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Magazine

The Wreck of the Kulluk

By McKENZIE FUNK DEC. 30, 2014

In 2005, Royal Dutch Shell, then the fourth-largest company on Earth, bought a drill rig that was both tall, rising almost 250 feet above the waterline, and unusually round. The hull of the Kulluk, as the rig was called, was made of 1.5-inch-thick steel and rounded to better prevent its being crushed. A 12-point anchor system could keep it locked in place above an oil well for a full day in 18-foot seas or in moving sea ice that was four feet thick. Its drill bit, dropped from a 160-foot derrick, could plunge 600 feet into the sea, then bore another 20,000 feet into the seabed, where it could verify the existence of oil deposits that were otherwise a geologist's best guess. It had a sauna. It could go (in theory) where few other rigs could go, helping Shell find oil that (in theory) few other oil companies could find.

The purchase was important not because Shell needed oil in 2005. The company had plenty of oil. It was important because Shell had spent the previous year engulfed in a scandal involving what are known as proved reserves: a petroleum company's most sacred promise about the future. Proved reserves are measured in barrels of oil, but the oil in question is still in the ground. Its total volume is unknowable, or rather it is constantly changing, because the amount a given deposit could produce depends as much on human factors as it does on geology. The same deposit will yield more or less if production methods improve (as was the case with hydraulic fracturing), if prices go up or down (some tar-sand deposits simply aren't

worth pursuing when oil is cheap), if the regulatory environment changes (like the United States moratorium, after the Deepwater Horizon disaster in 2010, on some offshore drilling) or if the actual environment changes (melt in the high Arctic may put difficult deposits within reach).

Despite their unreality, proved reserves define the total worldview of an oil company. They influence things like stock price and credit rating, and in a series of announcements, Shell admitted that it had overstated its proved reserves by 4.47 billion barrels of oil, or 22 percent. The company's stock dropped nearly 10 percent overnight. Its chairman was forced out. The Securities and Exchange Commission in the United States and the Financial Services Authority in Britain fined it a total of \$150 million.

For all its short-term growth, Shell still had to show investors that its long-term future was as bright as it once looked on paper. But the planet's easy oil — along with its shallow backyard wells and most pliant monarchs — was gone. In the era before the OPEC embargo in 1973, the so-called “supermajors,” including Shell and the predecessors of BP, Chevron and Exxon, controlled more than 80 percent of global reserves. By 2005, more than 80 percent of remaining reserves were controlled by state-owned oil companies: Aramco in Saudi Arabia, Petrobras in Brazil, Petronas in Malaysia, Gazprom in Russia, Cnooc in China and many others. As a result, the hunt for oil went to technical and geographical extremes like shale oil in South Texas, tar sands in Alberta, deepwater sites in Brazil and offshore wells in the Arctic. And the hunt became more expensive: The break-even point for many unconventional projects was \$70 or more per barrel. They made economic sense only if oil prices were high, which meant their reserves could be considered proved and added to company balance sheets only if oil prices were high — and, for the moment, oil prices were high.

In Inuvialuktun, the language spoken in the settlement of Inuvik in the Northwest Territories in Canada, the name Kulluk means “thunder.” (A local schoolgirl won a naming contest in 1982.) The rig had been purpose-built for

exploring what was now recognized as the last great energy opportunity. The United States Geological Survey said in a series of reports that the Arctic held nearly a quarter of the world's undiscovered petroleum. Beneath just the American portion of the Arctic Ocean, in the Beaufort and Chukchi Seas, were an estimated 27 billion barrels of recoverable oil and 130 trillion cubic feet of natural gas — more than 30 times America's annual imports from OPEC. The break-even point was substantial, but so was the prize. One federal estimate declared that at \$80 a barrel, 12 billion barrels would be pulled out of the Chukchi Sea alone.

In 2005, along with its purchase of the Kulluk, Shell bid \$44 million for 84 blocks of seabed in the Beaufort Sea. In 2006 it hired a subcontractor, Frontier Drilling, now part of the Noble Corporation, to staff and operate the Kulluk. In 2007, it bid another \$39 million to double its Beaufort holdings. In 2008, it paid a record-breaking \$2.1 billion on leases in the Chukchi. Over time, it spent \$292 million to upgrade the Kulluk. (The original purchase price for the rig was never disclosed.) From its North American headquarters in Houston, where executives oversaw logistics in the distant Arctic, Shell fought off lawsuits from environmental and native groups. It waited out the moratorium on offshore drilling imposed as a result of BP's Deepwater Horizon disaster.

The Arctic was a long-term investment — Shell would not start production on such a big project in such a distant place until at least a decade after it found oil — but the future is always getting closer, and by 2010 the company was anxious. It took out ads in newspapers, hoping to pressure the Obama administration into opening the Arctic. One pictured a little girl reading in bed, a figurine of a polar bear next to the lamp on her nightstand. "What sort of world will this little girl grow up in?" it asked. If "we're going to keep the lights on for her, we will need to look at every possible energy source. . . . Let's go."

Even with permission, getting to the oil would not be easy. The Alaskan

Arctic has no deepwater port. The closest is in the Aleutian Islands at Dutch Harbor, a thousand miles to the south through the Bering Strait. In the Inupiat whaling villages dotting the Chukchi coast, only a handful of airstrips are long enough for anything other than a prop plane. There are few roads; human residents get around in summer by boat, foot or all-terrain vehicle. Shell was trying the logistical equivalent of a mission to the moon. During the short Arctic summer, when the sea ice made its annual retreat, Shell would have to bring not only the Kulluk but everything else: personnel, tankers, icebreakers, worker housing, supply vessels, helicopters, tugboats, spill-cleanup barges and a secondary rig to drill a relief well in case of a blowout. In the wake of Deepwater Horizon, Shell would build a \$400 million Arctic-ready containment dome, an extra layer of spill protection that it would also need to drag north.

