Issued March 7, 2023 MIR-23/05

Breakaway of Moored Mobile Offshore Drilling Unit *VALARIS DS-16* and Subsequent Collision with Cargo Vessel *Akti*

On March 12, 2022, about 0020 local time, the mobile offshore drilling unit *VALARIS DS-16* was in layup status at the ST Engineering Halter Marine and Offshore Shipyard in Pascagoula, Mississippi, when it broke away from the dock, drifted across the Bayou Casotte channel, and collided with the bulk cargo vessel *Akti* moored at the Chevron Refinery dock no.6.[1] There were no injuries reported for the 164 crewmembers and personnel on board the *VALARIS DS-16* or the 22 crewmembers on board the *Akti*, and there was no pollution reported. The total damage resulting from the breakaway was estimated at $5 million.

Figure 1. *VALARIS DS-16* after the casualty. (Source: US Coast Guard)

[1] (a) In this report, all times are central standard time, and all miles are nautical miles (1.15 statute miles); (b) visit ntsb.gov to find additional information in the public docket for this NTSB investigation (case no. DCA22FM013). Use the CAROL Query to search investigations.

Casualty type	Collision
Location	Bayou Casotte, Pascagoula, Mississippi 30°20.1′ N, 88°30.57′ W
Date	March 12, 2022
Time	0041 central standard time (coordinated universal time –6 hrs)
Persons on board	164 (*VALARIS DS-16*), 22 (*Akti*)
Injuries	None
Property damage	$5 million est.
Environmental damage	None
Weather	Overcast skies, winds north-northwest 30-35 kts, gusts 45-50 kts, air temperature 53°F
Waterway information	Bayou, average depth 42 ft, average width 350 ft

Figure 2. Area where the *VALARIS DS-16* collided with the *Akti* as indicated by a red *X*. (Background source: Google Maps)

1. Factual Information

1.1 Background

The Marshall Islands-flagged, 752-foot-long *VALARIS DS-16* was a steel-hulled mobile offshore drilling unit (MODU), a vessel capable of engaging in drilling operations for exploration of subsea resources. The diesel-electric vessel was built in 2014 and was powered by six diesel engines, each driving a connected electrical generator. Propulsion was provided by six azimuthing thrusters, which could be retracted above the keel when not in use or when the vessel was in shallow waters. The draft of the *VALARIS DS-16* was about 49 feet with the thrusters extended and about 28 feet with the thrusters retracted. The vessel was equipped with a dynamic positioning system to maintain its position while drilling in deep water.

1.2 Casualty Events

In August 2020, the *VALARIS DS-16* was taken out of service and laid up in Las Palmas, Spain. On December 6, 2021, the MODU departed Spain en route to the ST Engineering Halter Marine and Offshore (STEHMO) Shipyard, located on the west bank of Bayou Casotte in Pascagoula, Mississippi, for reactivation (return to the market). The shipyard was built in 1998 and purchased by STEHMO in August 2017; the STEHMO dock ran in a north/south direction, and the water depth alongside ranged from 24 to 42 feet. Across the channel from the shipyard to the east were several refinery docks used for petroleum transfers.

In preparation for the *VALARIS DS-16*'s arrival, the shipyard's engineering department emailed a sample mooring plan for the MODU's location at their facility to the vessel's operating company on December 21, 2021. The operating company requested that shipyard engineers provide soundings or depths at the facility and "bollard details (pull strength, etc.)." Shipyard engineers provided a document with water depths; however, they did not have any records for pull test ratings specifically conducted on the bollards. They did have a bollard pull certificate for 154 metric tons (169.8 tons) from a tugboat's bollard pull test using one of the pier's bollards, and this certificate was provided by STEHMO.[2] The sample mooring plan from the shipyard recommended the vessel dock port side to the pier, using mooring lines provided by

[2] (a) One metric ton is equivalent to 1.1 short tons. (b) Bollard pull is a measure of the pulling capability of a vessel at zero speed and is typically required for ship assist tugs. It is determined by connecting the tested vessel to a pier bollard with a line and calculating the force (measured in metric tons) developed using a load cell.

the vessel. On the dock, there were 14 bollards, each spaced between 120 and 200 feet apart. The bollards were numbered north to south, ranged from 52 to 84 inches high, and contained various horn quantities, sizes, and positions. According to the proposed mooring plan, the bow of the *VALARIS DS-16* was to be located adjacent to bollards 6 and 7 with the vessel at a heading of 012°, facing in a northerly direction, using bollards 5 through 12 to tie up the vessel.

