National Transportation Safety Board

Marine Accident Brief

Grounding of Articulated Tug and Barge
Nathan E Stewart/DBL 55

Accident no.	DCA17RM001
Vessel name	*Nathan E Stewart/DBL 55*
Accident type	Grounding
Location	Edge Reef, off Athlone Island in Seaforth Channel, northwest of Bella Bella, British Columbia, Canada
Date	October 13, 2016
Time	0108 Pacific daylight time (coordinated universal time – 7 hours)
Injuries	None reported
Damage	$12 milion est.
Environmental damage	Approximately 29,000 gallons of fuel and lube oil released
Weather	Light rain, visibility 6–10 miles, winds east 10–20 knots, gusts to 25 knots, seas 3 feet, air temperature 48°F*
Waterway information	The Seaforth Channel is part of the Inside Passage between Seattle, Washington, and Juneau, Alaska. The bottom and shoreline in that area is predominantly rocky.

On October 13, 2016, at 0108 local time, the articulated tug and barge (ATB) *Nathan E Stewart*/*DBL 55* ran aground on Edge Reef off Athlone Island in the Seaforth Channel near Bella Bella, British Columbia, Canada. At the time of the accident, the *Nathan E Stewart* was en route to the Port of Vancouver with the empty *DBL 55*. None of the crewmembers were injured, but environmental damage occurred when approximately 29,000 gallons of fuel and lube oil were released. Damage to the vessel and barge was estimated at $12 million.

***Nathan E Stewart/DBL 55* near Quadra Island, British Columbia, in November 2013. (Photo by Dirk Septer)**

*Unless otherwise noted, all miles in this report are nautical miles (1.15 statute miles).

Marked by a red *X*, the accident site where the *Nathan E Stewart* grounded on Edge Reef off Athlone Island, northwest of Bella Bella, British Columbia, Canada. (Background by Google Maps and Google Earth)

Accident Events

The tugboat *Nathan E Stewart* and the tank barge *DBL 55* were connected through the JAK coupling system.[1] Controlled from a panel on the tugboat's bridge, this system uses a 16-inch-diameter, high-strength steel pin pneumatically actuated on each side of the vessel's bow to lock the vessel into a fitted socket plate welded to each side of the barge's inner notch. The plates have multiple sockets that run vertically, which allows the tugboat to position itself within the notch to accommodate changing barge drafts as well as to prevent, or minimize, the horizontal movement between the two units.

