National Transportation Safety Board

Marine Accident Brief

Grounding of Mobile Offshore Drilling Unit *Kulluk*

Accident no.	DCA13NM012
Accident type	Grounding
Vessel	Mobile offshore drilling unit *Kulluk*
Location	Near Ocean Bay, Sitkalidak Island, Alaska
Date, time	December 31, 2012 2040 Alaska standard time (coordinated universal time – 9 hours)
Damage	Substantial
Injuries	Four minor
Environmental damage	None
Weather and sea conditions	At departure, moderate winds and seas with scattered precipitation, expected to continue during first days of voyage; several days later, low pressure moved into Gulf of Alaska area. By December 31, recorded winds reached 40–55 knots, with seas more than 20 feet.
Waterway information	Gulf of Alaska lies south of the state of Alaska in the northern Pacific Ocean

The ice-class mobile offshore drilling unit (MODU) *Kulluk*, owned by Shell Offshore, Inc., and operated by Noble Drilling, grounded in heavy weather near Ocean Bay on the eastern coast of Sitkalidak Island off Kodiak Island, Alaska, about 2040 local time on December 31, 2012. The *Kulluk*, under tow by the ice-class anchor-handling tow supply vessel *Aiviq*, departed Captains Bay near Unalaska, Alaska, 10 days earlier for the Seattle, Washington, area for maintenance and repairs.[1] Four crewmembers on the *Aiviq* sustained minor injuries as a result of the accident.

Tow vessel *Aiviq*, left, tows Shell's conical drilling rig *Kulluk* before the *Kulluk* grounding in December 2012. (Photo from www.pbase.com)

[1] Affiliates of Royal Dutch Shell plc are referred to as "Shell" in this report.

Note: This report was reissued on June 16, 2015, with correction to page 1.

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The MODU sustained substantial damage. A postaccident inspection conducted by a third party before the vessel was refloated found underwater portions of the hull were extensively damaged although it retained watertight integrity. Widespread damage also was noted to areas including the vessel's superstructure, electrical equipment, lifesaving and safety equipment, and interior and engineering spaces.

No environmental damage was found as a result of the grounding. The vessel was carrying about 143,000 gallons of low-sulfur diesel oil and 12,000 gallons of other petroleum products at the time of the accident.

The US Coast Guard convened a formal hearing on the accident in Anchorage, Alaska, in May 2013. This accident brief is based on the National Transportation Safety Board's (NTSB) participation in the Coast Guard hearing and investigation and its analysis of evidence. Parties to the NTSB investigation were Shell, owner of the *Kulluk*; Offshore Service Vessels LLC,[2] owner of the *Aiviq*; and the Coast Guard. In accordance with the International Maritime Organization (IMO) Casualty Code, the Republic of the Marshall Islands, the flag state of the *Kulluk*, participated in the Coast Guard's investigation of this accident as a substantially interested state and provided the NTSB with technical assistance throughout its investigation of the accident.

Accident and Investigation

***Kulluk*.** The ice-class *Kulluk*, originally built in 1983, had a conical shape and strengthened hull to increase its capability for navigating in ice-covered waters. Shell acquired the MODU in 2005 and undertook extensive refurbishing for oil drilling operations north of Alaska. Without its own propulsion, the rig required towing to move from one location to another.

During normal operations, the *Kulluk* could accommodate 108 persons, but on the accident voyage, a skeleton crew of 18 was on board.[3] The tow master was from Offshore Rig Movers International, and the remaining marine crewmembers were employed by oil and natural gas drilling contractor Noble Corporation. Key positions and their responsibilities included:

- Tow master, on board the *Kulluk*—overall responsibility for controlling the movement of the *Kulluk* and operation of all assisting vessels during the tow, from unmooring in Alaska to mooring in Washington state, as well as interfacing with the *Kulluk* crew and other personnel
- Offshore installation manager (OIM), on board the *Kulluk*—in command of the *Kulluk*

[2] A division of Edison Chouest group of operating companies.

[3] The number of crew on the *Kulluk* exceeded the eight crewmembers required by its Minimum Safe Manning certificate of the flag state. Nonetheless, if requested, the flag state administrator would have granted a waiver to this requirement, as occurred in a previous 2012 tow.