By 2012, Shell had become the largest company in the world. It had \$467.2 billion in revenue and 87,000 employees in more than 70 countries. It was on track to spend \$6 billion preparing for Arctic Alaska, and that March the Obama administration approved exploratory drilling. The task that remained was not to tame the frontier so much as to bring it within reach, to bind Arctic Alaska to the rest of the world. Shell imagined a future of new ports, new airports and permanent rigs. Squint your eyes and you could see all the lines being drawn. Shell's Arctic program looked much like the Kulluk itself: something massive at the end of a long thin line.

The plan was simple: The Kulluk would anchor to the Arctic Ocean seabed above a suspected oil deposit and sink a bit deep enough to take core samples — the same operation carried out by hundreds of offshore rigs in warmer waters all over the world. If it found significant oil, its test wells would be replaced by a production well, the Kulluk by a permanent platform that would sit in place for decades.

Shell had the Kulluk refurbished at Vigor Marine shipyards in Seattle: new crew quarters, new cranes, new generators and a new blue-and-white

paint scheme that was chosen, according to a Vigor news release, “to accommodate the known preferences of whales.” The most important upgrade completed at Vigor, at least from the perspective of later Coast Guard investigators, was to the Kulluk’s steel tow shackles. These linked the Kulluk to the towline of its tugboat, the Aiviq, which was built for the Kulluk job by another subcontractor, the Louisiana shipbuilder Edison Chouest, which would also provide its crew. Shell hired a surveyor company, MatthewsDaniel, to give outside assurance that its tow plan was safe. MatthewsDaniel recommended a more robust connection between rig and tug for the rough Alaskan voyage ahead. But rather than order the replacements new, workers located some apparently stronger shackles in a shipyard storage bin. The shackles they found had no certification or records — but appeared “as new,” investigators were told. Onto the Kulluk they went.

On a sunny Wednesday in June 2012, Shell’s fleet set out for the Arctic. Behind the Kulluk and the Aiviq, in a blue-and-white convoy steaming through Puget Sound, was a third vessel, owned by Noble Drilling, the same subcontractor that Shell hired to operate the Kulluk. This was the 512-foot Noble Discoverer. Unlike the Kulluk, the Discoverer was self-propelled. Like the Kulluk, it was old, one of the oldest drill ships still operating anywhere in the world, having been built as a log carrier in 1966 and converted to a mobile exploration rig a decade later. The Noble Discoverer had its air-pollution controls refurbished alongside the Kulluk in the Seattle shipyard. It was a rush job. In a news release, Vigor declared that it had “mobilized a team of more than 500 skilled, quality-focused workers to complete upgrades which would normally take up to six months in just 10 weeks.”

The Kulluk, tugged along at the pace of a man jogging, and the Noble Discoverer, somewhat more quickly, traveled north across the Canadian border, past Vancouver Island and into the open Pacific Ocean. As the few remaining signs of civilization faded away, the ships passed the salmon

grounds of Haida Gwaii, the fjords of Glacier Bay National Park and the uncut expanses of the Chugach National Forest. They finally turned west to reach the deepwater port at Dutch Harbor, which sits alone in the middle of the long Aleutian Island chain, 800 miles from Anchorage and 800 miles from the Russian mainland. The 2,000-mile voyage from Seattle to Dutch Harbor took almost three weeks. Shell's closest Arctic leases were another thousand miles farther north and still covered in ice. The fleet would park in Dutch Harbor for as long as it took — weeks, not months, Shell thought — for the ice to melt.

The troubles soon began. The Noble Discoverer, not the Kulluk, was at first the problem ship. On July 14, a storm brought 30-knot winds, which were nothing unusual for the Aleutians or crew members accustomed to Alaska but enough to cause the Noble Discoverer to drag its anchor and be blown south, where it grounded or appeared to ground on a sandy beach near town. More than a dozen people watched from shore as tugboats pulled the Discoverer back into the bay. Some of them posted snapshots on Facebook. The biggest danger was political. For drilling opponents following Shell's every move — Greenpeace had dispatched a ship of its own to Alaska — a grounding incident would provide another chance to declare the company unfit to operate in the Arctic. Shell insisted, in a statement emailed to reporters, that there had been no grounding and that the drill ship had instead “drifted toward land and stopped very near the coast.” The Coast Guard sent divers to inspect the hull. They found no damage and cleared the ship to sail.

July turned to August and August to September. The ice in the Alaskan Arctic had melted weeks late — at least by the new standards of the warming north — and drilling had not begun. The hangup was the company's new Arctic containment dome and the spill barge another contractor, Superior Energy Services, was building to carry the dome north. The dome and the barge weren't ready, and without them, Shell would not be permitted to go

for oil. Its plan to drill five exploratory wells — three in the Chukchi Sea, two in the Beaufort — began to crumble. In September, in a sea trial in the calm waters of Puget Sound, a faulty electrical connection caused the \$400 million containment dome to shoot to the surface without warning, where it “breached like a whale,” a federal inspector wrote, before sinking 120 feet. When it was pulled to the surface again, it had been “crushed like a beer can.”

