded fuel barge upbound through the Houston Ship Channel, struck the towing vessel *Trinity* and one of its barges, which were moored and preparing to discharge cargo at the Kinder Morgan Pasadena Liquids Terminal in Pasadena, Texas. The contact caused the *Trinity* and its tow to shift about 100 feet upriver, breaking the cargo hoses and mooring lines and damaging the facility. About a half-gallon of jet fuel discharged into the channel. No injuries were reported by the crew of five aboard the *Dixie Vandal* nor by the *Trinity*'s crew of four. Damage to the facility and barges amounted to \$630,230.



Towing vessel *Dixie Vandal* under way in Houston after the accident.

<sup>1</sup> All miles in this report are statute miles.

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Location of the collision in Pasadena, Texas, as indicated by the red triangle. (Background source: Google Maps)

### Background

The *Dixie Vandal*, a twin-propeller towing vessel was built in 1968 and equipped with two 600-horsepower (hp) Mitsubishi engines. It was originally owned by Dixie Carriers, Inc. of Houston, Texas, and then transferred to Kirby Inland Marine, LP of Houston in 1998. The *Dixie Vandal* typically was connected to a fuel barge and would transfer fuel from facilities to vessels in the Houston/Galveston area.

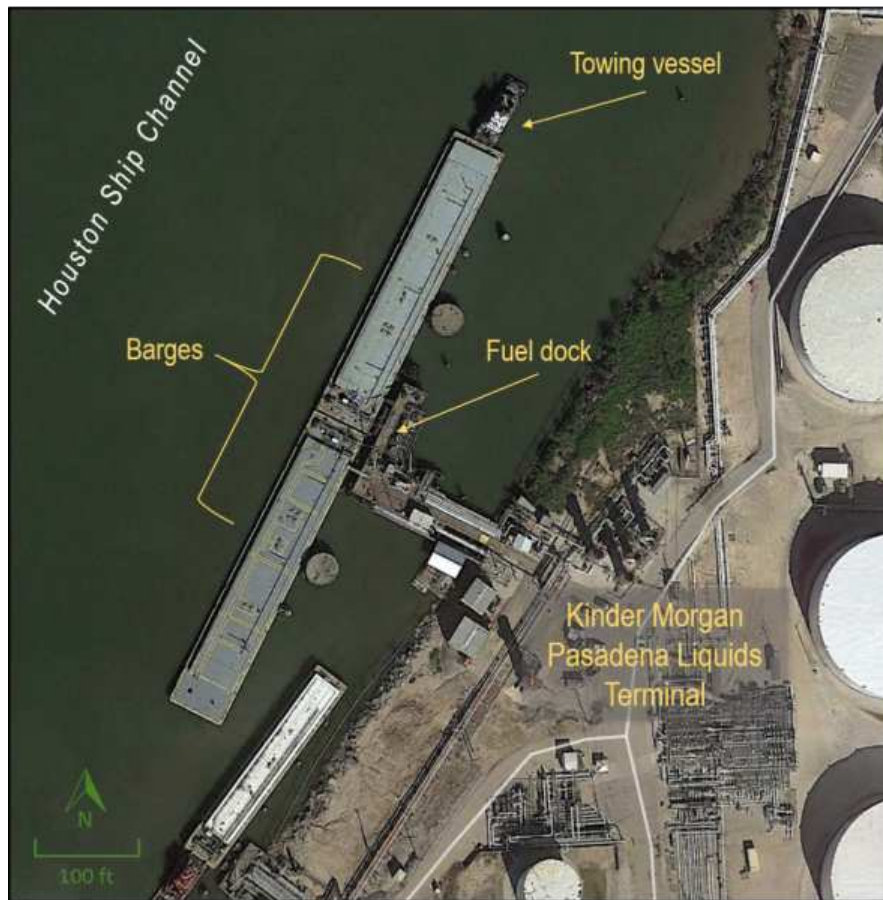
The *Trinity* was a twin-propeller towing vessel built in 1968 as the *Capt. Gus* before being renamed the *Trinity* in 1980. The vessel was transferred to Kirby Inland Marine in 1998 and a year later was repowered with twin 700-hp Caterpillar 3508 diesel engines.