- Shell's Alaska marine manager—Shell shoreside manager, located in Anchorage; oversight responsibility for planning and managing *Kulluk* rig moves
- *Aiviq* master—in command of the dedicated tow vessel and its crew; legally responsible for the tow once the towline was made fast and the vessels were under way

***Aiviq*.** The US-flagged *Aiviq* is an ice-class, anchor-handling tow vessel designed to operate in extreme weather and sea conditions. The tow vessel is capable of 15 knots in open water and 5 knots in ice-covered water, and its bollard pull, or towing power, at the time of departure was 208 tons, which exceeded the requirement for towing the *Kulluk* set in 2010. According to information Shell provided to the Coast Guard, the *Aiviq* had towed the *Kulluk* in three previous transits in 2012 before the accident voyage, the last trip concluding a month before the December 2012 departure.

The *Aiviq* experienced mechanical difficulties on earlier tow voyages. In a statement to the NTSB, Offshore Service Vessels noted that on August 31, 2012, a low fuel pressure alarm alerted for main engine #3. The fuel pressure gauge was found to be faulty and the fuel meter was found to be fouled. The fuel filter was replaced and the meter cleaned, and the problem was corrected. On November 10, 2012, an 11-minute blackout occurred, during which time the main engines continued to run but their cooling water pumps shut down due to the loss of electrical power to the grid. Four minutes into the blackout, main engine #4 shut down following an oil mist alarm. The crew was unable to restart the engine after the blackout was resolved. It was determined that two of the rod bearings had failed. They were replaced by the engine manufacturer under the provisions of the warranty, and the engine was tested by the manufacturer and the class society and functioned normally as a result.

Tow plan. Shell began planning early in 2012 for the *Kulluk*'s voyage from Unalaska to the Seattle area in December. A coastal route was chosen to maintain a distance less than 200 nautical miles from the shore of southern Alaska to allow easier access by search and rescue (SAR) personnel should the need arise. The 1,773-mile transit was expected to take 24.6 days at an average speed of 3 knots, 21.1 days at an average of 3.5 knots, or 18.5 days averaging 4 knots.

Shipyard capabilities and equipment in the Seattle area were deemed more suitable for performing the *Kulluk*'s planned maintenance and repairs than facilities available in Alaska, a primary factor in the decision to tow the *Kulluk* to Washington to enable the MODU to be fully operational for the planned 2013 oil exploration drilling season. In addition, there was a question as to whether the *Kulluk* would be subject to Alaska state property tax, anticipated to reach millions of dollars, had the vessel remained in Alaska beyond the end of the year.

Approximate course taken by the *Aiviq* towing the MODU *Kulluk* between Unalaska, Alaska, and the site of the grounding near the southeast coast of Kodiak Island. The Seattle, Washington, area was the intended destination. (Background by National Geographic MapMaker Interactive)

The towing plan was developed by Shell's Alaska marine manager and reviewed by the *Aiviq* master, the Shell Alaska operations manager, Alaska drilling manager, logistics team lead, health safety and environmental team lead, emergency response specialist, tow master, Noble Drilling *Kulluk* rig manager and operations manager for Alaska, and the GL Noble Denton warranty surveyor.[4] The Shell Alaska operations manager was the final approval authority. Because he was on vacation at the time the tow plan was approved, a subordinate whom he had designated approved the tow plan in his place.

The tow plan recognized historical climate data for the route and season. If adverse weather were encountered, the tow was to "turn into weather if possible and create as much sea room as possible, then proceed at a speed conducive with conditions." The tow master and *Aiviq* master were authorized to alter the course in response to weather conditions. Shell commissioned a private meteorological service to conduct a meteorological and oceanographic (metocean) tow route simulation study that provided hindsight weather forecasting. The study was based on 30-year global wind and wave hindcast data to determine the maximum wave height and wind speed that might be encountered along the possible routes of the planned tow.

Shell contracted with a weather forecasting service to provide daily forecasts tailored along the route of the towing operation. This weather information was to be e-mailed to the *Kulluk* tow master, *Aiviq* master, and Shell Anchorage management each day. If the weather

[4] Noble Denton and Germanischer Lloyd (GL) merged in 2009, and in 2012, Det Norske Veritas (DNV) and GL merged to form DNV GL.

deteriorated, weather reports would be more detailed and furnished more frequently. The *Kulluk* and *Aiviq* also had online access to additional weather prediction sources. Although rough weather was anticipated, according to the *Kulluk* OIM, "None of us expected to have seas as rough as we had." The 5-day forecast beginning the day of departure was considered by Shell officials and onboard managers to be acceptable for the vessel's planned departure. Coast Guard investigators determined:

> The Metocean study conducted for the December 21, 2012 tow of the *Kulluk* contained wind and wave statistics that, even at the least conservative 10% exceedance rate, were significantly higher than the wind and wave criteria established for the bollard pull requirements in the 2010 study conducted for the *Kulluk*. . . . After analyzing the data, the [Coast Guard determined that the] *Aiviq* would be capable of generally maintaining position with the *Kulluk* in tow during Beaufort 8 weather in 5 meter seas and 40 knot winds while encountering a 1 knot current, with all forces acting against the tow into the wind and seas. In weather conditions in excess of this standard, as predicted by the Metocean study, the *Aiviq* could not be expected to maintain position, and would be pulled astern by the forces acting on the *Kulluk.*

The potential hazards facing the transit were known. The day after departure, the *Aiviq* master wrote an e-mail to the *Kulluk* tow master stating, in part, "I believe that this length of tow, at this time of year, in this location, with our current routing guarantees an ***kicking."