Shell didn’t give up. Even before the containment dome was crushed, the company proposed a new plan that would allow them to show results before winter set in. The Kulluk and the Discoverer would each sink a partial well to roughly 1,400 feet, stopping just before the oil zone, then cap it, leaving the “top hole” primed for completion when Shell could come back with a working containment dome. The rigs were moved into place: the Discoverer in the Chukchi, north of the Bering Strait, and the Kulluk in the more distant Beaufort, which straddles the Alaska-Canada border to the east, a 1,700-mile tow from Dutch Harbor. The Department of the Interior signed off on the plan.

The Beaufort and Chukchi Seas are shallow, which makes them biologically productive and easier to explore. On the silty seabed, which kicks up plumes of sediment when an anchor or submarine sets down, are sea stars and snow crabs. The floating sea ice of the Chukchi, some of it thickly ridged and cracked like a glacial sérac, is home to roughly half of America’s polar bears, which feed on its ringed and spotted seals, and to tens of thousands of walruses. In the spring, as the ice begins to recede toward the North Pole, bowhead whales migrate along the Chukchi coastline and into the Beaufort, and the local Inupiat hunt for them. When the ice is gone, the seas are a dark shade of green, and there is frequent fog. Winds that scoured the frozen emptiness now push the water into rolling waves. There is little on the surface to see. Ships can go for weeks without sighting another vessel.

Pete Slaiby, Shell's vice president for Alaska, had worked hard to assure Alaskans that Arctic drilling would be safe. His previous posting for the company was in Brunei. Now he traveled to hundreds of meetings in villages and cities across the north. "Bruneians are every bit as tied to their live coral reefs as the Inupiat are to the whale," Slaiby said at a 2011 conference near Anchorage, emphasizing that he wanted "to highlight those ties as well as our sensitivity to those who are being asked to trust that an oil company *can and will* do the right thing."

On Sept. 8 in the Chukchi Sea, Shell achieved a milestone. The Discoverer attached a web of anchors to the seabed. The drill began to spin. Barely 24 hours later, the Arctic wind pushed an ice floe 30 miles long and 10 miles wide right at the ship, and it was forced to retreat. It didn't matter. A grainy video appeared that same day on Shell's official YouTube page. "Shell readies the drill bit for first spud!" the caption read. (To spud is to begin drilling.) "This marks the culmination of more than six years of effort by Shell. . . . This is the first time a drill bit has touched the sea floor in the U.S. Chukchi Sea in more than two decades." On Oct. 3 in the Beaufort Sea, which had been off limits for weeks during the local bowhead-whale hunt, the Kulluk performed much the same operation. Shell made the most of having only partly drilled just two of its five planned wells.

Then it was time to leave. By late October on the Chukchi and Beaufort Seas, it was dark more than 16 hours a day. The Arctic produced its standard mix of clouds, fog, wind and snow. Sea ice was already creeping back after its annual low point the previous month. Patches of it blotting out stretches of open water. This is when ships must either leave the Arctic or risk getting stuck fast in the ice.

The Discoverer departed the Chukchi for Dutch Harbor on Oct. 28. The voyage was uneventful, but two weeks later, in port, its revamped exhaust system emitted a loud blast that port officials felt hundreds of yards away. They called 911. The ship's crew extinguished a small blaze minutes before

the police and fire departments arrived. In an email to the local radio station, a Shell spokesman denied that the explosion had been anything other than “a common backfire.”

Ten days after that, near Seward, Alaska, the Discoverer’s propeller shaft began vibrating so badly that the crew shut down its engines and had it towed to port. Coast Guard safety inspectors boarded for a routine visit and found 16 violations, many of them serious. “As a result of backfires,” they wrote, “main propulsion machinery and all auxiliary machinery essential to the propulsion and safety of the unit may be compromised.” They temporarily impounded the ship so that it couldn’t leave port and called in a Coast Guard criminal unit from outside Alaska. Noble Drilling, Shell’s subcontractor, rushed to provide lawyers for the crew. When the criminal team arrived, the crew refused to talk. The case was passed on to the Justice Department. Eventually, with the help of a confidential informant, investigators would learn of the ship’s multiple unreported engine failures and makeshift hose-and-barrel system for bilge water that discharged oily waste into the ocean. (Two years later, on Dec. 19, 2014, Noble Drilling pleaded guilty to eight felony charges and agreed to \$12.2 million in fines and in community-service payments.)

While the Discoverer was making its way south from the Chukchi, the Kulluk was still sitting in the Beaufort Sea. It couldn’t leave until it discharged most of its 83-person drilling crew. To shuttle workers to and from the Beaufort shore, Shell had hired PHI, a helicopter company that it had long used in the Gulf of Mexico. As the weather worsened, the helicopters were often unable to make the trip. They had no de-icing equipment, and their pilots were unfamiliar with the Arctic. Adding to the delays, rough seas made it difficult to refuel the Kulluk’s tugboat, the Aiviq. The rig remained at 70 degrees north well into November. Snowdrifts piled up on its deck, and ice the consistency of a Slurpee formed in the water around it.

As Shell prepared the rig for the return voyage to Dutch Harbor and potentially on to Seattle, it again tried to hire MatthewsDaniel, the marine warranty-survey company that it had asked to independently examine and approve its June 2012 tow north. This time the company was unavailable, Shell told investigators. But according to a 152-page report on the grounding of the Kulluk that the Coast Guard released in April 2014, MatthewsDaniel was concerned that the second leg of the voyage might prove too dangerous. In an email, MatthewsDaniel told Shell that it “would not approve a tow of the Kulluk from Dutch Harbor to Seattle during the month of November as weather data shows that seas can reach as much as 10 meters in the Gulf of Alaska.”