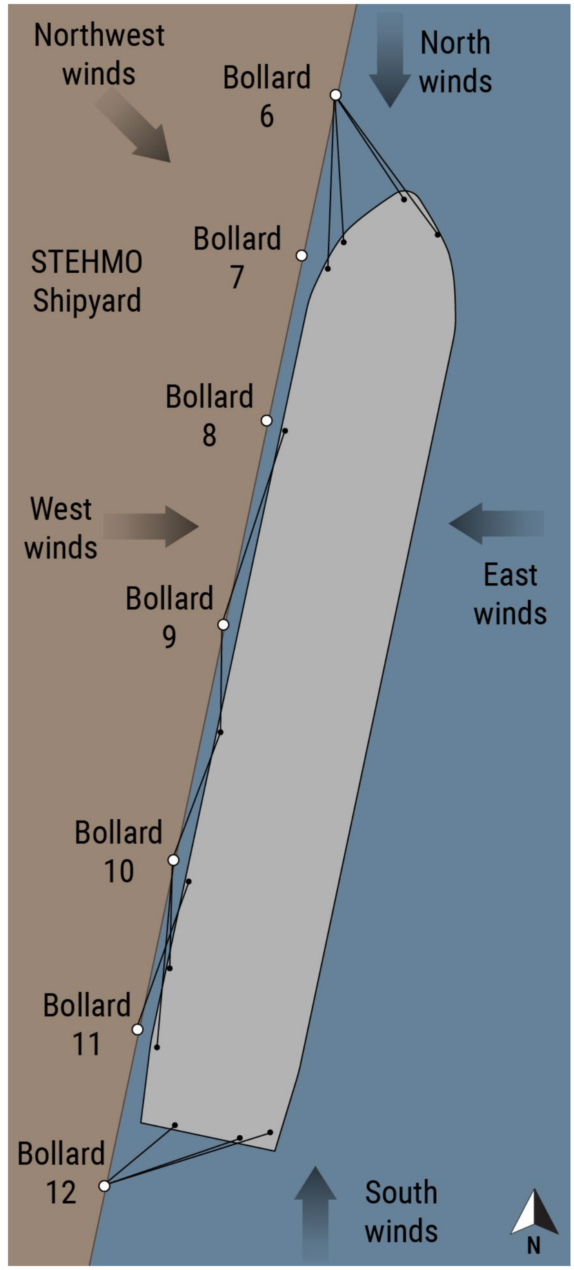

Figure 3. Representation of planned mooring arrangement for *VALARIS DS-16* used for mooring analysis with principal wind directions shown (scale approximate).

Before the vessel's arrival in Pascagoula, the captain worked with engineers from the *VALARIS DS-16*'s operating company to conduct a "Quayside Mooring Analysis" for the location. The captain modified the shipyard's sample plan to what he believed to be a "better arrangement" because "they were limited due to the spacing of the bollards." The analysis was based on mooring the vessel with four lines from its bow to bollard 6; six lines along midship attached to bollards 9,10, and 11; and three stern lines aft to bollard 12. This plan was approved by the operating company engineers and was sent to the shipyard by the captain. The analysis also defined limiting wind speeds for eight principal directions in 45° increments (north, northeast, east, southeast, south, southwest, west, northwest) and provided guidance that if the forecasted environment exceeded the limits defined by the mooring analysis, "the vessel shall drop anchor and call tugs alongside for assistance." The limiting wind speed for north winds was 60 knots, and the limiting wind speed for northwest winds was 34 knots. The limiting wind speeds were based on 1-minute sustained wind speeds.

The operating company's mooring analysis identified critical components in the mooring configuration in an intact condition. For a north wind, bollard 6 was identified as a critical component; the limiting sustained wind speed was 60 knots, and the calculated load on the bollard was 61 metric tons (67.2 tons). Bollard 6 was also identified as a critical component for a northwest wind; the limiting sustained wind speed was 37 knots, and the calculated load on the bollard was 131 metric tons (144.4 tons). Additionally, the mooring analysis calculated the effects of a single damaged mooring line: with a north wind and a damaged forward-leading midship line connected to bollard 10, the limiting sustained wind speed remained at 60 knots, the critical component was bollard 6, and the calculated load on the bollard increased to 74 metric tons (81.6 tons). With a northwest wind and damage to a bow line, the limiting sustained wind speed was reduced to 34 knots, with 117 metric tons (130 tons) calculated on bollard 6.

Table 1. Limiting wind speeds from eight principal directions. (Data source: Valaris)

Wind Heading (From)	Limiting Wind Speed (1-minute sustained)	Limiting Configuration
South	60 knots*	Intact
Southeast	55 knots**	Intact
East	50 knots**	Intact
Northeast	55 knots**	Intact
North	60 knots*	Intact
Northwest	34 knots	Single-line damaged
West	32 knots	Single-line damaged
Southwest	37 knots	Single-line damaged

*Study limited to 60-knot sustained wind speeds
**These directions limited by quayside fender compression

The *VALARIS DS-16* arrived at the STEHMO Shipyard on January 6, 2022, and was moored port side to the pier in accordance with the operating company's mooring analysis plan. Due to water depth limitations along the dock, all six of the vessel's thrusters were retracted above the keel before mooring, rendering propulsion unavailable even with the diesel generators online (the captain estimated that it would take about 2 hours in an emergency to lower the thrusters into operational position, but there was not enough clearance at the STEHMO dock to lower them). There was no shore power connection available, so the *VALARIS DS-16* provided its own electrical power using its diesel generators.

While the vessel was in lay-up, numerous equipment operators, welders, vendors, and contractors boarded and lived aboard along with the vessel's crewmembers while performing maintenance and repairs. Watchstanding deck officers and deckhands were assigned to 12-hour watches, changing over at midnight and noon, and an additional deck officer worked a daytime shift from 0600 to1800 due to the daily operations on and around the vessel. While on watch, one deck officer was stationed on the bridge to monitor fire and gas detection systems and bilge alarms and manage the vessel's power requirements. According to the captain, the deckhands made continuous roving rounds, overseeing jobs, checking mooring lines, and "maintaining [the] gangway's integrity."

Updated weather forecasts were sent to the bridge computer every 6 hours and were available to the deck officers on watch. Each morning the captain accessed and reviewed the daily weather forecast email provided by a commercial weather service. On January 16, 2022, due to forecasted weather with increased winds from the west, the *Signet Reliance,* a 5,000-hp tug, was mobilized to hold the vessel alongside throughout the weather event.

