National Transportation Safety Board

Contact of *Lindberg Crosby* Tow with Interstate 10 Bridge

Accident type	Contact	**No.** DCA19FM015
Vessel names	*Lindberg Crosby* and *Shawnee*	
Location	San Jacinto River, Channelview, Texas, at the Interstate 10 bridge 29°47.57' N, 95°3.73' W	
Date	February 11, 2019	
Time	1316 central standard time (coordinated universal time – 6 hours)	
Injuries	None	
Property damage	$1.56 million in damage to bridge; $26,279 to barge *Shawnee*	
Environmental damage	None	
Weather	Temperature 73°F, partly cloudy with winds from the south at 10 miles per hour, no precipitation	
Waterway information	The Interstate 10 bridge crosses the San Jacinto River about 16 miles east of Houston, Texas.[1] The waterway connects to the Houston Ship Channel and is transited by towing vessels, barges, and other small craft.	

At 1316 local time on February 11, 2019, the towing vessel *Lindberg Crosby*, with a crew of four, suffered a loss of engine control and struck the Interstate 10 (I-10) bridge while attempting to dock an empty tank barge at the nearby Southwest Shipyard dock on the San Jacinto River in Channelview, Texas. No pollution or injuries were reported. Damage to the bridge and barge was estimated at $1,595,887.

Towing vessel *Lindberg Crosby* docked in Houston, Texas, after the accident.

[1] Unless otherwise noted, all miles in this report are statute miles.

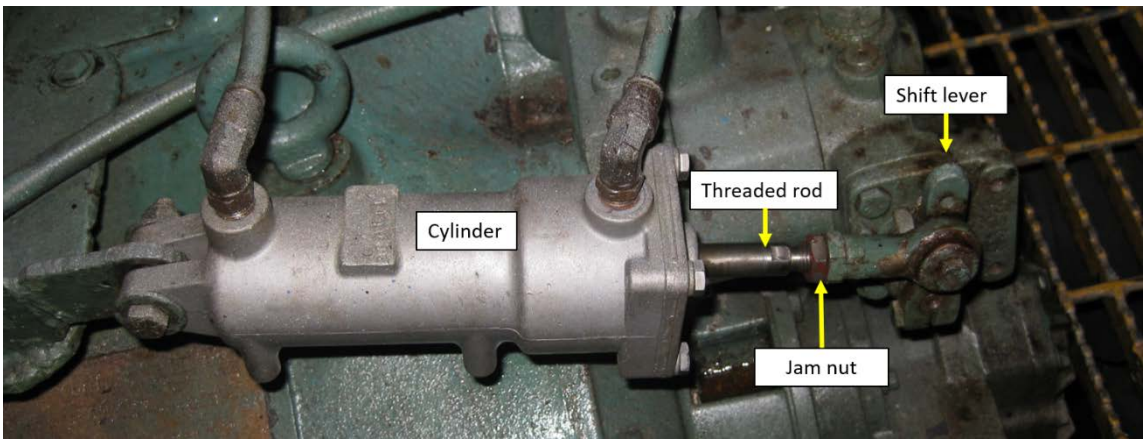
Area of accident where the *Lindberg Crosby* tow struck the I-10 bridge, as indicated by a red triangle. (Background source: Google Maps)

Background

The *Lindberg Crosby*, a twin-propeller towboat, was built in 1975 by Houma Shipbuilding Co. as the *Delbert Jr*. It was sold and renamed several times before being sold to Crosby Marine in 1995 and renamed the *Lindberg Crosby*. The vessel's propulsion system consisted of two General Motors 12V71 diesel engines and Twin Disc reduction gears with integrated transmissions.

Wheelhouse console engine throttle levers used to control each engine's speed and transmission.

Each propulsion engine's speed (rpm) and transmission (direction) was controlled by a pneumatic system that was operated by a throttle lever on the wheelhouse console. Moving the engine throttle levers sent two compressed air signals to each engine: one signal adjusted the engine speed by moving its fuel rack, and the other signal actuated a pneumatic cylinder that was connected to the transmission's gear shift lever, shifting the engine into ahead, neutral, or astern propulsion. The cylinder was connected to the shift lever by an actuation rod fitted with a threaded end that was fastened into a threaded connector on the transmission shift lever. The connection was secured with a jam nut to prevent the threaded rod from rotating and backing out of the connector.