Shell hired a different warranty surveyor, GL Noble Denton (not affiliated with Noble Drilling), that agreed to approve both legs of the trip. When the Kulluk arrived back at Dutch Harbor, it was almost Thanksgiving.

By December, the Gulf of Alaska is one of the stormiest places anywhere. According to the National Weather Service, gale-force winds are present 15 percent of the time during December and January; 20 percent of the time, the sea swells top 17 feet; and in an average year, hurricane-force winds hit two or three times. The sensible approach would have been to wait out the winter in Dutch Harbor, safe in the Aleutians, on the edge of the gulf. The Kulluk had a customized berth in Dutch Harbor — rounded to match its hull — and would be better positioned to go back up to the Arctic the following summer and complete the new wells. But the company wanted to make off-season upgrades to the Kulluk that would be either impossible or too expensive in Dutch Harbor. And there was another consideration: If the Kulluk was in an Alaskan port on New Year’s Day, executives believed, it would be subject to a state oil-facilities tax of as much as \$6 million. In late December, a spokesman confirmed Shell’s fears in an email to a longtime reporter at a local newspaper, The Dutch Harbor Fisherman, writing, “It’s fair to say the current tax structure related to vessels of this type influenced

the timing of our departure.” (“That was an unfortunate article,” Pete Slaiby, the Alaska vice president for Shell, told a crowd in Kodiak in early January, reiterating the need for “very specific things” it needed done on the mainland.)

The Aiviq also had problems. Towing the Kulluk over the summer, the tug had run into a storm that sent saltwater flooding over its back deck and into the fuel vents and interior spaces, damaging cranes, electronics and heating systems. In a separate incident on the November return from the Beaufort Sea, the tug had an electrical blackout, and one of its main diesel engines overheated, rendering it unusable until it was repaired in Dutch Harbor. By law, according to the Coast Guard report, such system failures should have been reported to the Coast Guard. They were not. The Aiviq’s captain sent an email to Chouest headquarters titled “Storm Damage Lessons Learned” and recommended that they raise the height of its fuel vents to avoid future submersion during the next big tow through heavy Alaskan seas, but this was never done.

On the morning of Dec. 21, as the Aiviq and Kulluk crews prepared to depart on the three-week journey back to Seattle, Shell’s new warranty surveyor took careful note of the certificates for the steel shackles that would connect the two vessels and bear the dead weight of the giant Kulluk — without noticing that they had been replaced with theoretically sturdier shackles of unknown origin. He examined the shackles but had little means by which to test their strength. He did not ask the crew to rotate the shackles, as one might rotate tires on a car. He did not consider it part of his job, he would tell Coast Guard investigators, to examine whether Shell’s overall plan to cross the Gulf of Alaska made any sense.

The Aiviq pulled the Kulluk away just after lunchtime. The Aiviq’s usual captain was on vacation for the holidays, as were Slaiby and other members of Shell’s senior Alaska staff. The rest of the tug’s crew had limited experience in the operation of the new, complex vessel. Onboard the Kulluk

was a skeleton crew of 18 men, along for the ride in large part because of an inconvenience of the rig's flag of convenience. The Kulluk was registered in the Marshall Islands, the same country where BP's contractors had registered the Deepwater Horizon, and the Marshall Islands required that the rig be manned, even when under tow. The new captain of the Aiviq, Jon Skoglund, proposed aiming straight for the Seattle area, a direct and faster "great circle" route that would leave the two ships alone in the middle of the North Pacific but would avoid the shoals, rocks and waves of the Alaskan coast. There would be no shore to crash into. They could lengthen the towline for better shock absorption and would have room to move if problems arose. The idea was dropped because the Kulluk's 18 crew members would then be out of range of Coast Guard search-and-rescue helicopters. Perversely, a flag of convenience, seen as a way to avoid government regulation, had Shell seeking a government safety net — and a longer, more dangerous, near-shore route.

Skoglund was so concerned as he began his first Gulf of Alaska tow that he sent an email to the chief Kulluk mariner on the other side of the towline. "To be blunt," he wrote, "I believe that this length of tow, at this time of year, in this location, with our current routing guarantees an ass kicking."

The Kulluk's crew celebrated Christmas Day three days later with a lonely barbecue on the deck of the rig. As forecast, the weather was turning. By midnight there were gale-force winds and swells the size of houses. Rather than crash forward through the building swells, as other ships might, the Kulluk marked their passage like a giant metronome, pitching and rolling a stomach-churning five, then seven, then 10 degrees off vertical. Six hundred yards ahead, the same waves were bucking the Aiviq, but the two ships were out of sync. The towline between them was slack one moment, then crackling with tension, then slack again.

The Coast Guard report describes the harrowing series of events that followed. At daybreak on Dec. 27, still two weeks out of Seattle, the Edison

Chouest employee managing the towline on the Aiviq side, Third Mate Bobby Newill, shot a cellphone video for his wife as he gradually let out a hundred yards more line, trying to find a sweet spot. The ship's tow system was built by Rolls-Royce: a winch on the back deck and computerized controls up in the wheelhouse. Newill's video shows the view through the wheelhouse window as the stern of the Aiviq bobs in the Gulf of Alaska, the Kulluk in the distance, then it pans to a computer monitor that displays towline tension. From 35 tons, the tension shoots rapidly into the triple digits — “Here we go,” Newill says — and peaks at 228 tons. “That is a good quality piece of wire,” he says as the numbers drop again.

Between 5:34 a.m. and 11:29 a.m., according to a later computer analysis by Rolls-Royce, the Aiviq's “wire tensile strength overload” alarm went off 38 times. It was set to trigger at 300 tons. The alarm, a piercing ring, would not stop until Newill acknowledged it on the computer screen. New to Alaska and new to a ship that was new to the world, Newill later claimed that the alarm never went off. Coast Guard investigators concluded that he mistook the tension alarm for another alarm that was known to be acting up.