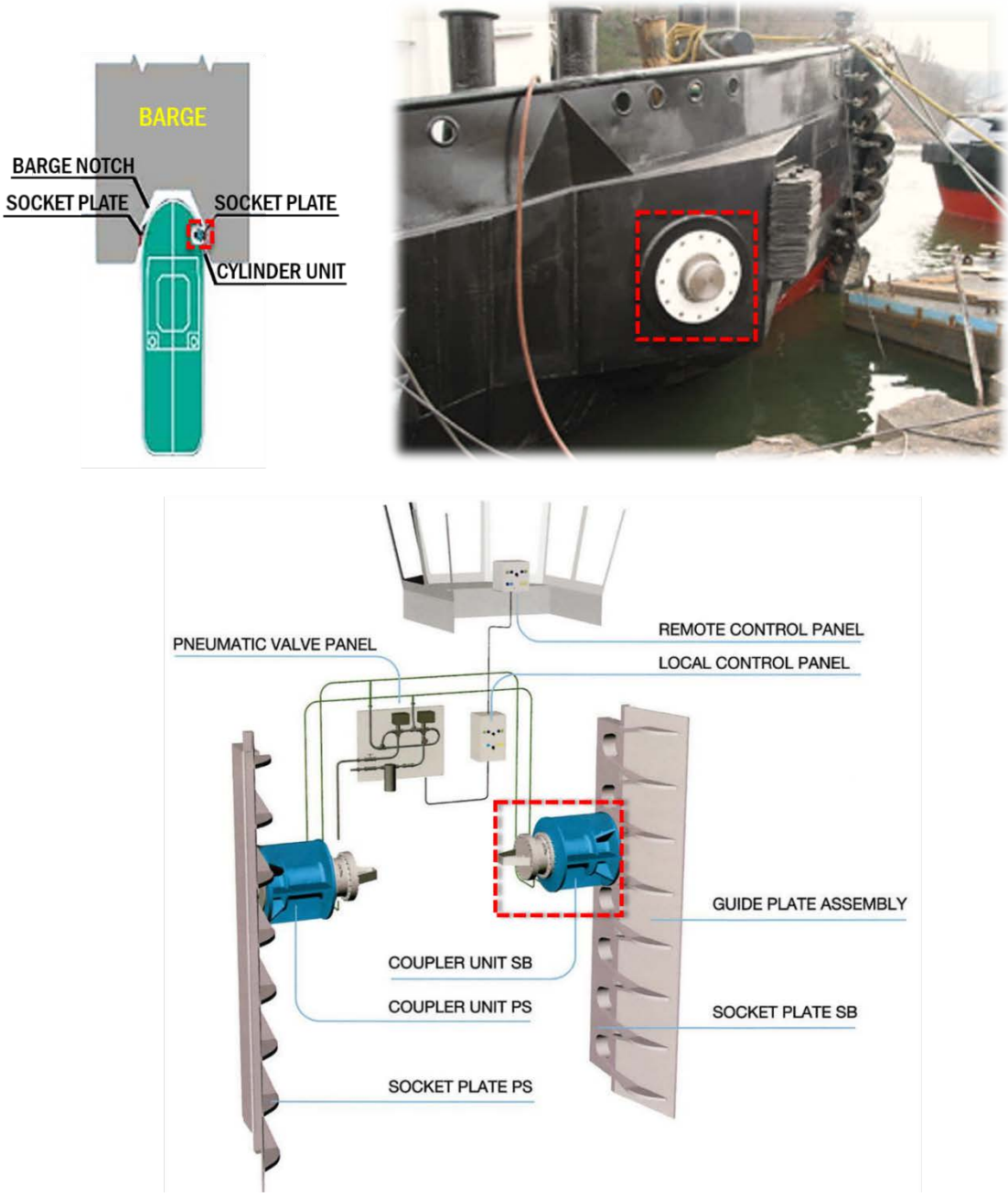
The *Nathan E Stewart* routinely transited from petroleum facilities in the state of Washington and Vancouver, British Columbia, with the *DBL 55* or one of the company's other tank barges loaded with refined petroleum products to be delivered to various ports in Alaska.

On October 4 at 0830, the ATB heaved anchor at its position in the "N" anchorage of Indian Arm fjord, before departing from the Port of Vancouver en route to the Ports of Skagway and Ketchikan in Alaska. The *DBL 55* was loaded with approximately 1.4 million gallons of jet fuel and 700,000 gallons of unleaded gasoline. On October 9 at 0545, while transiting northbound through a route known as the Inside Passage, the *Nathan E Stewart*/*DBL 55* stopped at the Petro Marine Services facility in Skagway to discharge ashore approximately 755,000 gallons of jet fuel. At 1630, the ATB departed from Skagway and continued its voyage to the Petro Marine Services facility in Ketchikan, where it arrived on October 11 at 0910.

The Inside Passage extends from southeast Alaska through Vancouver to Puget Sound, Washington. It provides seagoing vessels a sheltered route for passage on both northerly and

[1] The JAK® ATB Coupling System was designed by Jaakko Kallio in the early 1990s.

southerly routes if conditions offshore are unfavorable. Portions of the Inside Passage require transit through narrow and restricted channels, which often have strong currents called "tidal rapids." This natural occurrence is caused by seawater flooding or ebbing from the Pacific Ocean as the oscillating tide flows through sections of the waterway where it is restricted or narrow. The Inside Passage is also known to have unpredictable winds caused by airflow that has been disrupted by the cliffs, valleys, ridges, and other geographic features of the area, and consequently wind-generated waves from the movement of air across the water's surface.



Pneumatically actuated pin on an unidentified tugboat and graphics detailing components of the JAK coupling system. (Images courtesy of Beacon Finland)

Kirby Offshore Marine specifically addressed in the company's safety management system (SMS) the transits through the Alaska waterways and the Inside Passage. To ensure that the route followed the waypoints established by the company's Pacific division (hereafter referred to as Kirby), the SMS required the submission, review, and approval (by the shoreside operations department) of all voyage plans through those waters.

That procedure also addressed specific sections of the Inside Passage where the company required a second licensed deck officer to augment the navigation watch. For these areas there were also requirements for minimum visibility, tide management planning, parallel indexing, and the variable range marker tool on both radars. The voyage plan for both the northbound and southbound transits of the *Nathan E Stewart*/*DBL 55* had been reviewed and approved by Kirby's operations department. The section of the waterway where the accident occurred was not specifically identified in the company's procedures as one of the sections in the Inside Passage route requiring any special mitigation measures.