Warranty survey. A warranty survey assesses whether the vessels and the planned route, equipment, manning, and other aspects of a planned voyage will provide vessel and crew safety. According to a Shell representative, a Shell finance specialist advised that a warranty survey was not needed for insurance underwriting for towing the *Kulluk*, but the company decided to have the surveys carried out regardless. For earlier tows, Shell contracted with marine risk assessment specialists MatthewsDaniel or Noble Denton to provide warranty surveys. The December 2012 voyage was the *Kulluk*'s first transit of the Gulf of Alaska in winter.

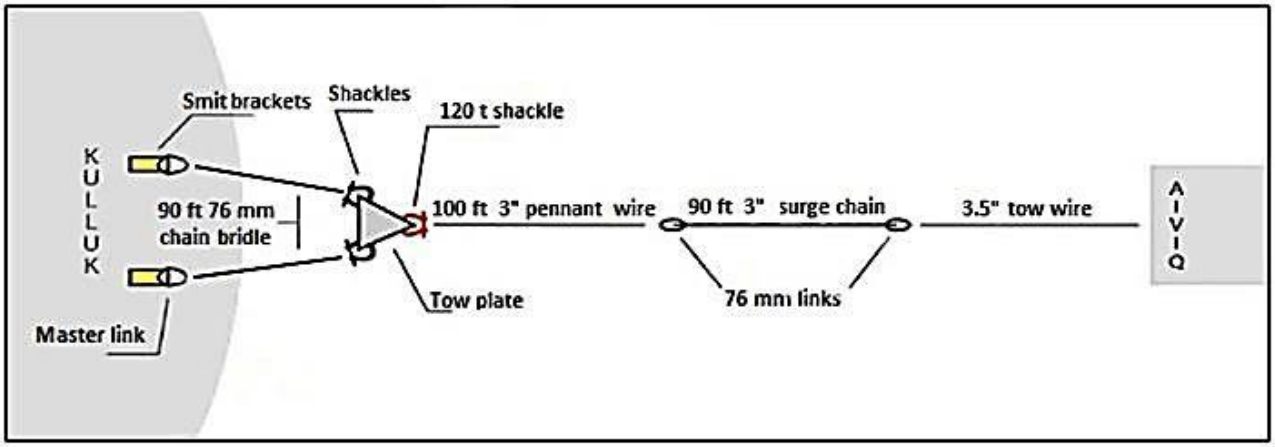
In November 2012, the *Kulluk* transited from the Beaufort Sea to Dutch Harbor, near Unalaska, ultimately to continue to the Seattle area. The Noble Denton warranty surveyor who conducted the December 2012 survey had conducted the surveys and approved two previous *Kulluk* voyages, including its November 2012 trip.

The warranty surveyor arrived in Anchorage prior to the December tow to meet with Shell shoreside personnel. The surveyor reviewed the tow plan and attended planning meetings with Shell's management team before proceeding to Dutch Harbor. The warranty surveyor completed his inspection of the towing equipment for compliance with the requirements of the Shell towing plan on December 21, the day of departure. His review included a visual examination of the tow gear components, examination of vessel records, and meetings with the tow master, the *Aiviq* master, the chief mate and the chief engineer, and an additional *Aiviq* engineer. The chief mate showed the surveyor around the *Aiviq*. The *Aiviq*'s chief engineer testified that he met with the surveyor for about 30 minutes before the departure from Dutch Harbor, and the surveyor asked him one question—"Do you have any major engineering issues?"—to which the chief responded, "No." The chief engineer was not asked about, nor did he provide information regarding, the previous incidents involving the *Aiviq*'s main diesel engines and the temporary repairs undertaken to the vessel's winch room covers and safe deck areas.