At 11:35 a.m. the towline snapped. Video shot from the Aiviq's closed-circuit cameras shows the moment. It is unremarkable: The taut line stretches into the sea. The tail of the tug rises once again, and the line suddenly whips back and goes limp. The Aiviq keeps bobbing. Aboard the Kulluk, the crew prepared an emergency towline. Retrieving and reconnecting with the original line was impossible, investigators would learn, because “the Kulluk cranes could only be used in ideal sea and wind conditions seldom found in the winter Gulf of Alaska conditions.” Instead, the Kulluk would now be towed from what was considered its stern, from a bracket beneath the helicopter deck, where an emergency line was already in place. Because the Kulluk was perfectly round, it was hard to imagine that the new orientation would make any difference.

To pick up the emergency towline from the Kulluk, the Aiviq made a U-turn, just as a water-ski boat might go back for a fallen skier. But it did so in swells that exceeded 25 feet. Briefly perpendicular to them, it took a heavy roll. A steel hook the size of a grand piano, secured to a wall when not in use, came crashing down, damaging handrails and vents. The engineer welded it to the floor to keep it from sliding; sailors chased down inflatable “anchor balls” now rolling loose around the ship. Seawater poured onto the deck and, once again — because no one had acted on the captain’s recommendation to move them higher before the Aiviq left Dutch Harbor — into the fuel vents.

Three hours after the Aiviq lost the Kulluk, the ships were connected again. To reduce stress on the emergency towline and shackles, the crew of the Aiviq reduced engine power, keeping tension to no more than 60 tons. They tried to put distance between the ships and a nearby area of shoals, where giant swells could crest or the Kulluk, with its 35-foot draft, could drag on the seabed. This, at the time, seemed the primary danger. The nearest land, Kodiak Island, was still 65 miles away. The wind backed off, but the seas remained heavy. By 4:30 p.m. it was dark.

In the early-morning hours of Dec. 28, the Aiviq’s four main diesel engines began to fail: No. 2, then No. 3 and No. 4 and, finally, No. 1. The apparent cause was saltwater intrusion. What remained were small, electric thrusters — not powerful enough to keep both vessels moving forward, but they could at least keep the Aiviq facing into swells and away from the Kulluk. The Aiviq’s course was now determined by the westerly current and southwesterly winds. In calls to the Coast Guard that day and the next, Skoglund, the Aiviq’s captain, would make reference to “some water in our fuel” and “some signs of water intrusion.” But in the aftermath of the Kulluk incident, the Aiviq’s engineer, Carl Broekhuis, theorized that saltwater intrusion wasn’t to blame after all. He suggested that an unknown fuel additive had ruined the Aiviq’s injectors, shutting down its main engines. Perhaps what happened was outside his or Edison Chouest’s or Shell’s

control. But when the engine manufacturer later analyzed the spent injectors, it found rust and high levels of sodium, chlorine, calcium and potassium. “These elements,” notes the Coast Guard report, “are major components of seawater.”

Skoglund and his counterpart on the Kulluk, a Shell subcontractor known as the “tow master” — in the official tow plan for the journey to Seattle, Shell never made clear who between them was in charge — notified Shell and Chouest almost immediately after the troubles began. Shell notified the Coast Guard. Early on Dec. 28, just as the Aiviq’s four diesel engines failed, a Coast Guard cutter appeared. The cutter tried to connect to the Aiviq by an emergency towline — it would tow the tug, which would tow the Kulluk — but in heavy seas, the line somehow became wrapped around the cutter’s own propeller. The rescue ship limped back to base on Kodiak. The Aiviq and Kulluk remained adrift. The second of what would be four successive low-pressure systems approached.

In Anchorage, 350 miles to the north, Shell, Chouest and the Coast Guard established a formal structure to deal with the growing crisis. The unified command, as it was called, reporting ultimately to a Coast Guard captain. It took over a downtown Marriott and quickly grew to hundreds of people wearing vests and lanyards and huddling in conference rooms. They updated Lisa Murkowski, a United States senator from Alaska. They called in more tugboats, including the Alert, one of the most powerful in Alaska, which began chugging toward the scene from Prince William Sound, a day away.

By the early, dark hours of Dec. 29, the unified command was convinced that lives were at risk, and it dispatched two Coast Guard Jayhawk helicopters to evacuate the 18 increasingly anxious men stuck aboard the Kulluk.

The rescuers had thought it would be a relatively easy job. The Coast

Guard air base on Kodiak Island, the northernmost such facility in the country, is an outpost at the edge of a wilderness of water and mountains. Its search-and-rescue area spans four million square miles. To have a case “so close to home plate,” as one of them put it — 45 flight minutes and roughly a hundred miles away — seemed a stroke of incredible luck. Further, the Kulluk’s size suggested stability, a straightforward rescue.

When it appeared out of the night, “the Kulluk was wicked lit up,” said Jason Bunch, the Coast Guard rescue swimmer on the first of two helicopters. “It was like a city.” The pilots illuminated the rig further with hover lights and spotlights. They wore night-vision goggles, just in case the lights weren’t enough. They had no problems seeing the rig and the crippled Aiviq and the taut line between them, but the surrounding darkness still eroded the pilots’ depth perception. With no horizon to reference, it was harder to hover, and the goggles took away their peripheral vision.