At the Petro Marine Services facility in Ketchikan on October 11, the crew discharged ashore the remaining cargo of jet fuel and gasoline from the *DBL 55*. They also loaded 23,128 gallons of ultra-low sulfur diesel fuel oil into the *Nathan E Stewart*'s fuel oil tanks. The captain and engineers performed day work, while the chief mate and second mate rotated watch 6 hours on followed by 6 hours off. The second mate was assigned to the 1000–1600 and 2200–0400 shifts, and the chief mate to the 1600–2200 and 0400–1000 shifts. Two tankermen rotated on the same schedule as the mates'.

At 2110, after the tankermen discharged ashore all cargo from the *DBL 55*, the ATB departed Ketchikan and began its southbound transit toward the Port of Vancouver via the approved voyage plan. The *DBL 55*, which was empty, had a forward draft of 5 feet 3 inches and an aft draft of 7 feet 2 inches. The *Nathan E Stewart* had a forward draft of 11 feet 0 inches and an aft draft of 12 feet 0 inches. The pins of the tug and barge's coupling system were inserted and locked into the second recess (from the bottom up) of both socket plates.

Once the vessel was under way, the watch rotation shifted to 4 hours on and 8 hours off, with the navigation responsibility being rotated between the captain, the chief mate, and the second mate. The chief engineer, the assistant engineer who was in training, and the two tankermen also shifted to the same watch rotation; they would perform rounds on the vessel to ensure that all systems were operational and to assist the navigation watch as directed.

On October 12, the captain of the *Nathan E Stewart* assumed the navigation watch from the chief mate at 2000. The captain was navigating from the vessel's upper wheelhouse using the approved waypoints that were plotted and checked throughout the voyage on the vessel's nautical (paper) charts and electronic chart system (ECS). According to statements by the captain and mates, the nautical charts were the primary navigation tool and the ECS was considered supplementary. Both were updated and maintained by the chief mate and the second mate.

The ECS on the *Nathan E Stewart* had a cross-track error alarm function, which, if used, would alert the operator if the vessel's GPS position deviated to the right or left of the trackline for the active route. If triggered, the system would sound an alarm and display a secondary trackline extending from the vessel's current position to the next waypoint, including numerical information for the relative bearing to the waypoint.

After waking up at 2230, the second mate went to the galley where he spoke with the engineer. He then proceeded to the upper wheelhouse to relieve the captain of the watch at 2300, earlier than his scheduled rotation time at 2400. Once relieved of the watch, the captain retired to his stateroom.

The second mate stated to investigators that on this watch he was running both main diesel engines (MDEs) at 1,650 rpm, which was producing speeds over ground between 8.4 and 9.3 knots. He had the port generator running to provide electrical service, and the vessel's autopilot was engaged.[2] Both radars were energized, but the second mate could not recall at what range scale he had either set. He was aware of the ECS's cross-track error alarm function, but on the night of the accident he was not using that navigation tool, which he said was "not typically used."

Around 2359, after relieving the chief engineer and the assistant engineer of their watch, one of the two tankermen checked in via radio with the second mate, who recorded the watch rotation in the vessel's logbook. Soon thereafter, on October 13 at 0024, as the ATB proceeded southeasterly through Queen Charlotte Sound, the second mate made a course change at a predetermined waypoint near Salal Island, which put the tug and barge on a course over ground of approximately 135 degrees with a speed over ground of 9.3 knots. Nearly half an hour later, around 0053, the *Nathan E Stewart*/*DBL 55* was near Ivory Island when the second mate missed the next waypoint. Per the voyage plan, he should have applied rudder input to alter course to port on a heading of approximately 98 degrees.

Around 0100, the tankerman on watch attempted to contact the second mate using a handheld UHF radio but received no response. After waiting an estimated 30 seconds to a minute, he attempted to contact the second mate again. When that radio callout also went unanswered, the tankerman began making his way from the galley area to the upper wheelhouse. En route, he felt what he described as "shuddering." During a third attempt to contact the second mate, the tankerman was informed by the second mate that the vessel had grounded. At 0108, the bow of the *DBL 55* and the starboard propeller (and/or propeller shaft) of the *Nathan E Stewart* contacted Edge Reef, a rocky area off Athlone Island in the Seaforth Channel. The ATB had continued under autopilot on the last heading input at 0024 until the time of the grounding.