### Accident Events

About 0100 on the morning of March 15, the towing vessel *Dixie Vandal*, which was connected to the multi-product tank barge *Kirby 29751*, completed bunkering operations at Morgan's Point in Texas, located on the shores of Galveston Bay at the inlet to the Houston Ship Channel. The *Kirby 29751* was loaded with intermediate fuel oil (IFO 380), aviation fuel, and marine gas oil (MGO). The vessel then started transiting up the channel toward City Docks at the Port of Houston to unload its cargo of MGO, with a crew of five (a captain, pilot, and three tankermen), as the pilot stood watch. The pilot came on watch at 1800 the evening before, about 12 hours before the accident, for his 12-hour watch and had been awake since 1600 that day. The crew was working a 12-hours-on/12-hours-off schedule.

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With its tow of two tank barges, the towing vessel *Trinity* had arrived at the Kinder Morgan Pasadena Liquids Terminal at mile 44 in the Houston Ship Channel at 2325 on March 13. The bow of the *Trinity* was faced up to the forward end of the barge *Kirby 29051*, which was moored starboard side-to the fueling dock at the terminal. Made up to the *Kirby 29051*'s stern was the stern of the barge *EBL 2997*, which was moored port side to the dock. Each barge was moored to the dock by six 3-inch-diameter polypropylene mooring lines. The *EBL 2997* was connected to the facility's fueling manifold by two 8-inch-diameter cargo hoses, each supported by a crane on the dock, as preparations were being made to start discharging its cargo of jet fuel to the facility.



**Aerial view of the Kinder Morgan Pasadena Liquids Terminal with a towing vessel and two barges moored in a similar arrangement to the *Trinity*, *Kirby 29051*, and *EBL 2997*. (Background source: Google Earth)**

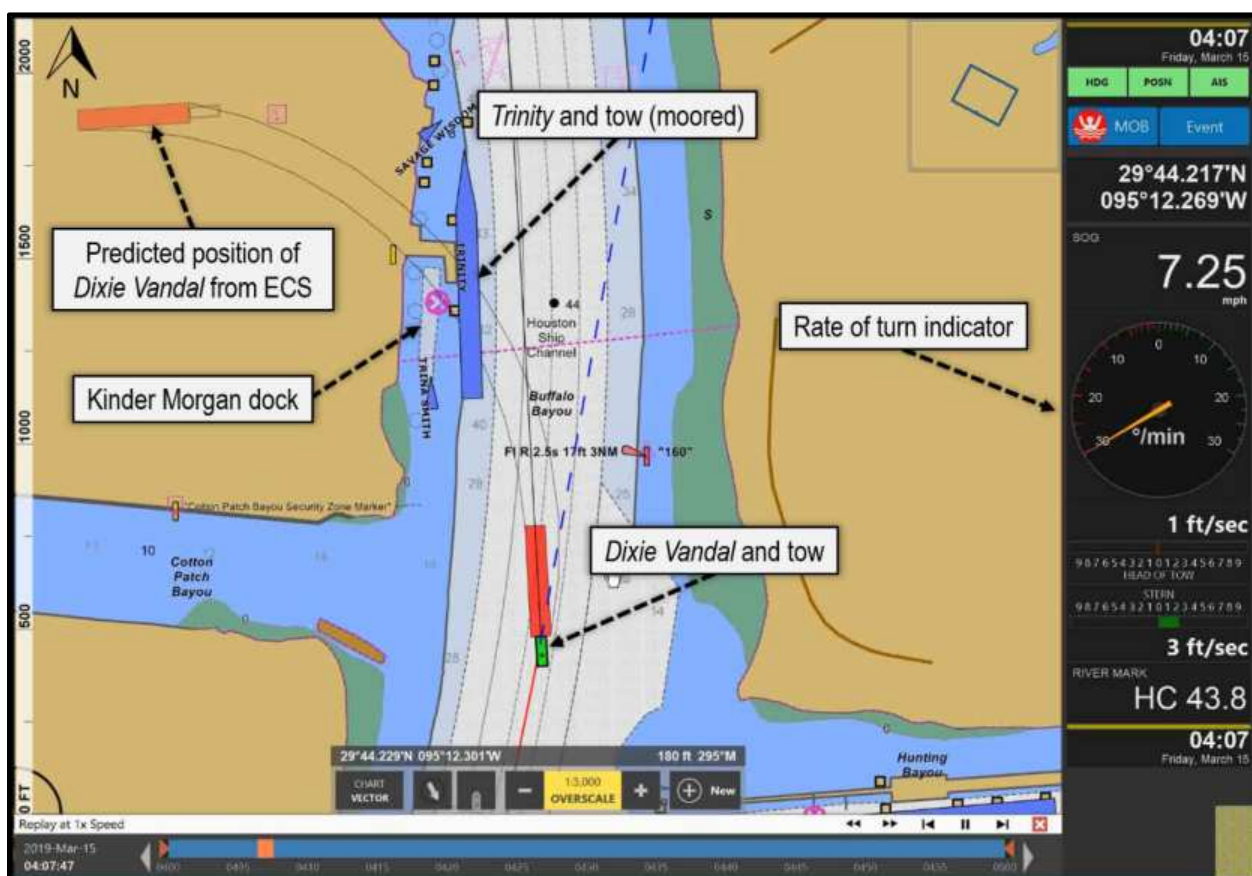
About 0400 on March 15, the *Dixie Vandal* and tow were approaching Crown Bend (just north of the Kinder Morgan facility) at about 6 miles per hour (mph) and was intending to pass the Kinder Morgan dock on its port side. The pilot was passing a protection cell across the channel from the Kinder Morgan terminal before executing the left-hand turn.