There are two primary ways Jayhawk crews save people at sea: They lower a basket to the deck of the stricken vessel and hoist them up, or they pluck them out of the water by lowering a basket and a swimmer like Bunch, a 12-year Kodiak veteran, who in 50-foot swells and 35-degree water will drag them to the basket himself.

But now that the Kulluk was being towed from its “stern,” the point of attachment for the emergency towline, it and the Aiviq were oriented exactly the wrong way for an approach. In order to maintain control, the helicopters would ideally face the heavy winds head-on, but the derrick blocked their path. If they tried to hover above the flight deck, the only obvious place for a hoist, there was a perfect tail wind, which made steering unpredictable and dangerous.

The wind blew the tops off some of the massive swells, but otherwise they weren’t breaking. The swells came in close sets, one right after another, interrupted by long sets of “monster waves” more than twice as high. The

Kulluk tipped severely but somewhat rhythmically until the monsters arrived. “As the bigger and bigger ones came, they made it go around in a circle,” Bunch told me in Kodiak. His eyes went buggy. His right hand gyrated wildly. The deck, normally 70 feet above the water, “was dipping so deep that the water was *surging* on it.”

“You know when you have a bobber on a fishing pole,” he asked, “and then you throw it out there and reel in really fast, and it makes a wake over the bobber? That’s what it looked like.” If the Kulluk’s deck was pitching that badly, he said, you could imagine what the derrick was doing. It looked as if it were trying to bat the helicopters out of the sky.

The two helicopters took turns circling the drill rig, looking for a way in, for any place to lower the basket. They radioed back and forth with the Kulluk’s crew — “Very, very professional, very squared away,” Bunch said, “considering the environment” — and briefly wondered if there was a way to get them in the water to be picked up by the swimmers. It was impossible. The jump from the deck to the sea could kill a man if he timed it wrong. If it didn’t, the Kulluk could kill him on the next swing of the bat. They flew back to Kodiak, refueled, brainstormed some more at the base, then went back out.

Six hours had passed from the moment Bunch and his crew first flew over the Kulluk. It was still night. Bunch took out his watch and began timing the gaps between big sets of swells. “We started coming up with some harebrained schemes,” he said. They looked for “maybe doable” spots for the hoist. “We’d have 90 seconds to be in and out, which is just impossible, but we were actually talking about it.” Reality — what their commander called “the courage not to do it” — slowly set in. The two helicopters returned to base. “We were experienced,” Bunch said, “so eventually we were like, ‘This is stupid.’”

It was just before dawn when a helicopter crew led by Lt. Cmdr. Jim

Cooley replaced Bunch and the other fatigued rescuers from the night before. The Kulluk was still about 16 miles from Kodiak Island but also 16 miles from another island, Sitkinak, and being blown toward it.

The sun was coming up as Cooley, a blond distance runner with a broad smile, reached the rig. The seas had slightly calmed. The wind angle had slightly changed. “Hoisting was still in the dicey category,” he said. But it now seemed possible. They did a test run first, hovering without the basket. The deck of the Kulluk still rose and fell significantly with every swell. The derrick was still pitching, and one of its cables had come loose and was whipping around in the air. But if they hovered in just the right spot and paid attention to the swell, it seemed possible.

There was another problem: The smallest of the 18 men aboard the Kulluk weighed 235 pounds. The largest ones were well over 300. Cooley seems to feel guilty even remembering how big they were. But when you’re flying a rescue mission, you notice. “They were huge,” said his flight mechanic, James Smith. “They were all huge — huge guys. There’s no other way to describe it.” Weight is everything to a helicopter pilot. You want just the right amount of fuel. Too much fuel, and you’re too heavy to fly. Too little fuel, and you don’t make it back to base. The same goes for the people you save: You want to be able to pack as many into the aircraft as possible, so you don’t have to do multiple sorties. But you don’t want to pack in so many big people that you can’t maneuver.

If they added an extra flight to Kodiak and back, if they were fast, they might just be able to do it before darkness returned. Cooley and his rescue swimmer watched the coming waves and called out “large . . . medium . . . small.” Smith, in charge of lowering the basket, directed the other pilot, who was at the controls that morning: “Easy left. Easy back and right. Back and left 30 feet. 30. 20. 10. Hold.” Lowering the basket and more than a hundred feet of line from the helicopter to the pitching deck below was like a mad version of going after a stuffed toy in an arcade claw-machine game. “Then a

flat sea came in, and we could crank out a hoist,” Cooley said.

One by one, the Kulluk’s crew were hauled up. Most were calm. But the rig rose up and gave the basket a bump just as one man was being lifted off the deck. “This guy’s a little nervous,” Smith said. “He’s got a death grip.” Cooley looked down and saw his face. “I’m seeing the reality,” he told me. “This guy is scared.” They pulled him into the helicopter and sat him on the floor. Four hours after the rescue crews arrived, they plucked the final man off the Kulluk and flew back to base.

The crew was safe, and now the Aiviq was coming back to life: Before and during the rescue, the helicopters had also hoisted 2,000 pounds of replacement parts to the crippled tug: injectors that had been flown to Alaska in a private jet, then transferred to the Jayhawks. All four main diesel engines on the Aiviq would eventually be restarted. With another low-pressure system on the way as the first engines fired up, the tug began trying to tow the Kulluk south into the open ocean.

The tugboat Alert arrived on the scene on Dec. 30, and one of the first communications that Craig Matthews, the Alert’s chief engineer, recalls hearing was more bad news. “Be advised,” a Southern drawl said over the radio. “We just parted our cable.” Communications — carried out over multiple radio channels and satellite phones between multiple ships and multiple federal and state agencies and Shell officials in Kodiak and Anchorage — had become so complex that they were now filtered through a Coast Guard C-130 flying somewhere in the clouds above. But the voice had come from the Aiviq. The emergency towline had snapped. The Kulluk was once again adrift, this time 30 miles from land.