The tow gear between the *Aiviq* and the *Kulluk* had been used on three previous voyages to tow the *Kulluk.* According to Offshore Service Vessels, heavy weather was encountered on

two of the tows. The warranty surveyor stated that he visually inspected the tow gear with the tow master and found it to be in good shape with no damage. He also stated that nondestructive testing is not required between uses unless the integrity of the equipment is in doubt. The tow master for the December 2012 tow, who also visually inspected the tow gear, stated that the industry standard for the life of towing gear is 5 years and, based on the age of the gear, a visual inspection was appropriate. Data were not available, nor were such data required, that would have enabled a determination of the remaining strength of the tow gear after its use towing the *Kulluk* in previous tows.

No regulations or class rules govern the demonstrated strength, useful life, number of cycles, or repeated stresses to which the tow line and tow gear could be subject, although the IMO has established guidelines and several countries have promulgated regulations to that effect. Shell testimony and documentation provided to the Coast Guard hearing demonstrated that the company followed industry practices with regard to manufacture, use, and inspection of the tow gear, and as noted, the warranty surveyor visually inspected the tow gear. The *Aiviq*'s towing gear consisted only of a 3.5-inch tow wire connected to the *Kulluk*'s gear with a segment of surge chain followed by the towing pennant. This pennant was connected to shackles and then to the towing plate. Shackles connected the towing plate to chain bridles, which were secured on the *Kulluk* with Smit brackets.[5]



Configuration of *Kulluk* and *Aiviq* tow gear. (Drawing adapted from Coast Guard)

Noble Denton publishes guidelines for marine transportation including towing, but the Noble Denton surveyor was not requested nor required to analyze or review the towing configuration to ensure it met these guidelines prior to approving the tows. The components were evaluated to ensure that they were in compliance with the towing plan as provided to him by Shell.

Accident voyage. Following oil drilling operations in the Beaufort Sea north of Alaska during the summer of 2012, the *Kulluk* was returned to Unalaska in November and remained moored until its December 21 departure for Washington state. On December 20, the *Aiviq* was refueled in Dutch Harbor with 443,000 gallons of fuel that were fed from a gravity drain shore side tank.

[5] Smit brackets are fittings welded on deck to enable towing connections to be made quickly and securely; the bracket consists of a large sliding pin to receive the eye of a tow line or chain; Smit brackets are often found in pairs; it was named after the inventor, Dutch towing specialist company, Smit International (http://www.m-i-link.com/dictionary/default.asp?term=Smit+bracket. , accessed May 15, 2015)

December 21−24—The *Aiviq* left Captains Bay, Unalaska, Alaska, at 1325 on December 21 with the *Kulluk* under tow, initially traveling about 3.5 knots, and the first few days were uneventful. On the second day of the voyage, the National Weather Service predicted winds increasing to 35 knots over the next 2 to 3 days with seas reaching 17 feet in 5 days. The *Kulluk* tow master, *Aiviq* master, and the OIM discussed altering their course to reduce the overall distance and transit time, but they decided to continue on the planned coastal route to remain within the 200-mile SAR limit.

December 25—Four days into the voyage, the National Weather Service issued gale warnings for the following day, forecasting wind velocity up to 40 knots and seas up to 15 feet. The *Aiviq* master and *Kulluk* tow master again discussed a course change, this time to the east to attempt to avoid the low pressure system approaching from the southwest, and they informed the Shell marine manager of their concerns.

December 26—Winds increased rapidly, from 15−20 knots late on December 25 to 35−40 knots by 0000 on December 26, and seas reached 10–15 feet. By the end of the day on December 26, the *Kulluk* was about 35 nautical miles southeast of the Trinity Islands at the southernmost point off Kodiak Island and encountering significant swells.

December 27—The *Aiviq* master changed to a more southerly route, away from the worsening weather. His decision was made in consultation with the OIM and the *Kulluk* tow master and authorized by Shell's marine manager.

The manufacturer of the *Aiviq*'s towing winch system, examining data from the vessel's winch system after the accident, revealed that on this day the vessel's alarm for "wire tensile strength overload on tow drum" activated 38 times between 0534 and 1129, each alert indicating that the *Aiviq*'s tow load exceeded 50 percent of the wire's preset breaking load of 600 tons, that is, a strain of at least 300 tons. The *Aiviq* paid out an additional 360 feet of tow line between 0500 and 1100 hours to ease the tension on the tow wire.

At 1135, when the vessel was roughly 50 miles southeast of Sitkalidak Island, the tow connecting the *Aiviq* to the *Kulluk* failed. Winds were recorded from the west-southwest at 15−20 knots, and sea swells were 20−25 feet, occasionally reaching 30 feet. Shell put its incident management team in Anchorage on notice immediately after the tow failure and was regularly informed of the *Aiviq*'s and *Kulluk*'s situation.