About a week before the casualty, the captain became aware of a cold front with strong winds predicted for the early morning hours of March 12. The captain continued to monitor the forecast throughout the week.

On March 8, a semisubmersible rig arrived and was docked to the north of the *VALARIS DS-16*. Two of its stern mooring lines were added onto the bottom of bollard 6, and the mooring lines from the *VALARIS DS-16* were shifted to the upper section of the bollard.

On March 11 at 1800, the commercial weather service emailed a weather "daily planner" that called for 25-knot north-northwest winds and 35-knot gusts at midnight on March 12, and 30-knot north-northwest winds and 44-knot gusts at 0600 later that morning. According to the captain, he had not seen any winds of that speed since the vessel arrived in January at the shipyard. About 2100, in anticipation of the strong winds, the *VALARIS DS-16* crew relocated an aft-leading mooring line from bollard 9 to bollard 7 to serve as a forward-leading spring line supporting the bow lines to hold the vessel more effectively against the predicted north-northwest winds. The captain stated that there were no other adjustments available to improve the mooring arrangement for the *VALARIS DS-16*, as bollard 7 was behind the bow, and believed that their mooring lines would not have reached bollard 5.

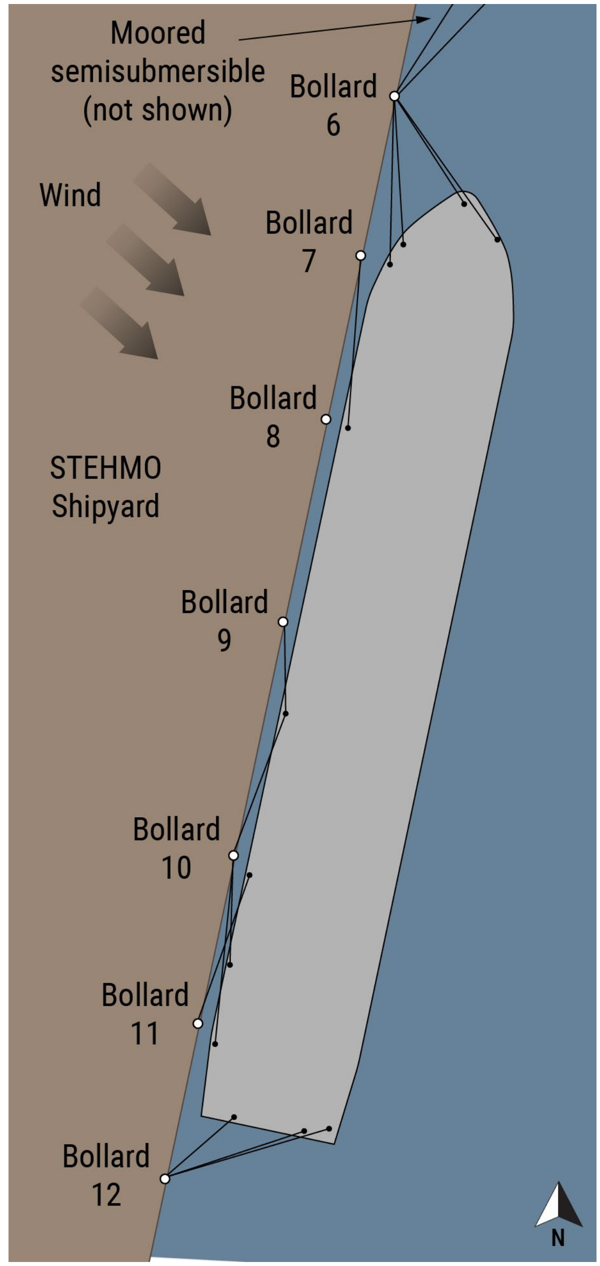

Figure 4. Representation of mooring arrangement at time of casualty. Wind direction estimated. (Scale approximate.)

The crew also prepared the port anchor for deployment, and the chief mate conducted training on how to properly let go of the anchor. The captain verified that the predicted sustained winds and direction were below the limitations of the operating company's mooring analysis. Deckhands were instructed to check the mooring lines every hour from the dock, and, as the winds increased, to remain on the dock to monitor how the lines were being loaded. About 2300, the weather frontal system began passing through the area with 30-knot northwest sustained winds from the direction of 312°.

Just after the midnight shift change, about 0020 on March 12, the captain was awoken by what he believed to be the sound of a mooring line snapping and the feeling that the vessel had shuddered. He arrived on the bridge as the officer on watch was calling his stateroom. According to crewmembers, bollard 6, which secured the *VALARIS DS-16*'s four bow lines and the semisubmersible rig's two stern lines, had broken free from the dock at its base, and the bow of the *VALARIS DS-16* was blown away from the dock.