Pneumatically controlled actuator connected to transmission shift lever with threaded rod and jam nut.

Accident Events

At 1030 on February 10, 2019, the 55-foot-long towboat *Lindberg Crosby*, pushing the 245-foot-long tank barge *Shawnee*, arrived at the Texas Petroleum Corporation (TPC) facility in Pasadena, Texas, to offload a cargo of butadiene from the barge.[2] The *Lindberg Crosby* had a draft of 8 feet, and the empty barge had a draft of 4 feet. At 1100 the following morning, after discharge operations were complete, the tow departed TPC and proceeded up the San Jacinto River towards Southwest Shipyard in Channelview to have the empty barge cleaned. Southwest Shipyard was located on the west bank of the San Jacinto River, directly south of the I-10 bridge. The barge was to be docked port side to with the bow about 100 feet from pier columns for the bridge's eastbound span.

On the day of the accident, the crew of the *Lindberg Crosby* consisted of a captain, a relief captain, and two deckhands. There was no crew aboard the barge. The captain of the *Lindberg Crosby*, who had about 20 years of experience in the maritime industry, was on watch at the time of departure from TPC. The captain estimated the ebb current to have been about 1 mile per hour (mph) opposing the vessel, with winds from the west at 15–20 mph.

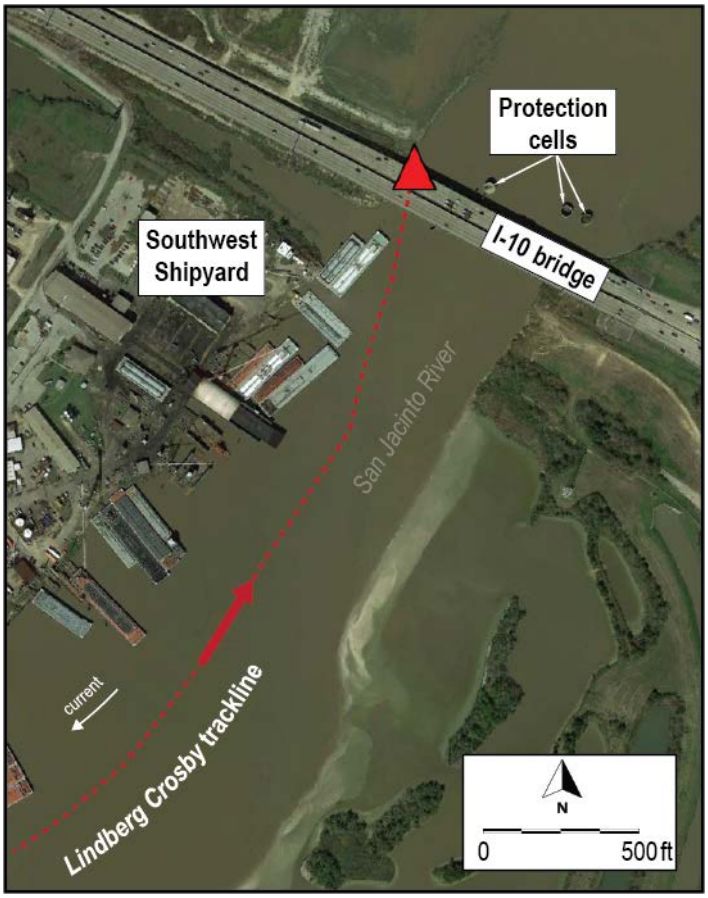
As the tow proceeded up the San Jacinto River, the captain was relieved by the relief captain about noon but returned to the wheelhouse about 1245 to maneuver the vessel to the shipyard dock. The relief captain had only been working in this capacity for about 6 months, and the captain felt more comfortable docking and handling the vessel in this section of the river. The captain described the San Jacinto River as being "extremely congested" with other vessels, and said that the area was locally referred to as "wheelwash alley" due to the propeller wash of towing vessels holding barges in position on both banks of the river.[3] He also explained that because the Southwest Shipyard dock was very close to the I-10 bridge, there was little room for error. The I-10 bridge had multiple sets of pier columns in the river supporting the highway. Protection cells and fendering were installed to prevent damage to the pier columns that made the boundaries for

[2] Butadiene is the organic compound with the formula $(CH_2{=}CH)_2$. It is a colorless gas that is easily condensed to a liquid. It is important industrially as a monomer in the production of synthetic rubber.