Following the failure of the tow gear, Shell shoreside personnel had two other vessels under long-term charters to Shell, the tug *Guardsman* and the oil spill response vessel *Nanuq*, moved to be in position to assist the *Kulluk* if needed. Shell shoreside personnel also located the tow vessel *Alert* and requested that it be moved to assist the *Kulluk*. Shell personnel also notified the Coast Guard of the situation, and the Coast Guard dispatched its cutter *Alex Haley* from Kodiak, Alaska, to the *Kulluk*'s location.

At 1430, the *Aiviq*'s emergency tow line was connected to the *Kulluk*. The tow master advised the *Aiviq* that the tension on the emergency tow gear should not exceed 60 tons. About 1900 that evening, according to engine data, one of the *Aiviq*'s engines shut down, and the other three engines also failed over an approximate 5-hour period starting about 2235. Offshore Service Vessels told investigators that, despite these engine failures, the *Aiviq* was capable of maintaining sufficient power to put a considerably greater force on the emergency tow line than what the tow master had advised. Shell called for the entire incident management team to be in place upon being informed of the *Aiviq*'s propulsion loss, and it implemented a 12-hour watch rotation for all incident response center personnel.

December 28—With the engines providing no propulsion, the *Aiviq* maintained a safe distance from the *Kulluk* by using its thrusters. The Coast Guard cutter *Alex Haley* arrived on scene about 0130 on December 28. The Coast Guard crew attempted unsuccessfully to rig a tow line to the *Aiviq*, and in the process, the tow line fouled the Coast Guard vessel's port propeller. The *Alex Haley* departed for Kodiak for repairs later that morning.

By the afternoon, the *Guardsman* arrived on scene, and at 1329, personnel connected a tow line from the *Guardsman* to the *Aiviq* while the *Aiviq* remained connected to the *Kulluk*, and both vessels, in tandem, then began to tow the MODU. Because of the worsening weather and continuing problems with tow lines and the *Aiviq* engines, a Shell representative contacted the Coast Guard about 1800 that evening to request evacuation of the 18 persons on the *Kulluk*.

Coast Guard MH-60 Jayhawk helicopters from Air Station Kodiak airlifted 18 crewmembers from the *Kulluk* on December 29. The oil spill response vessel *Nanuq* is in the background. (Photo by Coast Guard)

The *Aiviq* chief engineer stated that because all four engines failed, he believed the fuel system was likely contaminated. *Aiviq* engine room logs indicate that numerous injector failures occurred, with "trash and grit" found in the fuel strainers and "unidentified 'sludge'" blocking the engine filters. On the afternoon of December 28, personnel on the *Aiviq* contacted Offshore Service Vessels, the owner/operator of the vessel, to report that replacement fuel injectors were needed to restore engine function. Offshore Service Vessels contacted the engine manufacturer, Caterpillar, which had fuel injectors for the engines in stock at its Peoria, Illinois, manufacturing facility and one other location. Offshore Service Vessels dispatched its company airplane to those locations to pick up the fuel injectors and transport them to Kodiak, the airport nearest the *Aiviq*.

At 2250 that night, a Coast Guard helicopter arrived at the *Kulluk* to evacuate personnel. The wind velocity was then about 50 knots, however, and the pilot determined that both wind and sea conditions precluded a safe evacuation. The pilot returned to base, along with a second Coast Guard helicopter that had also been dispatched.

December 29—The Offshore Service Vessels airplane arrived in Kodiak and transferred 74 new fuel injectors to a Coast Guard helicopter. The helicopter delivered the fuel injectors and associated parts to the *Aiviq* about 0400 that morning, with a second delivery about 1000.

About 0510, the *Guardsman*'s tow line to the *Aiviq* parted. After engineers replaced the fuel injectors, the first of the *Aiviq*'s four engines was restarted at 0640, the second at 0715, the third at 1020, and the fourth at 1335. About 0630, the *Nanuq* arrived on scene, and at 1145, its tow line was connected to a 1,800-foot mooring wire from the *Kulluk*. Both the *Aiviq* and the *Nanuq* then towed the *Kulluk*. That afternoon, the Coast Guard again dispatched two helicopters to the MODU to evacuate personnel. In three flights during daylight, with six individual lifts per flight, all 18 personnel were evacuated from the *Kulluk*.

Because of the increasing severity of conditions near the *Kulluk*, Shell's incident management team was upgraded to a unified command under the authority of the Coast Guard's on-scene commander and including representatives of Shell and Offshore Service Vessels and, later, personnel from Noble Corporation, operator of the *Kulluk*; the state of Alaska; and Kodiak Island Borough.