Compared to the Aiviq, the Alert was small — half the Aiviq’s horsepower, a third of its length — but next to every other tug in Alaska, it was big. It usually worked in Prince William Sound, escorting oil tankers from the terminus of the Trans-Alaska Pipeline System in Valdez past Bligh

Reef, the site of the Exxon Valdez spill in 1989, the worst in Alaska history. The escorts were mandated after the spill. The Alert's job was to prevent another disaster, and its crew took that to heart when sent to keep the Kulluk off the rocks.

"I really wanted to do this thing," said Matthews, who is 57 but looks at least a decade younger. "I really did." He settled on a plan: His captain would back the Alert carefully up to the Kulluk, which was still lurching wildly in 30-foot swells. Matthews would go out on the deck with a grappling hook. When they got close enough to the rig's snapped emergency towline, he would throw the hook. He would reel it in by hand. Then he would get the Alert's own tow cable and tie the two together with the knot he suggested: a bowline.

The crew of the Alert stared at the Kulluk from a distance, through binoculars, in low light and tossing seas. It was drifting near Albatross Bank, "a wonderful halibut spot," Matthews said. He used to fish it. It was wonderful but shallow, and now the waves were so big that the Alert was looking down on the giant rig one moment and looking up the next. They worried that if they got too close, the Kulluk, half the weight of the Titanic, would crash on top of them.

The captain backed in until they were barely 200 feet from the heaving Kulluk. Matthews spotted the orange emergency line. He threw the grappling hook. He missed. The captain backed in closer. Now the Kulluk filled the sky, and Matthews threw again and hooked the towline. It was thicker than a man's arm, a soggy dead weight. "By the time I pulled it out of the water," he said, "I was so winded I didn't know whether I could tie a knot."

He and the tug's chief mate laid the orange line on the deck next to the yellow one from their tug. A third man stood on it so it wouldn't slip back into the water. Now Matthews tried to orient himself. A knot he could

normally tie with one hand without looking would have to be tackled by two people, chunk by chunk. The chief mate helped him lift the line again, and together they hurriedly bent it and forced the rabbit through the hole. As the tugboat bucked in the passing swells, they dragged and pulled the rope tight. Matthews had planned to do a second bend, just in case, but he was exhausted. “Is that it?” Matthews recalls the chief mate asking. His answer was to let the towline slide over the edge. They let out more line from their winch, slowly putting tension on it as the tug pulled away from the Kulluk. “Please hold, please hold,” he whispered. The line went tight. Everyone onboard started hooting.

For the next four hours, the Alert made halting progress against heavy winds and strong currents. Just before dawn, the Aiviq appeared on the horizon: Its crew wanted a last shot at the Kulluk.

“We’re gonna come around the Kulluk’s stern and grapple that other wire,” Matthews recalls the drawl announcing over the radio. “Don’t worry. We do this all the time. You won’t feel a thing.” The Aiviq snagged the 2,000-foot wire still trailing the rig. Soon a violent shudder was felt across the Alert — but Matthews’s knot still held. Now the Aiviq and Alert were towing the Kulluk side by side, one to starboard and one to port, a few hundred yards of churning Pacific Ocean between them. Despite the building storm, everything seemed to be under control. Matthews had been awake all night. He descended to his stateroom.

He doesn’t remember how long he slept, just what woke him up. Matthews keeps his space organized, his stateroom tied down. But suddenly pens and water bottles were loose and sliding across the floor. His corkboard dislodged from a wall and crashed to the ground. An alarm sounded. He rushed up to the wheelhouse.

They were stuck “in irons”: The stronger, younger Aiviq had moved away from the Alert in the storm. No longer were they towing in parallel — and the

Alert couldn't do anything about it. It was now at 9 o'clock to the Aiviq's 12 o'clock, almost perpendicular to the wind and unable to turn upwind and catch up to the larger tug because the Alert's towline to the Kulluk was too taut. The Alert was locked in place, slamming sideways into the troughs of the waves. "The waves were just beating us," Matthews said. "Our entire deck was exposed."

The line was riding so tight over the edge of the stern that there was a danger the Alert would flip if the right swell came along. Its captain made an urgent call to the Aiviq. The larger tug maneuvered closer to the Alert, which increased its speed. The two ships were just coming back together, straining against the storm, when the Aiviq's cable snapped for the third and final time.

The Alert slid right into place ahead of the Kulluk, suddenly out of irons and facing the waves and winds head on. "It was immediately so much better," Matthews said. "The only problem was that we were now the sole tow." Sitkalidak, a barrier island off Kodiak Island, was little more than 10 miles downwind. From that moment on, the wind would push the Kulluk inevitably toward the island, dragging the Alert along behind it.

Now more was at stake than the Kulluk or the prospects of the company that owned it. The men on the Alert had to save themselves. "Winds to 50 knots," Matthews recalled. "Seas 35 feet. We were going backward" — pulled by the Kulluk — "at 2 knots." They pondered the endgame. With their spotlight, they watched the tow wire pull out of the water and vibrate under the tension. They worried that it would break and snap back. At first, Matthews wanted to remain tethered to the Kulluk and take it into the beach at Sitkalidak Island. The tug could stay just offshore, he reasoned, away from any breakers; when the storm went down and the tide went up, it could pull the rig back off the beach.