[3] *Wheelwash* is a term that describes turbulence from a propeller. The wheelwash from these vessels, which holds them in position along the shoreline, could adversely affect vessels that were transiting the river by pushing them into the channel.

the navigable channel. There were three protection cells on the upstream side (two protecting the columns on the east side of the channel and one protecting the columns on the west side). The pier columns on the west side of the main channel were also protected by a series of horizontal fendering beams. There was no protection (protection cells or fendering) for the columns adjacent to the Southwest Shipyard.

As the vessel approached its intended berth at a speed of 3.2 mph, the captain shifted the engines (port and starboard) from ahead propulsion to neutral, then attempted to slow the tow by shifting them both astern.



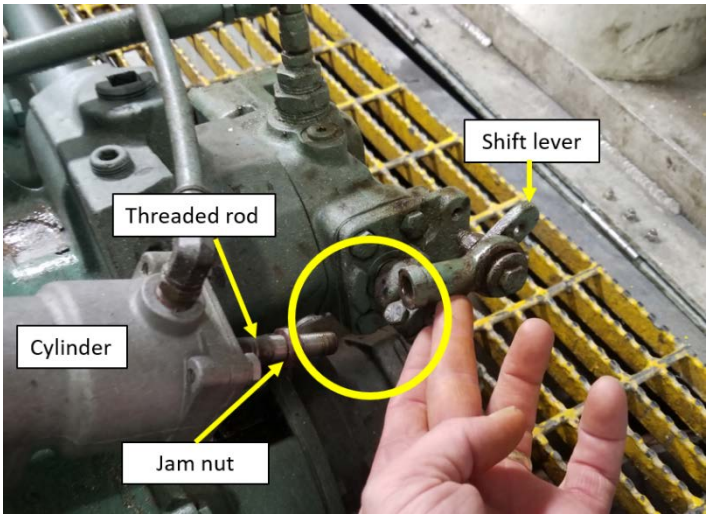
Trackline and location of the *Lindberg Crosby* when the tow struck the I-10 bridge (marked with red triangle). (Background source: Google Earth)

To further slow the tow as it neared the berth, the captain moved both throttle levers further in the astern direction; however, instead of slowing as the captain expected, the towboat and barge began veering to port. Realizing that there was a problem affecting control of the vessel, the captain attempted to steer the bow of the barge into the rocky shore to stop the tow and prevent the *Lindberg Crosby's* accommodation spaces from striking the bridge. Consequently, the barge (*Shawnee)* passed under the eastbound span, and at 1316, the bow of the barge contacted a westbound highway bridge pier column at a speed of 2.9 mph, bringing the tow to rest and damaging the pier column. Immediately after the tow stopped, the captain looked aft and saw wheelwash behind the starboard propeller. He realized that despite the fact that he put the starboard engine control in the astern direction, it was still "clutched in," or stuck in, and providing propulsion in the forward direction.

Contact of Lindberg Crosby Tow with Interstate 10 Bridge

Wheelwash from the *Lindberg Crosby's* starboard propeller, circled in yellow, after striking the I-10 bridge. (Source: Screenshot from Harris County Sheriff's Department video)

The captain stopped the starboard engine. He used the port engine to back the *Shawnee* out from under the bridge and moored the tow at the shipyard dock. He went to the engine room and found the transmission shifting lever of the starboard engine stuck in the ahead position because the threaded rod of the actuating piston had disconnected from the connector affixed to the shifting lever, preventing any shifting from the wheelhouse lever controls. Later that afternoon, representatives from the company's maintenance department reconnected the two pieces of the transmission shift linkage and tightened the jam nut. The control system was tested, and the cylinder and transmission appeared to function normally.



Starboard engine pneumatic gear clutch actuator linkage disconnected aboard the *Lindberg Crosby* as found after the accident. (Source: *Lindberg Crosby* captain)

The westbound highway's southernmost concrete pier column, located approximately 15 feet from the west bank shoreline, showed an impact area approximately 8–10 feet above the waterline. The pier column was completely sheared above the impact area and no longer vertical. Damage to the barge consisted of a 3-inch inset to the bow; distorted internal components, such as vertical stiffeners, longitudinal angles, bulkheads; and a bent cargo tank relief stack. There was no damage to the *Lindberg Crosby*.

Left: Damaged section of pier column, circled in yellow, under westbound lanes of I-10 bridge. Right: Bow of barge *Shawnee* after the accident with damaged section circled in yellow.