December 30—About midnight on December 29–30, the unified command directed the *Nanuq* and *Aiviq* to head east and then north in an attempt to bring the *Kulluk* to a safe harbor—Marmot Bay on the northeastern side of Kodiak Island. This route would take the vessels around the eastern side of Sitkalidak Island. At 0856 on December 30, the *Aiviq* master wrote in an e-mail to Offshore Service Vessels operations personnel that he doubted the *Aiviq*'s emergency tow could withstand more pressure, adding, "The long-range forecast doesn't give me confidence that this situation will change within the next three days."

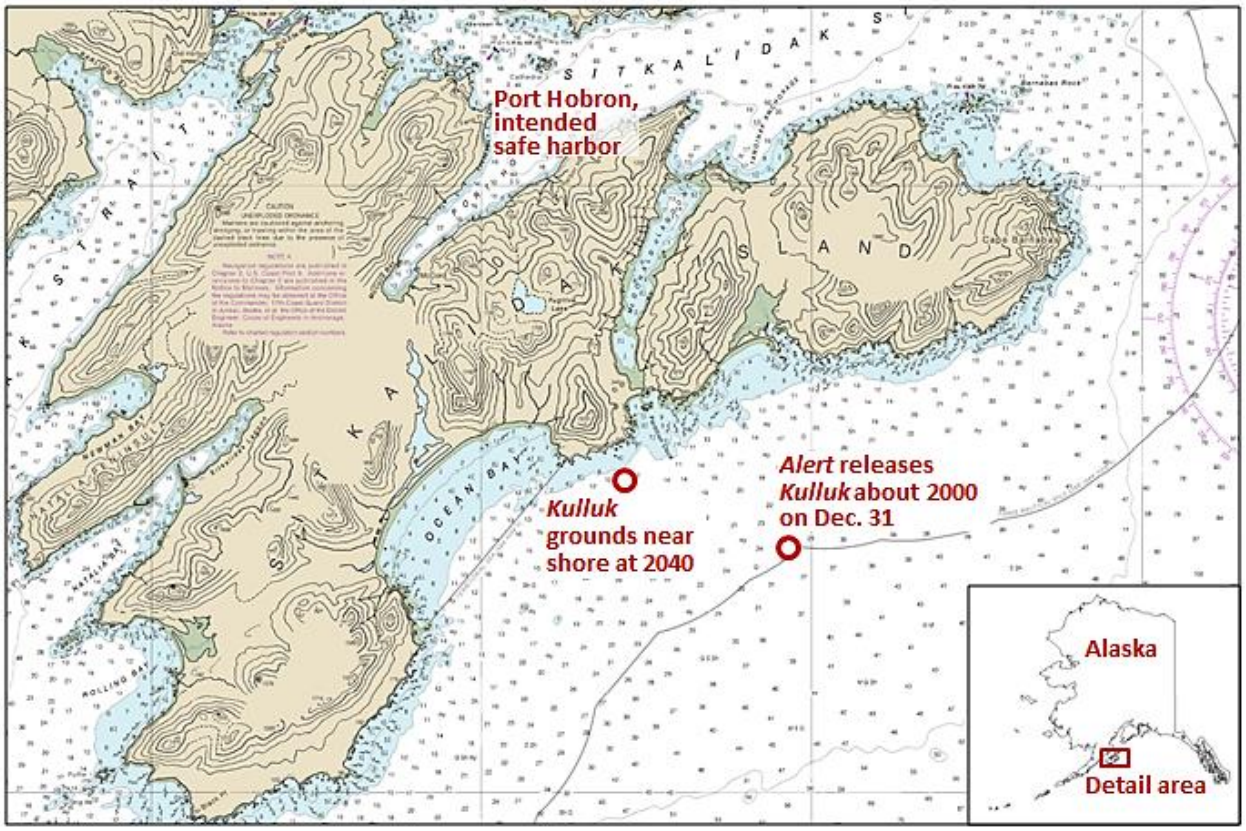
About 1310, the tow line connecting the *Nanuq* to the *Kulluk* parted but was still connected to the *Kulluk*. About 1330, the *Aiviq*'s tow line separated as well. The tow vessel *Alert* arrived at 1325 in response to Shell's request for assistance. Around that time, wind velocity was estimated to be 35 to 45 knots, with 20- to 25-foot seas.

The *Kulluk* was about 30 miles from the coast. *Aiviq* personnel determined that the vessel's heavy steel grapple anchor was suitable for retrieving the mooring wire that had been used by the *Nanuq* to tow the *Kulluk*. This anchor would need to be retrieved from a vessel storage area and secured to the *Aiviq* towing equipment on its main deck—an operation deemed best undertaken in more protected waters. For this reason, the *Aiviq* departed at 1930 for a sheltered area off Sitkinak Point, about 20 miles away, where *Aiviq* personnel deployed the grapple and then returned the vessel to the *Kulluk*'s location the next morning.