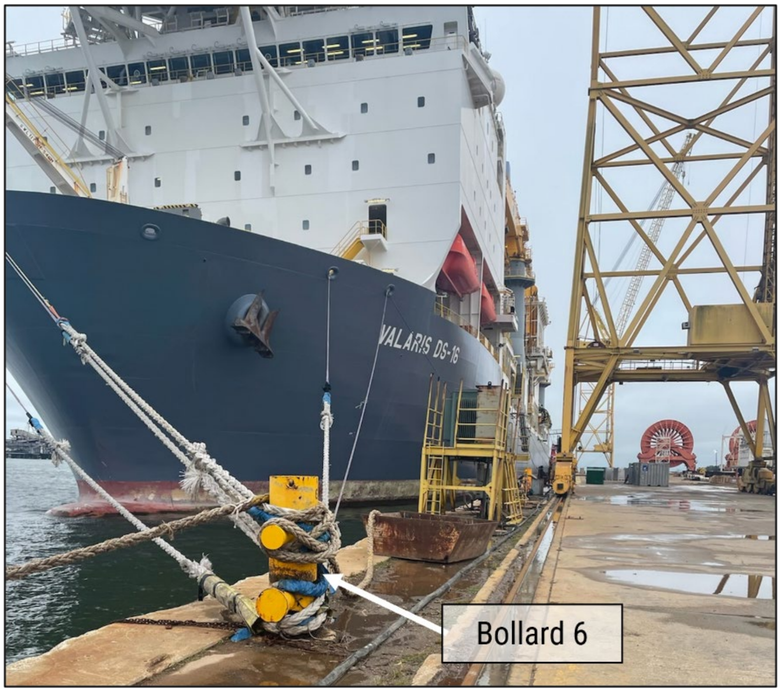

Figure 5. *VALARIS DS-16* moored at STEHMO Shipyard at unknown date before the casualty with lines secured to bollard 6 (before lines were adjusted for the March 12 strong winds). (Source: *VALARIS DS-16* captain)

As the bow of the vessel began to peel away from the pier, the remaining mooring lines parted. The vessel began to drift into the channel in an east-southeast direction. The captain sounded the general alarm to alert the crew, hailed nearby tugboats for assistance, sounded multiple blasts on the ship's whistle to attract the attention of any vessels in the immediate area of the danger, and alerted the *VALARIS DS-16*'s crew to prepare for the possibility of contact with vessels moored on the opposite (east) side of the channel. The chief mate radioed nearby vessels on VHF channel 16 and advised of the vessel's breakaway and uncontrolled movement across the channel. At 0025, the deck crew released the port anchor. All crewmembers and personnel on board were mustered, and the radio operator confirmed that all persons were accounted for (two deckhands who were monitoring the mooring lines from the dock were unable to return to the vessel throughout the event).

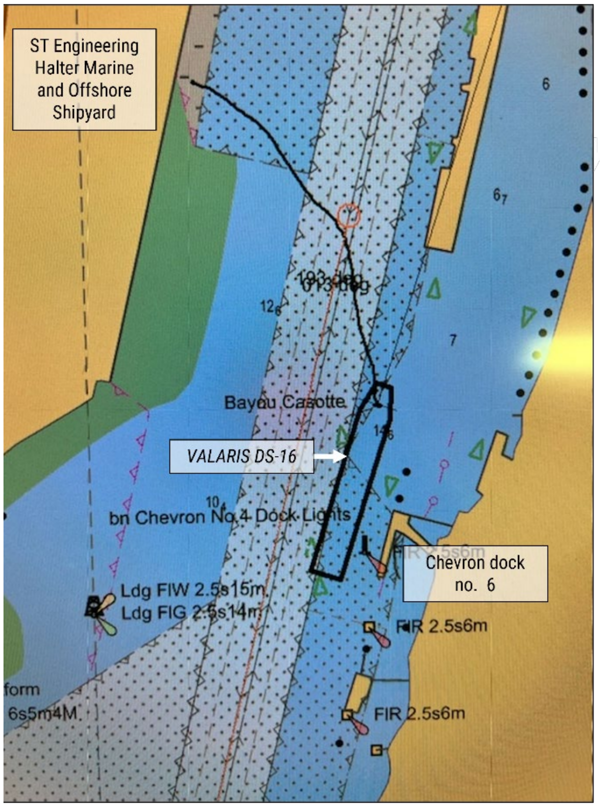

Figure 6. *VALARIS DS-16*'s path as it drifted across Bayou Casotte on March 12. (Background source: *VALARIS DS-16* electronic chart display and information system)

About 0035, the port anchor fetched up (dug into the seabed). A few minutes later, the crew lowered the starboard anchor, and it fetched up. The vessel's movement was slowed to the south-southeast toward Chevron dock no. 6, where the 623-foot-long, steel-hulled cargo vessel *Akti* was moored with its bow facing south (port side to the pier). The vessel had arrived in Pascagoula the previous day (March 11) to load petroleum coke; loading operations had begun at 1648 and ceased at 2205 due to rain.

Several tugboats arrived to assist the *VALARIS DS-16* and began pushing against the drifting vessel, attempting to stop the MODU's movement. According to the captain, after the anchors fetched up, the *VALARIS DS-16* stopped drifting, but the tugs were not able to completely stop the vessel's stern from moving toward the *Akti*. The captain of the *VALARIS DS-16* alerted the *Akti*'s crew of the impending collision via VHF radio.

At 0041, the starboard side of the *VALARIS DS-16* made contact with the starboard side of the moored *Akti* and came to rest alongside the cargo vessel. Crewmembers inspected their respective vessels for damage, sounded all tanks, and made required casualty notifications. The *VALARIS DS-16* remained alongside the *Akti* until the MODU could be safely moved back to the STEHMO dock later that afternoon.