Playback from the *Dixie Vandal*'s electronic charting system (ECS) showed that about 04:07:30, as the *Dixie Vandal* and tow was proceeding around the left-hand turn by the basin, the tow began turning off course to port. At 04:07:47, the rate of turn indicator on the electronic charting system reached its maximum display of 30° to port. At 04:08:31, at a speed of about 6.5 mph, the forward port corner of the lead barge, *Kirby 29751*, contacted the starboard side of the *Trinity* and then struck the forward port corner of the barge *Kirby 29051*.

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The impact caused the *Trinity* and its tow to shift about 100 feet along the dock, straining and subsequently parting all 12 mooring lines (6 per barge). Also, two cargo hoses that connected the tank barge *EBL 2997* to the facility's manifold parted. About a half-gallon of residual jet fuel inside the cargo hoses spilled into the channel.

After the accident, the pilot on the *Dixie Vandal* told investigators that he believed he had dozed off in the seconds before striking the *Trinity* and was awakened by the impact; he was unsure how the tow had turned to port.

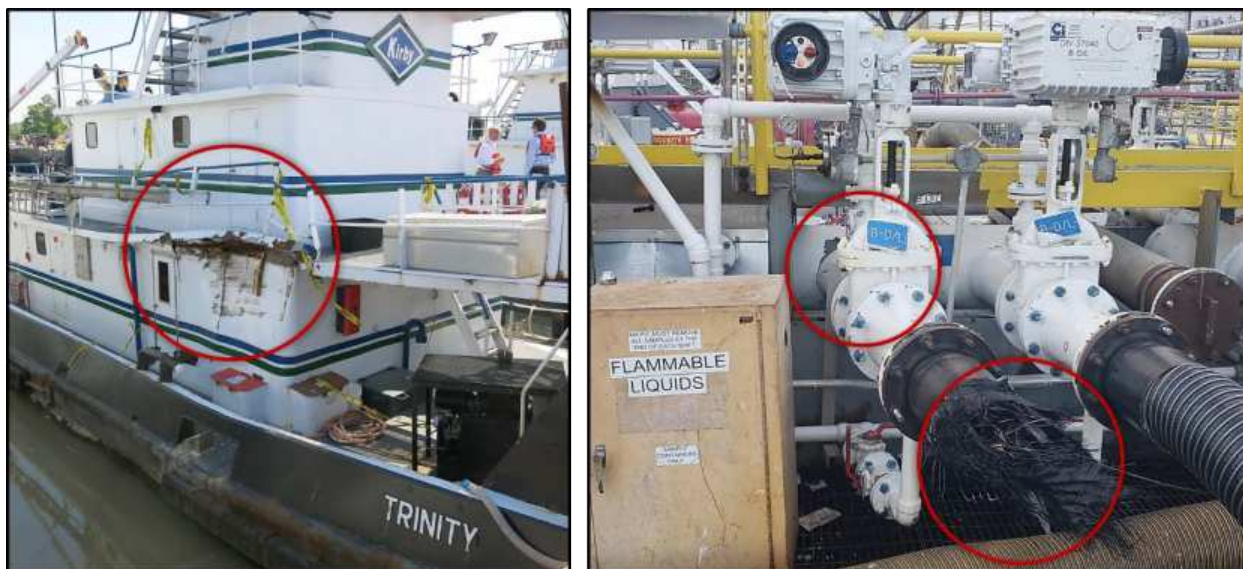


A screenshot captured at 04:07:47 from playback of the *Dixie Vandal*'s ECS shows the towing vessel as it approached the Kinder Morgan facility. (Source: Rose Point)

The starboard side of the second deck on the *Trinity* was damaged, including the decking, handrail, and house structure. The vessel was sold "as is" postaccident; therefore, no repairs were made to it. Damage to tank barge *Kirby 29501* included indentation of the deck and hull's upper sheer strake and bow plating. Additionally, a stanchion on the deck was ripped from its weld due to the parted mooring lines. Tank barge *EBL 2997*'s 10-inch-diameter cargo liquid manifold piping was distorted. The facility reported damage to the pipeline, loading systems, dock, and two cranes that were supporting the cargo hoses. The *Dixie Vandal* was not damaged in the incident.



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**Left:** Damage to the *Trinity*'s starboard side from the impact of barge *Kirby 29751*. **Right:** Damaged shoreside cargo hose and deformed piping at the manifold at the Kinder Morgan facility. (Source: Kinder Morgan Pasadena Liquids Terminal)