Response

The captain was awakened by the sound of the tugboat's port MDE backing down "hard" as well as by what he described as cavitation that "seemed abnormal." He then proceeded to the upper wheelhouse where the second mate informed him, "It just came right," regarding the movement of the ATB. The second mate and captain stated to investigators that they believed only the bow of the *DBL 55* was aground at that time.

The captain assumed the navigation control of the tugboat from the second mate, who had the port MDE in astern propulsion. Intending to keep the *Nathan E Stewart* off the shoreline, the captain continued with the attempt to refloat the barge because the ATB had swung to starboard. However, realizing that the starboard MDE was not running, he directed the chief engineer to proceed to the engine room to restart the starboard MDE. The chief engineer managed to restart it, but the starboard engine would only idle with the transmission in neutral; every time the transmission was put into gear, it would shut down.

[2] The vessel's autopilot system was configured to maintain only the set heading and was not integrated with the ECS.

When the captain's attempt to refloat the vessel proved unsuccessful, he sent the second mate below to alert the crew to the emergency situation. At 0116, the captain used the VHF radio to report the accident to the Canadian Coast Guard's Marine Communications and Traffic Services (MCTS) in the Port of Prince Rupert, British Columbia. The watchstander at MCTS in turn notified the Joint Rescue Coordination Centre in Victoria, which tasked three Canadian Coast Guard vessels with assisting the *Nathan E Stewart*. These vessels were the *John P. Tully*, a 226-foot oceanographic research vessel; the *Bartlett*, a 190-foot buoy tender; and the *Cape St. James*, a 47-foot, high-speed motor lifeboat.

The chief engineer and assistant engineer began a damage assessment of the engine room and compartments of the *Nathan E Stewart*, as the chief mate proceeded to the lower wheelhouse to assist the captain. The second mate and two tankermen proceeded to the *DBL 55* to inspect the voids for water. According to the captain and chief engineer, at that time there were no indications of damage to either the tugboat or barge.

The tide cycle at the accident location was semidiurnal: the area experienced two high and low tides within a lunar day, or roughly every 24 hours and 50 minutes. The tide had reached a high tide of 13.8 feet (height above chart datum) on October 12 at 2249 and was falling at the time of the initial grounding.[3] The next low tide in that area was determined to occur on October 13 around 0512 at 3.9 feet. The swell (wind-generated wave) in the area was increasing due to a weather system approaching from the west.

At 0130, the captain ordered the crew to begin moving personal, safety, and survival gear over to the *DBL 55* in case there was a need to abandon ship. At 0200, he reported the situation to the operating company dispatch via satellite telephone. About 20 minutes later, the *Cape St. James* arrived on scene to assist the crew.

According to the captain, approximately an hour or an hour and a half after the grounding, the second mate admitted, "I fell asleep," during a discussion with him about the accident. (The second mate confirmed this admission when interviewed by investigators after the accident.)

At 0240, as a precautionary measure directed by shoreside Kirby personnel, the second mate and two tankermen began to set up a transfer hose from the port bunker (fueling) station to the manifold system of the *DBL 55*. The arrangement was aligned to allow movement of diesel fuel from the multiple tanks on board the *Nathan E Stewart* to the undamaged no. 3 port cargo tank on the *DBL 55*.

At 0305, the chief engineer recommended to the captain that the port MDE be shut down, because the port keel cooler unit was out of the water; the captain acted on this request. At 0407, the chief engineer observed that the fluid level was rising in the no. 1 center fuel tank and was dropping in the no. 1 port fuel tank. The vessel's port, center, and starboard forward fuel and lube oil tanks were built integral with the hull. The forward bulkhead in the engine room was common with the aftermost bulkhead of these fuel tanks. The chief engineer suspected that either the no. 1 port fuel tank had been compromised, or the common bulkhead between the no. 1 center fuel tank and the no. 1 port fuel tank had been breached. At 0410, first responders and crewmembers observed diesel fuel in the water surrounding the grounded vessel.

[3] *Chart datum* is the level of water that depths displayed on a nautical chart are measured from, commonly the lowest astronomical tide level or mean lower low water.

The fuel release was briefed to the captain, who communicated the situation to the shoreside Kirby support team. Once they received permission from Kirby at 0415, crewmembers began to transfer the vessel's fuel from the port bunker station to the *DBL 55*.