December 31—At 0110 on December 31, *Alert* crewmembers retrieved the *Kulluk*'s emergency towline from the water and connected it to a shackle on the *Alert*'s tow line. The *Aiviq* returned by 0400, and crewmembers grappled and retrieved the *Kulluk*'s mooring wire and connected it to the *Aiviq*'s towing wire by about 0700. Nevertheless, the two vessels towing the *Kulluk* in tandem were unable to withstand the combined effects of the wind and the seas, which pulled the vessels toward the shore. The unified command then decided to move the *Kulluk* to a closer safe harbor—Port Hobron, about 74 miles away on the north side of Sitkalidak Island.

At 1626, the tow line between the *Aiviq* and the *Kulluk* parted again. The *Alert* continued to tow the *Kulluk* about 7 miles offshore with its engines at 85 percent power. Weather

conditions continued to worsen, and with winds as high as 55–60 knots and seas 30–35 feet, the *Alert*, with the *Kulluk* in tow, continued to be pulled toward shore. At 1815, the master of the *Alert* ordered that the engines be set at 100 percent power. They were brought back to 85 percent power at 1835 due to the alerting of engine alarms at the 100 percent setting. When the vessels were 3 miles from shore, the unified command ordered the *Alert* master to release the tow, and the *Kulluk* grounded off Ocean Bay, Alaska.



Vessel positions when the *Alert* released the *Kulluk* and location of the *Kulluk* grounding about 40 minutes later on December 31, 2012, near Ocean Bay, Sitkalidak Island, Alaska. (Excerpt from NOAA chart 16592)

The broken component of the *Kulluk*'s tow gear, a 120-ton shackle that was connecting the towing plate to the 100-foot-long, 3-inch pennant, was lost at sea during the initial December 27 tow gear separation, and investigators were unable to determine the cause of its failure.

MODU *Kulluk* aground off Ocean Bay, Sitkalidak Island, Alaska. (Photo by Coast Guard)

Discussion

No single error or mechanical failure led to this accident. Rather, shortcomings in the design of a plan with an insufficient margin of safety allowed this accident to take place. The plan was created to move the MODU at a time of year with a known likelihood of severe weather conditions for reasons unrelated to operational safety.

Shell had retained warranty surveys on all five previous tows of the *Kulluk*. No regulatory requirement existed for a warranty surveyor to review and approve, or suggest modifications to, the tow plan and its components. The surveyor that Shell retained for the accident voyage approved the tow plan in its entirety. This was the only external review of the tow plan and the equipment that was to be used in the planned tow.

The Coast Guard was not required to oversee the tow. Rather, the Coast Guard's role, a critical one given the circumstances, was limited to its response to this accident—delivering the needed engine components to the *Aiviq*, unsuccessfully attempting to tow the *Kulluk*, and, most important, rescuing *Kulluk* personnel when their lives were endangered, an operation that itself risked the lives of the Coast Guard rescuers.

Many maritime regulators in countries with operations in environments with the potential for severe weather actively oversee tow operations. For example, Norway addresses many of the shortcomings in the oversight of tow gear and severe weather avoidance that were evident in this accident.[6] Canada similarly addresses safe towing operations, including specifying parameters for tow gear strength, by recommending that operators adhere to IMO towing guidelines (IMO

[6] Norwegian Maritime Authority, Regulation 17, December 1986, No. 2319, "Concerning field moves and towing of mobile offshore units and concerning towing system and mooring of supply ships at such units."

MSC Circ. 884, 21 December 1998).[7] IMO and the Norwegian Maritime Authority provide guidance for oceangoing tows with margins of safety for encounters with adverse weather.

The *Aiviq* lost engine power at a critical point in the *Kulluk*'s tow. Coast Guard investigators believe that the design of the fuel oil storage tanks' common vent and overflow system was flawed and that these flaws led to the seawater contamination of the fuel tanks during the *Aiviq*'s transit during rough sea conditions. Offshore Service Vessels contends that fuel contaminants were present in the fuel taken on by the *Aiviq* in Dutch Harbor and that this contamination, rather than seawater that entered the system later, led to the engine power loss. Regardless, the source of the fuel contamination was outside the scope of the NTSB's investigation of this accident and, therefore, was not determined.