### Additional Information

**Postaccident testing.** Alcohol and drug tests were conducted on all crewmembers aboard the *Dixie Vandal* about 6 hours after the accident; all results were negative. After the accident, the pilot underwent a medical examination, which determined that he was fit to continue his duties.

**Pilot.** The pilot had worked aboard the *Dixie Vandal* for about 2 years; he had been working aboard towing vessels for Kirby Inland Marine (the operating company) for about 17 years since he started in the maritime industry.

During the pilot's typical 12-hour watch, his duties varied, depending on the operations that were being conducted. If the vessel was transiting or docked in a restricted area, the pilot was required to be in the wheelhouse. If the crew was engaged in bunkering vessels or cargo-loading of the barge, he was not restricted to the wheelhouse and would monitor the fuel transfer from several locations on the vessel. The pilot stated that he could not recall a time when he was restricted to the wheelhouse for an entire 12-hour shift. He said 8 hours was the maximum time he had been required to maneuver in the wheelhouse at one time, given that their transits were generally 8 hours or less. The tankerman on watch with the pilot was typically assigned duties outside the wheelhouse such as cleaning the vessel; the pilot believed that he was in the galley at the time of the accident.

Based on the records the pilot provided for his work-rest history for the 96 hours prior to the accident, he worked each day from 1800 until 0600, was off duty from 0600 until 1800, and slept from 0800 until 1600. At the time of the accident, the pilot was on his tenth day of a 20-day rotation. The pilot stated that during the time he was off duty from the vessel, he remained awake during daytime hours; when he returned to the vessel, he reported that he had no issues adjusting from being awake during the day while at home to having to be alert at night while working on the vessel. He reported using cetirizine for allergy symptoms. Cetirizine is a sedating antihistamine available over the counter, commonly marketed with the name Zyrtec, which carries the following

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warning, “When using this product drowsiness may occur; avoid alcoholic drinks; alcohol, sedatives, and tranquilizers may increase drowsiness; be careful when driving a motor vehicle or operating machinery.” He stated that did not feel the effects of drowsiness from the medicine and did not feel fatigued on the night of the accident. According to the captain who evaluated the pilot for watch readiness at 1800 the evening before the accident during their watch turnover, he believed that the pilot seemed “more than fine” and appeared to be “upbeat and well aware of what was going on” at the start of his shift.