From the time of the initial grounding through the morning hours of October 13, the falling tide, wave action, and repeated contact with the rocky bottom subjected the hull and structure of the *Nathan E Stewart*/*DBL 55* to significant static and dynamic forces. Racking, hogging, sagging, and torsional moments caused deformation of the hull and the structure of both vessels. At low tide, the bow of the *DBL 55* rested on the rocky shoreline with its stern still afloat.

Around 0530, the crew attempted to surround the vessel with an oil containment boom, which had been stored on the *DBL 55*; however, the sea state and winds caused the boom to part at one or more of the connection points and open into the surrounding water. While continuing to monitor the fuel transfer operation, the chief engineer discovered that water had begun to enter the bilge from an area near the bottom of the forward no. 1 starboard fuel tank. He estimated that the rate of flooding was initially a gallon per minute. The chief engineer did not use the vessel's fixed bilge suction system at first because the bilge contained only fuel and oil with very little water at the time. He also stated that the fluid in the bilge was in the forward area of the engine room away from the bilge suction.

An oil containment boom was deployed around the ATB following the grounding. (Photo by Canadian Coast Guard)

Pollution and Partial Sinking

Around that time, the chief engineer believed that the no. 1 starboard fuel tank was breached, but he could not determine whether the tank's fuel was entering the environment or possibly the vessel's gray water tank, which had begun to overflow.[4]

The rate of water ingress in the damaged area near the no. 1 starboard fuel tank had increased, resulting in more water entering the engine room. The 2-inch gate valve on the no. 1 starboard fuel tank subsequently failed, or possibly a fracture in the tank's bulkhead occurred, which allowed the fuel to begin entering the bilge. The rate of flooding at the time was unknown, but the captain stated that the level of the water in the engine room bilge appeared to be rapidly rising.

According to the chief engineer, the fuel transfer continued for an undetermined time. Having visibly detected fuel vapor in the air column in certain areas of the engine room, he felt that the potential for a fuel-fed fire was significant; therefore, he and the assistant engineer attempted to secure the vessel's port generator, which was online, and then began securing the watertight fittings to the engine room as well. Around that time, the water level in the engine room was "halfway up the generator," based on the chief engineer's observation.

Before the generator could be manually secured, it failed on its own. The chief engineer stated to investigators that he felt the generator failure was most likely due to the water in the engine room reaching a level where it entered the generator's turbocharger or short-circuited the electrical control system.

Between 0710 and 0735, the crew managed to set up and deploy three portable dewatering pumps (one from the vessel and two from the barge) in an attempt to dewater the engine room. At 0826, the *Bartlett #1*, a rigid-hull, inflatable boat launched from the *Bartlett*, arrived on scene with four additional portable pumps. Nearly 15 minutes afterward, the crew of the *Nathan E Stewart*, with the assistance of the Canadian Coast Guard members on scene, had the additional dewatering pumps operational and were extracting water from the engine room; however, the pumps were not able to keep up with the ingress of water. The *Bartlett* arrived on scene at 0856 and assumed the role of on-scene coordinator.[5]

Around 0927, the stern of the *Nathan E Stewart* partially submerged. The chief mate, chief engineer, and second mate were on the main deck aft. The chief mate and second mate were swept into the water by waves, while the chief engineer was swept forward and managed to grab hold of the tow winch system. The crew on the *Bartlett #1* recovered the chief mate from the water. The second mate pulled himself along the port side of the *Nathan E Stewart*, climbed the vessel's bulwark, and then proceeded onto the *DBL 55*.

The commanding officer of the *Bartlett* ordered the remaining crew on board the *Nathan E Stewart* to abandon the vessel for safety. The chief engineer, assistant engineer, and captain climbed from the bow of the *Nathan E Stewart* to the *DBL 55*. The two tankermen were already on the *DBL 55*. By 0937, the *Bartlett #1* had safely transported all seven crewmembers to the *Bartlett*. The *John P. Tully*, which had been tasked with collecting various pollution-response

[4] *Gray water* describes water that has collected from non-contaminated sources, such as sinks and showers. Water collected from toilets and other sources where the potential for contamination exist is generally referred to as *black water*.