Figure 7. Postcasualty photos showing *VALARIS DS-16* alongside the *Akti* after making contact (*left*) and the remaining base of bollard 6 after breakaway (*right*). (Source: Coast Guard)

1.3 Additional Information

1.3.1 Damage

As a result of the collision, the *VALARIS DS-16* sustained damage to the riser handling system, deck fittings, transfer hose-reel system, walkways and platforms, and other equipment on board. A bulwark panel was deformed on the starboard side, and insets on the side shell plating and port stern were also noted. Divers found no damage to the underwater portion of the hull during an underwater inspection. Damages were estimated at $4.2 million.

The *Akti* sustained damage to the starboard-side bridge wing, handrails, deck coaming, side shell plating, and lighting fixtures. Damages were estimated at $778,000.

STEHMO estimated the cost to replace bollard 6 at their facility at $20,000. The bollard was not recovered from the channel after it broke away. There were no reported damages to Chevron dock no. 6 where the *Akti* was moored.

1.3.2 Mooring Lines

The mooring lines used on the *VALARIS DS-16* were placed into service in 2020 and visually inspected monthly. Each mooring line was 30 millimeters in diameter and had a rated breaking strength of 76 tons. The 8-strand lines were constructed with polypropylene resin and polyester yarn. Each of the lines had an

11-meter (36-foot) "stretcher"—a thicker elastic polypropylene, which was designed to add 1 meter (about 3 feet) of stretch to the line while under load. All of the mooring lines were stopped off and then placed on the vessel's mooring bitts. The *Valaris DS-16* was not equipped with self-tensioning winches of any type.

After the casualty, the four mooring lines that had been used to secure the *VALARIS DS-16*'s bow to bollard 6 were found to be intact. All other lines used to tie up the vessel had parted.

1.3.3 Shipyard Bollards

Construction drawings from 1997 showed that the bollards at the STEHMO Shipyard were to be constructed of studded steel pipe that was 20 feet long and 18 inches in diameter with a wall thickness of 0.75 inches. The pipe was then to be filled with concrete and set into another pipe that was 95 feet long, 34 inches in diameter, and 0.5 inches thick, and filled with concrete in the upper 30-foot section. The top of the bollard was designed to extend 2 feet 2 inches (bollard pipe) above the larger diameter pipe (casing pipe) with a concrete crown with a single set of 8-inch horns extending 8 inches on either side.

At unknown dates before STEHMO acquired the facility, the bollards were replaced or modified to different configurations with increased height and additional vertical sections and horns to accommodate more mooring lines. At some point, three of the bollards were replaced with larger, 24-inch-diameter bollards that had bolted, flanged bases. There were no records of these modifications. There were no policies or procedures addressing the frequency of inspections for the shipyard's bollards, nor were there any statutory requirements for inspections.

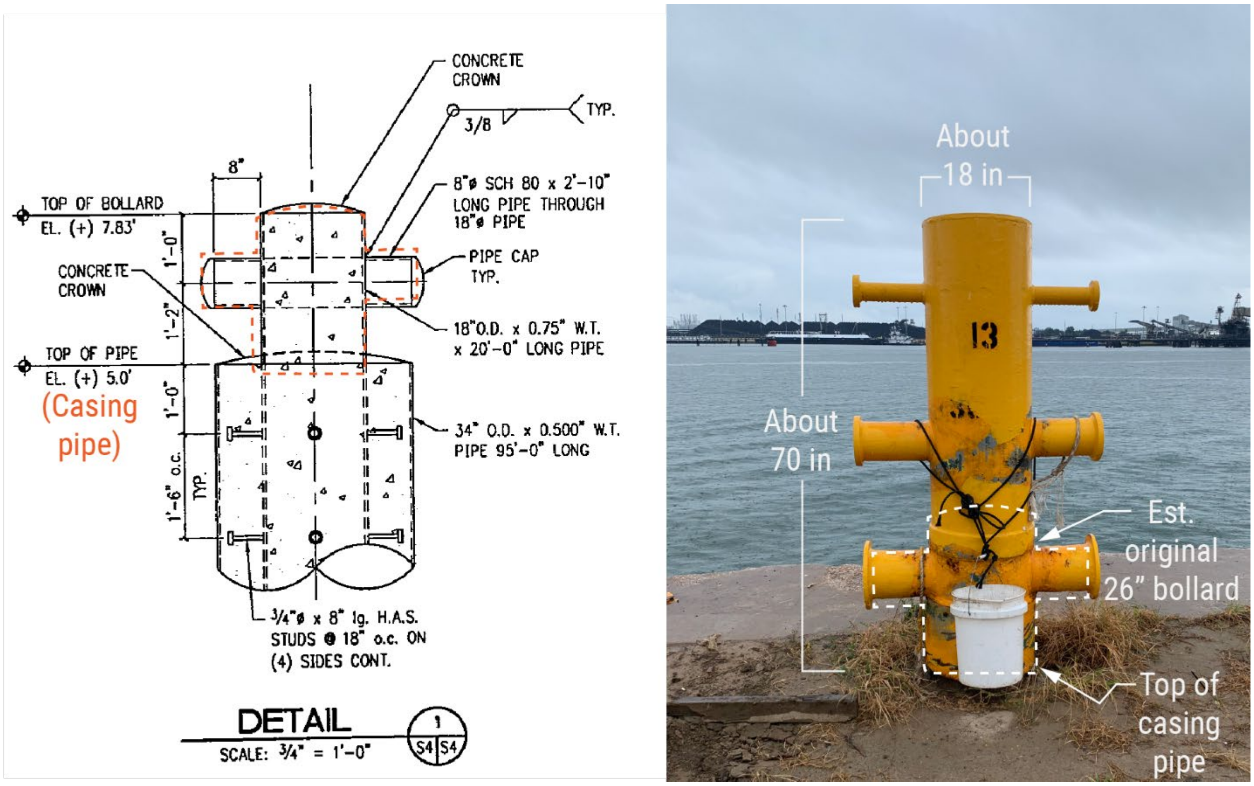

Figure 8. 1997 construction plans for bollards (*left*) and a modified bollard in October 2022, 7 months after the casualty (*right*). (Background sources: STEHMO [*left*], Coast Guard [*right*]).