Additional Information

In a postaccident interview, the captain told investigators that the crew checked the *Lindberg Crosby's* engine room every hour while under way, looking for fire, flooding, or any abnormalities. He said that the crew filled out a daily checklist, which included visual checks on systems such as the engines, transmission, and gears (which included the control linkages for shifting and the fuel rack), and other auxiliary equipment. There were no abnormalities noted. The starboard engine was overhauled in April 2018, but the pneumatic cylinder, which was mounted on the transmission gear, was not included in this overhaul.

Following the accident, replacement pneumatic cylinders were installed on both engine transmissions, and the starboard cylinder was removed for testing.

The cast aluminum, pneumatic, three-position, spring-centered cylinders were manufactured by Aventics Corporation. The manufacturer provided installation instructions, which stated that the cylinder should be mounted with the air ports facing down to prevent foreign material from accumulating in the cylinder. An adjustable link was required to be included between the piston rod and the transmission lever to ensure the clevis pin was free from load in the center position. There were no tightening or torque requirements for the jam nut. The manufacturer stated that because the cylinder is used in so many different applications, they provided generic guidance for the jam nut installation requirements, stating that the "user of these devices must conform to all applicable electrical, mechanical, piping and other codes in the installation, operation or repair of these devices."

Materials Testing. The removed cylinder was first inspected at the National Transportation Safety Board (NTSB), where a materials lab engineer determined that the threads on the rod shaft and the bolts used to fasten the cylinder appeared intact and free of residual seal tape or similar substances. The bearing ball at the rod end had extensive wear marks, was loose in the mating housing, and rotated freely with abundant play in the movement. Also, the shank of the mating attaching nut had multiple longitudinal flat areas around the circumference consistent with

wear. The cylinder was tested using a regulated air supply, and the shaft actuated as expected under pressure without any noticeable binding.

In October 2019, investigators from the NTSB and the US Coast Guard and representatives from the cylinder manufacturer, as well as the vessel operator, met to inspect and test the cylinder. All parties reviewed pictures of the cylinder installation aboard the *Lindberg Crosby* taken after the accident. It was noted that the cylinder was mounted with the air ports facing up, which was inconsistent with the manufacturer's installation instructions. The nameplate data was stamped with the manufacturing date (fourth week of 2006) and the characters "1440DG," which the manufacturer determined to be a stamping from an external source that possibly indicated an overhaul date of 2014. During the inspection of the cylinder, the rod was able to be rotated by hand, which the manufacturer determined to be normal, as the cylinder model was not fitted with guides to prevent rotation in order to make up for any misalignment in varying installations. Compressed air was applied to both sides of the piston via a switching valve, and the piston actuated in both directions as expected. A mark was then etched on the housing and shaft, and the unit was actuated 50 times with no load. The marks showed that the rod rotated clockwise (looking from rod end) about .07 inch (about 15 degrees).

After all the external components were inspected, the cover was removed from the cylinder, and all internal components were disassembled and inspected. The internal components showed some rust and dirt accumulation, and there was some scale on the internal face of the cylinder. The nut on the piston shaft was intact, and the spring was not broken. All O-rings and seals were in apparent good condition. All parties agreed that the cylinder operated properly.

The operating company was unable to determine the length of time that the cylinder had been in service on the starboard engine and could not provide details of any maintenance that had been performed on the cylinder, other than replacement after this accident. The manufacturer stated that the cylinder "should provide a minimum of 1,000,000 cycles of maintenance free service when used and lubricated as recommended. However, these products should be visually inspected for defects and given an 'in system' operating performance and leakage test once a year. Where devices require a major repair as a result of the one million cycles, one year, or routine inspection, the device must be disassembled, cleaned, inspected, parts replaced as required, rebuilt and tested for leakage and proper operation prior to installation."

According to the operating company, the most common issue that they had experienced with these cylinders was piston seal failures due to operating in severe conditions. The environment can cause debris and moisture in the air, and consequently, air eventually passes by the worn piston seal, and the unit does not actuate. The company typically replaced failed units with new units instead of rebuilding. After the accident, the *Lindberg Crosby*'s operating company instituted a mandatory cylinder replacement program at 2.5 years, coinciding with vessel drydock.