[5] On-scene coordinators are senior government officials or other designated individuals from a response organization charged with the responsibility of monitoring or directing responses for search and rescue operations, oil spills, hazardous substance releases, or other emergency incidents.

equipment from storage locations in the Ports of Shearwater and Bella Bella, British Columbia, arrived on scene about 1114. The crewmembers of the *Nathan E Stewart* were taken ashore to Bella Bella at 1530 by a local water taxi service, concluding the search and rescue operations.

Around 1840, the *Nathan E Stewart* separated from the *DBL 55*, and the barge floated free. The *Nathan E Stewart* remained partially sunk in approximately 28 feet of water, resting on the rocky bottom with a slight list to port. The *DBL 55* was towed to an anchorage area off Dundavan Inlet by the tugboat *Haisea Guardian*. Several of the barge's void tanks were punctured, but all the cargo tanks remained intact. The operating company reported that approximately 6,554 gallons of diesel fuel—of the 59,924 gallons on board at the time of the sinking—were transferred by the crew from the *Nathan E Stewart* to the *DBL 55* before the tugboat sank.

***Nathan E Stewart*, shortly after being hoisted by the heavy-lift floating crane *D.B. General*. (Photo by Kirby Offshore Marine)**

Salvage Operations

On November 14, nearly a month after the accident, the *Nathan E Stewart* was raised by a salvage team using the heavy-lift floating crane *D.B. General* and then placed on the deck barge *MLT 4000-2* to be towed to Surrey, British Columbia. A postaccident survey of the *Nathan E Stewart* revealed extensive deformation of the bottom of the vessel's hull with multiple

penetrations in the hull plating.[6] The transverse and longitudinal hull framing was distorted throughout the vessel. The blades on the port propeller were severely damaged, as well as the shaft bracket; the propeller shaft was also bent. The starboard propeller, which was not attached to the shaft, also had severe blade damage, and the shaft bracket was missing; the starboard propeller shaft was significantly bent upwards. Both rudders were broken off. One of the JAK coupling pins was fractured and found in two pieces. The tugboat was considered a constructive total loss at an estimated value of $6.4 million.

A postaccident survey of the *DBL 55* found that the barge's external double hull was significantly damaged from its bow completely aft to the skegs on the stern. There were multiple areas where the hull plating had been inset and penetrated. Some of the framing also had been damaged, but none of the inner steel plating comprising the bottom, sides, or top of the cargo tanks had been breached. The JAK socket plates on the inside of the barge's notch showed slight damage, with the second recess (from the bottom up) on both socket plates indicating scarring and heavy contact. Repair costs for the barge were estimated at $5.6 million.

Prior to the grounding, all the vessel's vital systems were functional, and there were no indications of a mechanical failure that may have led to the accident.

The newly implemented domestic requirements for inspection of towing vessels—contained in Title 46 *Code of Federal Regulations* (CFR), Subchapter M—require that towing vessels furnished with overnight accommodations and manned by alternating watches, like the *Nathan E Stewart*, install a monitoring system that requires periodic human interaction to prevent an alarm from activating.[7] Referred to as a "pilothouse alerter system," it must be installed on all existing towing vessels no later than five years after issuance of the vessel's first certificate of inspection. To keep the system from going into an alarm mode, every 10 minutes it requires input, such as pressing a push button; it can also be linked to the vessel's steering and throttle inputs or a motion sensor on the navigation bridge. The *Nathan E Stewart* did not have a pilothouse alerter system installed at the time of the accident.

Drug tests were conducted on all seven crewmembers: the results were negative. A company representative stated that alcohol testing was performed on the crew after the accident, but those samples were lost with the vessel when it partially sank.

Based on the *Consolidated Regulations of Canada* (CRC), the Canadian portion of the Inside Passage where the accident occurred was deemed to be a compulsory pilotage area that fell under the jurisdiction of the Pacific Pilotage Authority (PPA).[8] International vessels of 350 gross tons or larger were required to hire a PPA-licensed pilot as a risk mitigation measure to ensure safe transits through the waterway. However, the law allowed for a waiver from the compulsory pilotage requirement for vessels under 10,000 gross tons that met certain conditions.

[6] Independent Maritime Consulting (Pacific) Ltd conducted the survey on behalf of the Heiltsuk First Nation. The survey was released in the Heiltsuk Tribal Council's March 2017 investigation report.

[7] Title 46 CFR, Parts 143.200(c) and 143.450. The final rules of Subchapter M, which were published by the Coast Guard on July 20, 2016, require that all towing vessels be in compliance with those regulations by July 20, 2018. The inspection of vessels and issuance of a certificate of inspection will be phased in between July 2019 and July 2022.