**Company work/rest policy.** According to the pilot, the crew—consisting of the captain, the pilot, and three tankermen—had been operating on a 12-hours-on/12-hours-off schedule for about 1.5–2 years. According to a company representative, after the accident, the crew switched to a 6-hours-on/6-hours-off watch schedule. A manager for the operating company stated that the watch schedules were established by the vessels’ crews at their discretion, as long as they did not work more than the prescribed 12 hours per day. The manager stated that work/rest hours were recorded in a computerized management system monitored by the captain of the vessel and reviewed by the company in the event of a near miss or an accident.

The manager said several modifications had been made on many of the vessels in the fleet (before the accident) to increase the crews’ quality of sleep, such as installing higher-quality exhaust mufflers that reduced noise, blacking-out windows, improving doors to reduce noise, and providing exercise equipment and healthier food. Additionally, he said the crews were trained in endurance management to mitigate fatigue, and coaches were designated to oversee their endurance on the vessels. One of the facets in Kirby’s safety action plan was a “watch ready” system in which crews were trained to detect the readiness of other crewmembers and advised to call for a relief if anyone did not feel ready to handle the tasks at hand. There were several placards posted around the vessel reminding crewmembers about the watch-ready system and the stop-work authority to ensure they were properly prepared for the tasks at hand. He said that the company would also bring a relief to a vessel or let a vessel sit moored at a dock if a crewmember was not able to complete their duties. The manager stated that the company had previously ordered shore tankermen to assist when a crewmember notified the company about not getting sufficient sleep.

In addition, the wheelhouse of the *Dixie Vandal* was outfitted with a bridge navigational watch alarm system (BNWAS) equipped with motion sensors. In describing the BNWAS system to investigators, the crewmembers said that after the throttles for the engines were engaged, the system automatically activated; if the sensors did not detect motion for about 40 seconds, an audible alarm would sound in the wheelhouse; and about a minute later, if there was still no motion detected, the general alarm would ring throughout the vessel. The manager stated that BNWAS systems were installed aboard nearly every vessel in the fleet as a result of the I-40 bridge strike in 2002 in Oklahoma. According to the captain and pilot, the system was tested weekly, had been tested satisfactorily on March 10, 2019, and then again after the accident. On the morning of the accident, the pilot said that he did not hear the BNWAS system alarm in the wheelhouse, nor did the captain hear the general alarm from his room.

## Analysis

The *Dixie Vandal*’s ECS playback displayed a course change to port about 04:07:30, a maximum rate of turn to port at 04:07:47, and a significant drop in speed at 04:08:35, indicating contact occurred between the vessels just over a minute after the course change. The pilot did not recall making this sudden course change nor did he recall hearing the BNWAS alarm on the bridge;

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after the accident, he told investigators that he believed he had dozed off. There was no evidence to suggest the system was deactivated or inoperable at the time of the incident. Based on testing of the crew five days before and after the incident, the system was likely operating as designed. Therefore, it is likely that the sensors detected motion in the wheelhouse just before the pilot fell asleep or while he was drifting off to sleep within the time frame of the setpoints of the BNWAS system, because the BNWAS system did not sound in the wheelhouse nor did the general alarm sound throughout the vessel before the collision.

Fatigue has been recognized as a leading cause of accidents in the transportation industry. There is evidence that fatigue can adversely impact operator performance. Individuals vary in their requirements for sleep in a 24-hour period; however, cognitive function, alertness, and performance are all affected by a circadian process that is optimal on a “day-oriented” schedule.<sup>2</sup> Circadian troughs, or dips, occur when the body has a stronger desire to sleep, which typically occurs between the hours of 0100 and 0500, depending on individual factors. Research has shown, and National Transportation Safety Board (NTSB) investigations have further highlighted, that fatigue-related accidents are more likely to occur at the end of the night or during very early morning hours. The *Dixie Vandal* tow struck the *Trinity* at 0408, which, studies have concluded, is a time when the circadian rhythm is at a low. This dip in circadian rhythm often makes a person feel inclined to sleep, even when the person is not overly fatigued. Some effects of fatigue include lapses of attention, diminished decision-making ability, slowed responses, and an inability to concentrate. Of the 14 marine accidents the NTSB has investigated between 2014 and 2019 in which fatigue was found to be a contributing factor, 10 accidents occurred between 0100 and 0600.