The captain called the Coast Guard, but no one wanted to go scout the

landing conditions, Matthews said. It was too risky. The call came from Shell at 8 p.m. on New Year's Eve: Cut it loose.

Matthews didn't want to do it. "I felt this attachment to succeeding," he said. He wondered about the emotion. "We're trying keep this chunk of metal off a beach, where a chunk of metal shouldn't be. But otherwise it's just a chunk of metal that belongs to a rich oil company. It's bottom line to them. Why does it matter to me? Is this important?" But somehow it was. "I felt tears welling up in my eyes when I had to let go of the Kulluk."

The shore was only a few miles away, and now Matthews had to figure out how to untie his knot. His bosses called and suggested that he cut the thick cable with an acetylene torch tied to a broomstick. When he peered out the back window at the tow winch, three feet of water was surging over the tug's weather deck. He put on foul-weather gear and tried to time the waves. The first one came over his chest and filled his boots and pants. But he got an idea: If he let the winch unspool all the way, all that would connect the Alert and the Kulluk would be a metal plate and two bolts. They wouldn't hold.

The control room filled with smoke and bits of rust as Matthews let the winch spin.

"Is it gone yet?" the captain asked. Matthews had three wraps left. He was trying not to rats-nest the cable.

"Is it gone yet?" the captain asked again. "Is it gone? Let it go!"

There was a loud boom and a shower of sparks. It was gone. Matthews turned to see why the captain was so anxious. He found himself staring at a wall of water — a 50-foot wave, the biggest they had seen. The Alert went straight up its face. "There was this feeling of up and up and up and up and up and up," he said. He put his hands against the back window to stabilize himself. White water was running over the front window. They couldn't see anything. "When is this going to stop?" the captain asked.

At the top of the monster wave, they could suddenly see for miles. “This incredible moon was out,” Matthews said. “There was this oceanscape. These mountains of water. Storm clouds. It was a thing of awesome beauty.” It lasted for only a second or two. Then the Alert tipped down the other side, and the whole tug shuddered as it dived into the trough. The window filled with the view below the waterline, a Pacific green. It looked like an aquarium.

He watched the Kulluk on the radar. It started out slow, but let loose from its tether, it accelerated. It hit the gravelly shore 45 minutes later. Waves crashed over its hull, the wind kicked up a spray and the shoreline was soon littered with the Kulluk’s lifeboats and life jackets and hundreds of little silver packets of drinking water meant for men lost at sea. There was no spill. In the early hours of New Year’s Day, the Coast Guard flew over the wreck. In aerial photos published around the world, the rig was dwarfed by the auburn, grass-covered hills of the uninhabited island where it had finally come to a rest.

Eight weeks later, Shell announced a “pause” in its Arctic exploration. It wanted to “prepare equipment and plans for a resumption of activity at a later stage.” The company declared the rig a total loss and hauled it atop a larger ship by way of Singapore to China, where it was dismantled in a shipyard south of Shanghai.

Shell accepted the resignation of the executive in Houston overseeing exploration in Alaska and the rest of North America, a 29-year veteran of the company. It became the subject of multiple reviews and investigations by the Coast Guard, the Interior Department and the Environmental Protection Agency. One investigation resulted in felony charges for Noble, one of the subcontractors. And instead of adding to its reserves, it was burning through them. In early 2014, Shell issued a surprise profit warning, the first since the reserves scandal a decade earlier.

Little about the increasingly extreme hunt for energy had changed. Shell still needed oil. The Chukchi and Beaufort Seas had oil. Shell still had its leases, and in August, and as oil hovered around \$100 a barrel, the company announced its intention to return to the Arctic. Its new exploration plan called for placing two rigs in the Chukchi, to maximize the exploration time between the ice's retreat and its return. One rig was a replacement for the Kulluk: equally massive and also lacking propulsion, but not round. It would have to be towed. The other was the Noble Discoverer, which had been refurbished yet again — deemed unable to leave Alaska on its own power in 2013, it had been hauled to South Korea on a larger ship — and was now 49 years old. The company also announced that it would improve safety measures and more closely manage its contractors. “All to say we’ve taken a critical look at the experiences we’ve had in Alaska over the last several years,” Curtis Smith, a Shell spokesman, told The Times in August, “and this exploration plan takes those learnings into account.”

Pete Slaiby, still on the job in Alaska even after his boss in Houston was replaced, set out to fix a new problem: If oil production doesn't soon begin on Shell's Arctic leases, they will expire, the first ones in 2017. Slaiby petitioned for an unprecedented five-year extension in the Beaufort and Chukchi Seas, laying out the logic in a 10-page letter to the Bureau of Safety and Environmental Enforcement. “Despite Shell's best efforts and demonstrated diligence,” he wrote, “circumstances beyond Shell's control have prevented, and are continuing to prevent, Shell from completing even the first exploration well in either area.”

The oil giant lurched forward, seeming to regain power with every step: a joint venture in July with Inupiat villages, a September meeting about the Arctic at the White House, progress in November in a legal fight over drilling the Chukchi. The future looked promising but for one thing. In September, almost as soon as Shell had submitted its exploration plan, oil began a free fall. The price dropped from \$90 a barrel that month to \$80 in October and

to \$70 in November — the point at which unconventional oil tends to become uneconomical. Last month, the price went as low as \$55 a barrel, the lowest in five years. On the two-year anniversary of the wreck of the Kulluk, the Arctic, at least for now, had stopped making any sense.

Correction: January 25, 2015

An earlier version of a map with this article included two imprecise locations for the Kulluk. The locations of the rig's first drill site in the Beaufort Sea and the Sivulliq prospect drill site are approximately 45 and 15 miles from shore.

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