Analysis

As the vessel approached its intended berth just south of the I-10 Bridge, the captain attempted to slow the vessel by moving the throttles for both engines from ahead to astern. The port engine shifted astern, but unbeknownst to the captain, the starboard engine remained clutched in the ahead direction. The result was that the vessel began to veer to port. When the captain attempted to slow the vessel further by pushing the throttles further astern, the port engine responded with increased rpm astern as expected, but the starboard engine continued to push ahead

(at higher rpm), which increased the rate of turn to port. The control loss of the vessel's starboard engine resulted in the tow's barge striking a pier column of the bridge.

When the captain examined the starboard engine following the accident, he found that the threaded rod of the actuating piston had disconnected from the connector affixed to the shifting lever. This prevented any direction changes from being transmitted from the wheelhouse throttle levers to the shifting lever on the transmission, resulting in the transmission remaining stuck in the ahead direction. With twin propulsion engines and no positive feedback system to alert the operator that shift commands were not followed, the captain did not immediately discern the loss of starboard engine control and discovered it only after observing wheelwash coming from behind the starboard propeller (indicating that it was still pushing ahead).

Although it is unknown how long the pneumatic cylinder had been in operation or how many cycles it had actuated, the stamped numbers on the name plate indicate that the unit was built in 2006 and possibly overhauled in 2014. Due to the large number of vessels with these types of cylinders in its towing fleet, the operator was unable to provide a date of installation. Following the accident, the company changed its policy from replacing units that had failed to replacing units at regular time intervals.

As a result of the postaccident tests, the NTSB believes that there was not a material failure of the pneumatic cylinder or its components; the cylinder operated as expected. The design of the piston within the cylinder allowed it to rotate to account for misalignment in various applications. Postaccident testing showed that during repeated operation, the piston rod rotated in a direction that would unscrew a threaded connection. To prevent cylinder shaft rotation as it was fitted on the vessel's transmission, a jam nut was provided to tighten down against the shift lever threaded connector. The most likely cause of the separation of the linkage between the cylinder and the transmission lever was the jam nut becoming loose over time, therefore allowing rotation of the piston rod, resulting in the rod unthreading from the shifting lever connector piece.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the towing vessel *Lindberg Crosby* contacting a pier column of the Interstate 10 bridge was the undetected loss of starboard engine directional control due to a separation of the control system mechanical linkage to the pneumatic gear clutch, resulting in the engine not shifting in response to the operator's commands.

Ensuring Jam Nuts and Locking Devices are Secured

Many vessels use mechanical linkages to transmit control commands to critical machinery. Operators of vessels using adjustable linkages that include jam nuts, locking nuts, or other devices should frequently examine the position of the nuts on shafts to verify their security and develop procedures to effectively ensure critical control system components are included in preventative maintenance programs. Component and control system manufacturers should provide guidance/options for passively securing jam nuts, such as locking wire, locking washers, securing tabs, thread-locking insert materials, thread-locking fluid, or other means.

Vessel Particulars

Vessel	*Lindberg Crosby*	*Shawnee*
Owner/operator	Crosby Tugs, LLC	Kirby Inland Marine LP
Port of registry	New Orleans, Louisiana	Memphis, Tennessee
Flag	United States	United States
Type	Towing Vessel	Bulk Liquid Cargo (Tank) Barge
Year built	1975	2011
Official number (US)	569107	1235319
IMO number	N/A	N/A
Construction	Steel	Steel
Length	55 ft (16.8 m)	245 ft (74.7 m)
Draft	7 ft (2.1 m)	12 ft (3.7 m)
Beam/width	22 ft (7 m)	48 ft (14.6 m)
Tonnage	66 GRT	1,100 GRT
Engine power; manufacturer	1,000 hp (747 kW); GM 12V-71 Marine Diesel	N/A
Persons on board	4	0

NTSB investigators worked closely with our counterparts from Coast Guard Sector Houston/Galveston, Texas, throughout this investigation.

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID DCA19FM013.

Issued: January 17, 2020

The NTSB has authority to investigate and establish the probable cause of any major marine casualty or any marine casualty involving both public and nonpublic vessels under Title 49 *United States Code*, Section 1131(b)(1). This report is based on factual information either gathered by NTSB investigators or provided by the Coast Guard from its informal investigation of the accident.

The NTSB does not assign fault or blame for a marine casualty; rather, as specified by NTSB regulation, "[NTSB] investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." Title 49 *Code of Federal Regulations*, Section 831.4.

Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by conducting investigations and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. Title 49 *United States Code*, Section 1154(b).