The watch schedule for the crew on the *Dixie Vandal* was 12 hours on and 12 hours off. The pilot had been awake for about 12 hours at the time of the accident and had been on watch for about 10 of those hours. He reported to investigators that he did not feel fatigued that night, and the captain believed the pilot was “upbeat and well aware of what was going on” during his evaluation for watch readiness at 1800. Company policy, which the captain seemingly supported, stated that if the pilot was feeling tired during his watch, he could have contacted the sleeping captain to assist or called the company to provide a relief, but he did not. Self-reported (subjective) alertness, such as the pilot stating that he felt alert and awake for his shift, is often deceptive. Individuals are often not able to judge their own levels of fatigue. Additionally, while the captain had evaluated the pilot for watch readiness, the accident took place 10 hours following that subjective evaluation; thus, that earlier evaluation was not indicative of his alertness before the collision.

Shift work adds more complexity to the circadian process, because individuals have a harder time acclimating when switching from a day shift (or in this case, off-duty) to a night shift, when a crewmember’s entire schedule is flipped from day to night. A 2018 study (Boudreau et. al) conducted on marine pilots working irregular shifts, when shifts were distributed around the clock rather than a fixed or rotating work schedule, reported a prevalence of daytime sleepiness and insomnia. Although the accident pilot had more than a week to adjust to the night shift, his work/rest schedule was shifted in direct opposition to what was considered “normal” for him (in

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<sup>2</sup> Philippe Boudreau, Sylvain Lafrance, & Diane B. Boivin (2018), “Alertness and psychomotor performance levels of marine pilots on an irregular work roster,” *Chronobiology International*, 35:6, 773-784.

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this case, changing from staying awake during the day to sleeping at night) and his circadian process was likely affected, resulting in fatigue and thus reducing performance.

### Probable Cause

The National Transportation Safety Board determines that the probable cause of the collision of the *Dixie Vandal*'s tow with the moored *Trinity* and tow was the fatigued pilot falling asleep near the end of his 12-hour watch while maneuvering in the Houston Ship Channel, resulting in the loss of control of the vessel. Contributing to the pilot's fatigue was the extended length of duty through the night and early morning hours and his use of an over-the-counter antihistamine.

#### Managing Crew Work/Rest Hours

Companies should monitor the watch schedules of their crews to ensure that they are properly rested and afforded proper work/rest schedules. Crewmembers should be encouraged to request assistance from other crewmembers if they feel fatigued.



## Vessel Particulars

Vessel	<i>Dixie Vandal</i>	<i>Trinity</i>	<i>Kirby 29751</i>	<i>Kirby 29051</i>	<i>EBL 2997</i>
<b>Owner/operator</b>	Kirby Inland Marine LP	Kirby Inland Marine LP	Kirby Inland Marine LP	Kirby Inland Marine LP	Empty Barge Lines II Inc.
<b>Port of registry</b>	Wilmington, Delaware	Wilmington, Delaware	Miami, Florida	Wilmington, Delaware	Houston, Texas
<b>Flag</b>	United States	United States	United States	United States	United States
<b>Type</b>	Towing Vessel	Towing Vessel	Tank Barge	Tank Barge	Tank Barge
<b>Year built</b>	1968	1968	2008	2012	2003
<b>Official number (US)</b>	5125570	515037	1207849	1243775	1144783
<b>IMO number</b>	N/A	N/A	N/A	N/A	N/A
<b>Construction</b>	Steel	Steel	Steel	Steel	Steel
<b>Length</b>	71.2 ft (21.6 m)	75 ft (22.9m)	297.5 ft (90.7 m)	297.5 ft (90.7 m)	297.5 ft (90.7 m)
<b>Draft</b>	10.2 ft (3.1 m)	9.1 ft (2.8m)	12 ft (3.7 m)	12 ft (3.7 m)	12 ft (3.7 m)
<b>Beam/width</b>	24.2 ft (7.4 m)	26 ft (7.9 m)	54 ft (16.5 m)	54 ft (16.5 m)	54 ft (16.5 m)
<b>Tonnage</b>	143 GRT	102 GRT	1,619 GRT	1,619 GRT	1,619 GRT
<b>Engine power; manufacturer</b>	1,200 hp (894 kW); Mitsubishi Marine Diesel	1,400 hp (1,044 kW); Caterpillar 3508 Diesel			