Given the risks associated with this transit, including the likelihood of the tow encountering severe weather, Shell and its contractors, particularly Offshore Service Vessels, the operator of the *Aiviq*, who reviewed and approved the tow plan should have either mitigated those risks or departed at a time of year when severe weather was less likely. For example, Shell and its contractors could have included additional tow vessels to the entire transit to reduce the likelihood of catastrophic results from a failure of the *Aiviq* or its tow gear. Redundancy is a necessary element of safety-critical transportation systems, and given the hazards of operations in Alaskan waters, those involved in the tow plan should have recognized and addressed the lack of redundancy.

The series of failures that led to this accident began when Shell failed to fully address the risks associated with a late December tow in Alaskan waters, and ended with the grounding of the *Kulluk*. Although multiple parties were involved in the review and approval of the tow plan, the ultimate decision to approve and implement the tow was Shell's. The dynamics of a single entity approving a go/no-go decision in the face of risks, with multiple parties involved, have been addressed in studies of previous catastrophic events.[8] This research demonstrates that, even with formal review processes involving multiple entities, the ability of parties involved in a decision to articulate and draw attention to risks is limited when a single entity bears ultimate decision-making responsibility and at the same time favors a particular outcome of the decision. For this reason, Shell, as the organization responsible for designing, approving, and implementing the tow plan, is considered to be ultimately responsible for this accident.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the grounding of the mobile offshore drilling unit *Kulluk* was Shell's inadequate assessment of the risk for its planned tow of the *Kulluk*, resulting in implementation of a tow plan insufficient to mitigate that risk.

Adopted: May 22, 2015

[7] Transport Canada, TP 13585 E, Policy Regarding Ascertaining the Safety of International Towing Operations of Deadships Departing Canada, 1 September 2013.

[8] Janis, I. L. (1982). *Groupthink: Psychological studies of policy decisions and fiascoes*. Boston: Houghton Mifflin; Vaughan, D. (1996). *The Challenger launch decision: Risky technology, culture, and deviance at NASA.* Chicago: The University of Chicago Press.

Vessel Particulars

Vessel	*Kulluk*	*Aiviq*	*Nanuq*	*Alert*	*Guardsman*	*Alex Haley*
Owner/operator	Shell Offshore/Noble Drilling	Offshore Service Vessels	Offshore Service Vessels	Crowley Maritime Corp.	Crowley Maritime Corp.	US Coast Guard
Flag	Marshall Islands	United States	United States	United States	United States	United States
Type	Mobile offshore drilling unit (ice class)	Anchor-handling tug supply (ice class)	OSRV oil spill response vessel	Tug	Tug	Medium-endurance cutter
Builder, date	Mitsui Engineering & Shipbuilding, Tamano, Japan 1983	North American Shipbuilding November 2011	North American Fabricators June 2007	Dakota Creek Industries February 2000	McDermott Shipyard May 1976	Brooke Marine, Lowestoft, UK 1967
IMO/official number	802785	9579016	9382841	9214381	7506003	—
Construction	Steel	Steel	Steel	Steel	Steel	Steel
Length overall	265.7 ft (81 m)	360 ft (109.7 m)	301.8 ft (92.0 m)	140 ft (42.7 m)	136 ft (41.5 m)	283 ft (86.3 m) (length between perpendiculars)
Breadth	(conical hull)	80.0 ft (24.4 m)	60.0 ft (18.3 m)	42.0 ft (12.8 m)	36.5 ft (11.1 m)	50.0 ft (15.2 m)
Draft	35 ft (10.7 m) (at sailing)	28 ft (8.5 m)	17 ft (5.2 m)	20 ft (6.10 m)	16 ft (4.9 m)	17 ft (5.2 m)
Gross tonnage	27,968*	12,892*	3,575*	845*	538*	3,100 long tons
Propulsion/main engines	n/a	Four 21,776-hp (16,240-kW) diesel oil engines, geared drive	Two 7,268-hp (5,422-kW) diesel oil engines, geared drive	Two 10,192-hp (7,500-kW) diesel oil engines, geared drive	Two 7,200-hp (5,148-kW) diesel oil engines, geared drive	6,800-hp (5,001.4-kW) diesel engine
Service speed	n/a	16 kts	14 kts	16 kts	14 kts	n/a
Towing capabilities	n/a	Low pressure towing winch with auxiliary wire, chain drums, and a computer monitoring system	250-ton anchor winch	Markey TDS-40 towing winch	Markey TDSDW 36C double drum winch	Towing bit on fantail
Bollard pull (tons)	n/a	208	90	150	75	—
Persons on board	18	18	10	7	7	104

*Tonnage according to International Tonnage Convention

n/a not applicable
— not available

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID number DCA13LM012.

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 49 *United States Code* 1131. 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." 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. 49 *United States Code*, Section 1154(b).