Each of the bollards used by the *VALARIS DS-16* was stenciled with its corresponding number and "300T," indicating an assumed safe working load of 300 tons. According to shipyard managers, the bollards were stenciled before STEHMO acquired the shipyard. Before the casualty, on December 24, 2020, a static pull test was performed to determine the bollard pull capacity of a tugboat using one of the bollards at the STEHMO shipyard; the test was witnessed by a surveyor. The resulting certificate for the tug did not indicate which bollard was used for the pull test. The rated static bollard pull of the tugboat was calculated to be 154.5 metric tons (170.3 tons). As stated earlier in this report, this test certificate was sent to the engineers at the *VALARIS DS-16*'s operating company for docking analysis.

Figure 9. Bollards 7, 8, and 9 at STEHMO Shipyard after the casualty.

Following the casualty, on March 23, 2022, ultrasonic thickness tests were completed on 13 bollards at STEHMO Shipyard. Testers attempted to take eight measurements in 45˚ increments 12 inches from the top and 2 inches from the bottom of each bollard. Several bottom measurements could not be taken due to obstructions. Fifteen measurements at the bottom of the bollards were less than 0.25 inches thick. Investigators measured the steel of the remaining base of bollard 6 and found it to be less than 0.25 inches on the side farthest from the the edge of the pier. Additionally, investigators found many of the bollards exhibited signs of wastage and external corrosion: bollard 9 had a steel doubler patch around a portion of the base over a smaller-diameter steel pipe showing signs of external corrosion, and bollards 7 and 9 had steel wire and chains around their bases from which fendering equipment was hung.

Figure 10. Steel chain wrapped around base of bollard 7 after the casualty. (Source: Coast Guard)

1.3.4 Weather

The National Weather Service Storm Prediction Center identified the cold front moving eastward across the southern United States and from west to east across Pascagoula about midnight on March 12, allowing for showers, storms, and gusting northwest winds behind the front.

Trent Lott International Airport (KPQL) in Pascagoula, Mississippi, located 8 miles north of the casualty site, was the closest official weather station. Observations from the airport at the time of the breakaway indicated wind speed at 12 knots with gusts as high as 24 knots from 320° (northwest direction) and a peak wind of 27 knots from 340° (north-northwest direction).

In the 30 minutes leading up to the time of the breakaway, the wind speeds recorded by the *VALARIS DS-16*'s four wind sensors averaged between 25 to 35 knots (depending on the height above the waterline each sensor was located on the vessel). During this time, the sensors indicated the winds affecting the vessel from the north-northwest direction, about 325°. The highest recorded 1-minute observed wind speeds at the time of the breakaway were about 45 knots on wind sensor no. 4, located on the vessel's forward radar mast about 168 feet (51 meters) above the waterline, and 51 knots on wind sensor no. 2 on the derrick, about 303 feet (97 meters) above the waterline. According to calculations by the operating company, the 45-knot, 1-minute sustained wind speed on the forward radar mast was equivalent to a 37.8-knot wind speed at 10 meters (32.8 feet) above the waterline.

1.3.5 Previous US Coast Guard Safety Alert

In May 2018, as a result of several bollard failures and subsequent vessel breakaways, the US Coast Guard published Safety Alert 06-18: "Don't Let Your Vessel Get Underway Unexpectedly," which discussed bollard failures at marine facilities.[3] The alert stated that

> …in several cases the underlying deficient material condition of the bollards was unknown until the failures occurred… Typically, the failures are associated with abnormal dynamic loads transferred to the bollard from a vessel. The abnormal loads are oftentimes caused by excessive winds acting against the sail area of vessels… Also, vessel operators often encounter facilities that have an insufficient number of bollards or not enough bollards in the correct locations to ensure good marine mooring practices are followed.

The Coast Guard recommended that "facility owners and operators take steps to develop a routine inspection program for bollards and other mooring equipment. Furthermore, vessel personnel should report discoveries of apparently deficient shoreside mooring equipment to facility managers." The safety alert acknowledged that neither the Coast Guard nor the Occupational Safety and Health Administration had regulatory oversight over bollards.

The US Army Corps of Engineers, Naval Facilities Engineering Command, and Air Force Civil Engineer Center developed a handbook in 2001, which was later updated in 2020—Unified Facilities Criteria "Mooring Hardware Inspection" UFC 4-150-08—that provided naval facilities guidance for the planning, inspection, assessment, and reporting of mooring hardware conditions.[4]

1.3.6 Postcasualty Actions

Shortly after the breakaway, the operating company for the *VALARIS DS-16* revised the vessel's mooring analysis while moored at the STEHMO Shipyard and

---

[3] US Coast Guard, "Don't Let Your Vessel Get Underway Unexpectedly! Bollard Failures at Marine Facilities," (Marine Safety Alert 06-18, May 30, 2018), https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/INV/Alerts/0618.pdf?ver=2018-05-30-135040-633.