[8] "Pacific Pilotage Regulations," CRC, c.1270.

Kirby had such a waiver and, on February 24, 2016, obtained a renewal of the waiver from the PPA, which was valid until March 1, 2017. The waiver was granted to specific tugboats and barges in the company fleet that were operated by a list of deck officers who met the sea time requirements for the route.

The *Nathan E Stewart* and the *DBL 55* were both on the PPA list of entitled Kirby vessels, and the vessel's captain and chief mate were listed among the deck officers who satisfied the sea time requirements. The second mate, however, was not on the PPA-approved list. The captain of the *Nathan E Stewart* stated to investigators that he was not familiar with the compulsory pilotage requirements for the waterway, nor with the details of the company's waiver and its requirements. The PPA revoked Kirby's waiver from the compulsory pilotage requirements on October 16, 2016.

Under the waiver, the PPA regulations did not require a second individual to be on the navigation bridge for vessels operating in pilotage waters. However, the company's SMS required that the *Nathan E Stewart/DBL 55* have an additional watchstander in the wheelhouse with the licensed deck officer while they were under way in pilotage waters, unless that individual was making safety rounds, answering alarms, or performing other tasks of short duration.[9] Per the SMS, safety rounds should be made on an hourly basis while the vessel was under way and the captain was responsible for ensuring that they were conducted and properly logged.

There is no evidence indicating that a second watchstander was ever present on the bridge with the second mate. Had there been a second watchstander, the only valid reason to depart the wheelhouse was for safety rounds. Yet, there were no entries in the *Nathan E Stewart* logbook noting the departure of a second watchstander from the navigation bridge to perform safety rounds or other designated tasking or the return of a second watchstander after performing such duties.

The second mate graduated from California State University Maritime Academy in 2013 and earned a merchant mariner credential as a third mate of vessels of unlimited tonnage upon oceans, with towing endorsement. Since his graduation, he had worked with Kirby as an ordinary seaman/able-bodied seaman from October 2013 through June 2014. He rejoined the company as a mate in April 2015 and continued this employment through the time of the accident. He joined the crew of the *Nathan E Stewart* 24 days before the accident, on September 20, 2016; since that time, he made two northbound transits on the ATB via the Inside Passage and one southbound transit previous to the accident. Prior to his employment with Kirby, he had worked as a deckhand on a commercial fishing vessel.

Postaccident Actions

After performing a Pilotage Risk Management Methodology following the casualty, the PPA issued a revised version of the organization's "Pilotage Waiver Standard of Care" on September 15, 2017. These revised guidelines, which applied to all waiver-holders, modified the requirements for obtaining a waiver by requiring that a minimum of two people be present on the navigation bridge of vessels operating under a PPA waiver when in pilotage waters. It also mandated that all waiver-holders have an installed pilothouse alerter system set to alarm at intervals of 10 minutes or less.

[9] Kirby Marine, *Common Procedures Manual*, "Bridge and Deck Management," CPRM.07.23 (Minimum Number of Persons Required on Watch).

Kirby implemented several similar measures, such as a "Wheelhouse Assessment Program," to provide direct oversight of the captain and crew of each towing vessel. Under the program, a senior qualified captain rides along on each vessel for 10 consecutive days evaluating navigation procedures, change of watch routines, and bridge-layout ergonomics, in addition to conducting an overall internal audit of the vessel and crew performance. The company also outfitted all vessels in the offshore fleet with a pilothouse alerter system that meets the standards in Subchapter M and implemented a training program for all navigation team members to operate the ECS and associated software. Additionally, captains and mates must attend a 5-day simulator training program in Houston, Texas, designed as a high-intensity approach to navigation techniques and navigational decision making. Besides these changes, port captains for each Kirby operational region now conduct random vessel ride-alongs and evaluations of the captain and crew, in addition to the measures mandated by the Wheelhouse Assessment Program. Lastly, Kirby implemented an external, third-party audit program that examines navigation watch procedures, alarm reporting requirements, and training sessions the company calls "safety summits."

Analysis

Safety management systems are intended to mitigate the risk associated with vessel operation, but the procedures and processes outlined in each system must be successfully implemented and applied by all crewmembers. It is the company's overall responsibility to ensure that the system is implemented and maintained at all levels of the organization, both ashore and aboard each vessel. On board the vessel, the captain is responsible for motivating the crew to comply with the provisions of the SMS and, ultimately, for ensuring that the procedures and processes are followed. Kirby's SMS had written procedures that required an additional watchstander in the wheelhouse with the licensed deck officer while the vessel was operating in pilotage waters.