[4] Department of Defense, Unified Facilities Criteria (UFC), "Mooring Hardware Inspection," (UFC 4-150-08, October 28, 2020), https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-4-150-08.

decreased the sustained wind speed limitations to 20 knots (from the north, northwest, west, southwest, and south directions). Additionally, the company completed a root cause analysis of the incident. The analysis used a calculated value of 37.8 knots from a 312° relative direction as the highest 1-minute sustained observed speed for 10 meters (32.8 feet) above the waterline. Four configurations were analyzed:

- the precasualty mooring analysis
- the precasualty mooring analysis with two additional semisubmersible mooring lines added to bollard 6
- the mooring arrangement after moving a mooring line from bollard 9 to bollard 7
- the mooring arrangement with the shifted mooring line from bollard 9 to bollard 7 with two additional semisubmersible mooring lines on bollard 6

In each of the cases, the highest calculated load on bollard 6 was 141 tons. The analysis determined that the forces applied to bollard 6 due to the addition of two mooring lines from the semisubmersible rig docked to the north of the *VALARIS DS-16* were minimal given the wind direction and mooring arrangement at the shipyard. The company developed three corrective actions to prevent similar events from occurring: (1) the company planned to develop formal shipyard audits to include reviews and verifications of bollard certifications, maintenance, and testing; (2) the company's mooring analysis format would be amended to include explicit detail concerning environmental limitations and vessel-specific wind sensor locations; and (3) the company would institute a mandatory review of approved mooring analyses between the vessel's offshore and shore-based management teams.

As of the publication of this report, the STEHMO Shipyard has replaced 10 of the 14 bollards on the pier, with plans to replace an eleventh bollard by the end of March 2023. Shipyard managers have begun evaluating the safe working load of the new bollards and scheduling a pull test using a tugboat.

2. Analysis

Before the *VALARIS DS-16* arrived in Pascagoula, the vessel's operating company completed a mooring analysis, which identified the critical components in the mooring arrangement and sustained wind speed limitations for the eight principal wind directions. The mooring analysis considered the loss of a single mooring line and calculated critical components (the analysis did not consider the unlikely event of losing a bollard). According to the mooring analysis, because the *VALARIS DS-16* would be moored with its bow facing a northerly direction (012°), the vessel would be most vulnerable to wind forces from the west, which would exert pressure directly on the port side of the vessel (winds from the east would have exerted pressure on the starboard side, blowing the vessel against the dock). The mooring analysis determined this vulnerability and calculated the limiting sustained wind speed to 34 knots with northwest winds and 60 knots with north winds. The vessel's crew was directed to drop anchor and call tugs alongside for assistance if they expected the limitations to be exceeded.

About a week before the casualty, the captain was notified of a weather system (which would be moving through the area where the MODU was moored on March 12) with predicted 25- to 30-knot north-northwest winds and gusts up to 44 knots. The vessel had been moored at the shipyard for over 2 months, and according to the captain, it had not previously been exposed to winds of that force from that direction while he was aboard. The maximum predicted winds and direction for the March 12 cold front were less than the limitations of the mooring analysis, and the captain believed that additional measures (beyond preparing the port anchor, shifting a mooring line, and monitoring the mooring lines with deckhands on shore), such as a tug to support the vessel alongside, were not needed. On the evening of March 11, the crew reconfigured the mooring arrangement by relocating one aft-leading mooring line and shifting it to have a forward lead in preparation for the predicted north-northwest winds, which would push the vessel away from the dock, and checked the mooring lines hourly to prevent unequal loading. When the cold front passed through the area, the *VALARIS DS-16* was exposed to 30- to 40-knot winds from the north-northwest (verified by a 1-minute observed wind speed of 37.8 knots as calculated for 10 meters [32.8 feet] above the waterline), not directly on the vessel's most vulnerable side: its beam. Due to the northerly component of the wind direction at the time of the breakaway, the operating company's engineers calculated vessel mooring analysis limitations were not exceeded. Therefore, the *VALARIS DS-16*'s mooring arrangement should have been sufficient to secure the vessel to the dock.

During elevated sustained winds, bollard 6, which secured the *VALARIS DS-16*'s four bow lines and a semisubmersible rig's two stern lines, broke free at its base, and was pulled off the pier into the water. After the casualty, ultrasonic thickness tests performed on the remaining bollards in the area where the *VALARIS DS-16* was moored indicated that there was deteriorated steel at the lower portion of several bollards. The broken top of bollard 6 was not recovered from the channel and was not analyzed, but a postcasualty measurement of the remaining 18-inch-diameter base of the bollard showed that the steel wall thickness was less than 0.25 inches on the side farthest from the the edge of the pier—an apparent reduction in thickness of about 0.5 inches (original bollard design drawings showed a wall thickness of 0.75 inches). Additionally, several bollards showed signs of external corrosion and wastage: steel wires and chains were looped around the bases of bollards from which pier fenders hung, causing chafing and wear.

Investigators found that although each of the bollards used by the *VALARIS DS-16*, including bollard 6, was stenciled with a "300T" marking, likely to indicate they could safely sustain a working load of up to 300 tons, there were no records of any pull tests that could confirm this stenciled safe working load. Additionally, there were no records of any modifications to the bollards, nor tests, inspections, or maintenance conducted on the bollards, with the exception of a bollard pull test for a tugboat that resulted in a load of 154.5 metric tons (170.3 tons) applied to an unknown bollard in December 2020. Further, all the bollards used by the *VALARIS DS-16* had been modified from the original 1997 design, and vertical components (for which there were no engineering records) were added to each of the bollards to accommodate more lines. The bollard pipes' overall height increased from just over 2 feet (26 inches) to anywhere from about 4 to 7 feet—about 2 to 5 feet higher than originally designed—with additional horns for mooring lines added well above the height of the horns on the original design. The additional horns allowed for mooring lines to be placed higher on bollards than planned for in the original design. As the height of a bollard (or its horns) increases, the horizontal or up-leading pull on the upper portion of the bollard significantly increases the moment of force applied to the base of the bollard.[5] Therefore, bollard 6—and many of the other bollards used to secure the *VALARIS DS-16*'s mooring lines—were likely incapable of sustaining the working loads of their original design.

Observations from the nearby Pascagoula Airport weather station indicated wind gusts as high as 27 knots from 340° around the time of the breakaway. Most of the wind gusts reported by the wind sensors located on the *VALARIS DS-16* were between 30 to 40 knots from the northwest around the casualty and breakaway times; however, there were two peak gusts from wind sensor no. 2, located about 97 meters (318.2 feet) above the surface, gusting near 51 knots. Because each of the four wind sensors on the *VALARIS DS-16* were located at a higher altitude than the Pascagoula Airport weather station, the *VALARIS DS-16's* wind sensors recorded stronger wind conditions. Calculating for altitude, it is likely that the *VALARIS DS-16* had sustained northwest winds between 30 to 40 knots at 10 meters (32.8 feet) above the waterline with wind gusts to 51 knots near 100 meters (328 feet) above the waterline at the time of the breakaway.

After the bollard failed, the *VALARIS DS-16* was exposed to strong winds and continued to drift across the channel for about 20 minutes until it made contact with the moored cargo vessel *Akti*. As the *VALARIS DS-16* began drifting away from the dock and into the channel, the vessel's marine crew took timely and appropriate

[5] A *moment* is the product of quantity (such as a force) and the distance to a particular axis or point (force times distance). In this case, the mooring lines pulling on the uppermost horns are the "force," and the base of the bollard is the "axis or point."

actions to attempt to reduce the effects of a collision. The chief mate alerted nearby vessels; the captain radioed nearby tugs (since the vessel had no propulsion systems available), which quickly arrived to push against the drifting vessel to reduce its easterly motion; and the *VALARIS DS-16*'s anchors were deployed, thereby stopping the MODU's drift. However, the swing of the vessel's stern to starboard continued due to the force of the wind, and the *VALARIS DS-16* made contact with the *Akti*'s starboard side.

3. Conclusions

3.1 Probable Cause

The National Transportation Safety Board determines that the probable cause of the breakaway of the *VALARIS DS-16* from the ST Engineering Halter Marine and Offshore Shipyard dock and the subsequent collision with the cargo vessel *Akti* was the failure of one of the shipyard's mooring bollards—which had been modified to increase its height to accommodate more lines—used to secure the *VALARIS DS-16*'s bow mooring lines to a pier, during a cold front with strong winds.

3.2 Lessons Learned

Bollard Inspections

As a result of continuing increases in vessel size and sail area, bollards that were previously sufficient may not have adequate capacity to moor larger vessels. There are currently no US Coast Guard or Occupational Safety and Health Administration regulatory requirements for facilities to inspect and verify loading capacities of bollards at shoreside facilities. Bollards and associated pierside mooring equipment are vital equipment that must be capable of withstanding the tremendous forces that large vessels exert on them. Due to their exposure to seawater, bollards and associated pierside mooring equipment are also at high risk for corrosion, which can significantly affect service life. The Coast Guard has recommended that facility owners and operators develop routine inspection programs for bollards and other mooring equipment.

Vessel	***VALARIS DS-16***	***Akti***
Type	Offshore (Mobile offshore drilling unit)	Cargo, Dry Bulk (Dry bulk carrier)
Owner/Operator	Rowan Rigs S.a.r.l./Ensco International Inc. (Commercial)	Akti Maritime Inc./Z. & G. Halcoussis Co. Ltd (Commercial)
Flag	Marshall Islands	Marshall Islands
Port of registry	Majuro, Marshall Islands	Majuro, Marshall Islands
Year built	2014	2014
Official number (US)	N/A	N/A
IMO number	9630078	9660619
Classification society	American Bureau of Shipping	Nippon Kaiji Kyokai
Length (overall)	752.0 ft (229.2 m)	623.3 ft (190.0 m)
Beam	118.1 ft (36.0 m)	106.0 ft (32.3 m)
Draft (casualty)	28.2 ft (8.6 m)	19.4 ft (5.9m)
Tonnage	52,242 GT ITC	32,350 GT ITC
Engine power; manufacturer	6 x 10,728 hp (8,000 kW); Himsen	1 x 9,669 hp (7,210 kW); Mitsubishi Man B&W 6S50MC-C7X

NTSB investigators worked closely with our counterparts from **Coast Guard Sector Mobile** throughout this investigation.

The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, and pipeline safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974, to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident 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 investigating accidents and incidents 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)).

For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident ID DCA22FM013. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting–

National Transportation Safety Board
Records Management Division, CIO-40
490 L'Enfant Plaza, SW
Washington, DC 20594
(800) 877-6799 or (202) 314-6551