Based on the statements of the crew as well as the lack of documentation in the vessel's logbook or elsewhere regarding the performance of the safety rounds (which would have documented that someone was leaving and returning to the wheelhouse), there is no evidence to support the conclusion that this SMS procedure was implemented on board the *Nathan E Stewart*. Although the company's SMS addressed the identified risks associated with the potential incapacitation of the navigating officer, those procedures were not adhered to by the captain and crew on board.

The second mate stated that at the time of the accident he was not taking any prescription medications and had only brought on board a bottle of ibuprofen in case he experienced any back pain or a headache. He claimed that he had never been diagnosed with any sleep-related disorders and felt that he had "adequate" rest during the 3 days preceding the accident. He said that on the underway watch rotation he would normally sleep from the time he completed his early morning watch at 0400 until 1115, and then again for a second period of rest around 1900 before awakening to assume the 2400–0400 watch.

Work/Rest Schedule for Second Mate of *Nathan E Stewart*

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
OCTOBER 2	3	4	5	6	7	8
0001–0400	0400	0400	0400	0400	0400	0400
1000–1600	1000–1600	1000–1600	1200–1600	1200–1600	1200–1600	1200–1600
2200–	2200–	2359–	2230–	2359–	2300–	2200–
(12 hours)	(12 hours)	(10 hours)	(9.5 hours)	(8 hours)	(9 hours)	(10 hours)
9	10	11	12	13		
0400	0400	0400	0400	0108		
	1201–1300					
1000–1600	1300–1600	1000–1600	1000–1600			
2200–	2200–	2200–	2300–			
(12 hours)	(10 hours)	(12 hours)	(11 hours)	(1 hour)		

The schedule that the second mate worked a week and a half prior to the accident on October 13 at 0108. It begins with the navigation watch he had already assumed on October 1 at 2200. In addition to his scheduled shifts, he participated in a mandatory fire drill on October 10 between 1201 and 1300.

Although the second mate was aware of the ECS's cross-track error alarm function, he was not using that navigation tool on the night of the accident. According to the second mate, it was normal practice for the navigation team to not utilize that tool. Had it been utilized, the ECS would have entered into an alarm mode after the second mate missed the port course change required near Ivory Island at 0053. Based on time, speed, and distance calculations, the alarm would have activated at approximately 0055 and thereby provided ample time for the second mate to take corrective action to return the *Nathan E Stewart* to the intended track.

The second mate had fallen asleep sometime after 0024, based on the last-known control input near Salal Island. When investigators asked him why he missed the course change at Ivory Island, he stated simply that he had fallen asleep. It is unknown whether the frequent variation between the two watch-rotation schedules, or other factors that could have impacted his circadian rhythm, influenced his sleep/wake cycles. It is known, however, that the second mate had awakened and relieved the captain earlier than usual and lost an hour of sleep during his second rest period.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the grounding of the articulated tug and barge *Nathan E Stewart/DBL 55* was the second mate falling asleep while on watch. Contributing to the grounding was the ineffective implementation of the company's safety management system procedures for watchstanding.

Vessel Particulars

Vessels	*Nathan E Stewart*	*DBL 55*
Owner	Kirby Offshore Marine	Kirby Offshore Marine
Operator	Kirby Offshore Marine	Kirby Offshore Marine
Port of registry	New York, New York	Portland, Oregon
Flag	United States	United States
Type	Towing vessel	Tank barge
Year built	2001	2011
Builder	Hope Services	Zidell Marine
Official number (US)	1120997	1229343
Classification Society	N/A	American Bureau of Shipping
Construction	Steel	Steel
Length	95.3 ft (29 m)	287.5 ft (87.3 m)
Draft	12 ft (3.6 m)	8 ft (2.4 m)
Beam/width	32 ft (9.7 m)	77.7 ft (23.7 m)
Gross tonnage	116	4,717
Engine power	3,400 hp (2,535 kw)	N/A
Propulsion	2 – Cummins KTA50 M2 main diesel engines	N/A
Persons on board	7	N/A

NTSB investigators worked closely with our counterparts from Coast Guard Sector Puget Sound throughout this investigation.

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID DCA17RM001.

Issued: November 21, 2017

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).