RRS Sir David Attenborough ice trials in Antarctica

Ice Load Monitoring Systems are becoming increasingly important as a way of mitigating risks in ice. Merely specifying a system is, however, not enough. It needs to be set up properly and calibrated, which was done for RRS *Sir David Attenborough* during ice trials in Antarctica at the beginning of 2022.

British Antarctic Survey, BAS, is a U.K. governmental organisation, delivering and enabling world-leading interdisciplinary research in Antarctica and the Arctic, as well as running five research stations on the Antarctic mainland and sub-Antarctic islands. Their two ice-capable research vessels that brought supplies and scientists to and from Antarctica for many years have been replaced with a new state-of-the-art multipurpose polar research ship, the RRS *Sir David Attenborough*, named after the British broadcaster and natural historian.

Teemu Heinonen, Sami Saarinen, Jillian Adams and Rob Hindley headed to Antarctica to perform the ice trials of the new research vessel.

Ice trials in Antarctica

In January 2022, an Aker Arctic team comprising Rob Hindley, Jillian Adams, Teemu Heinonen and Sami Saarinen headed to Antarctica to perform the ice trials of the new research vessel.

The trip began with a 14-day quarantine in the UK to ensure that everyone was safe to travel. After being cleared, the group boarded a plane taking them from London via Cape Verde to the Falkland Islands. Once there, they stepped on-board RRS *Sir David Attenborough* for the three-day transit south to the Antarctic Peninsula and onwards to Case Corner on the English Coast of Antarctica.

Two-tier trials

The ice trials were conducted over a period of ten days, in fjords along the Antarctic Peninsula, the pack ice in the Bellingshausen Sea and the fast ice at Case Corner. They consisted of two important parts: Firstly, tests were carried out following a relatively standard set of Aker Arctic procedures to ensure that the vessel fulfils contractual specifications when performing in ice.

"The second part of the trials was aimed at calibrating the ice load monitoring system and, as a result, refine the operational limitations of the ship, which is something new," explains Rob Hindley, head

RRS Sir David Attenborough is a multipurpose polar research ship. It brings supplies to Antarctica and the sub-Antarctic islands and conducts scientific research. Photo courtesy of BAS.

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of machinery and structures at Aker Arctic. "This will help the operator understand what the ship is capable of in ice conditions from a safety point of view."

The trials were performed along the Antarctic Peninsula at a few large bays with fast ice; ice that is attached to the coast and not moving. These are the ideal conditions for level ice tests because

Aker Arctic team taking ice measurements for the trials.

there is a regular consistency of ice, coming as close to a scientific test as possible.

The standard ahead tests were done in level ice with various power levels to measure the resistance, followed by turning tests in level ice and other controlled manoeuvres. The ship then went searching for other ice conditions in the Bellingshausen Sea to evaluate the full range of environmental conditions expected for the ship's service.

Calibration tests

"After the first part, we moved over to the tests for operational limitations, which was the more fascinating part," continues Hindley. "We wanted to do controlled manoeuvres in measured conditions with the aim of getting the right trends in terms of the response of the ship, the ice load monitoring signals and the forces we were measuring from the hull, versus what manoeuvres the ship was doing in ice. These results will be used to build up the practical operational envelope for the ship."

"After the fast ice tests for level ice evaluation, we used the ice we had broken up as a test area. We also searched for other types of ice conditions for turning tests, ahead tests and manoeuvring, ranging from close pack to open pack ice to get a variety of ice conditions and concentrations to test the ship in," Hindley says.

Meet Rob Hindley

Rob is currently head of Machinery & Structures at Aker Arctic. His role involves coordinating machinery systems, structural, and deck outfitting disciplines as well as consultancy work supporting the practical application of Arctic technology to new, and often novel, ice-going ships. In addition, Rob works in a project management role for early concept and tender design projects as well as acting as structures discipline lead across the design development process.

Previously Rob was global principal specialist for Arctic technology at Lloyd's Register, where he held overall technical authority for ice class, winterization and implementation of the Polar Code. This included an assignment representing IACS at the IMO during the development of the Polar Code. Rob has worked in Canada, the UK, the Middle East, and in South Korea in roles involving ship surveying, classification rule development and consultancy. He is a chartered engineer and holds a master's degree in naval architecture from Newcastle University, U.K. He is currently undertaking postgraduate study at Aalto University with a focus on operational risks for Arctic shipping.

Hindley and his team are helping BAS to get the full potential out of the ship.

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The trials team also worked with the crew to attempt to hit certain ice floes at specific angles, so that the hull contacted the ice where the ice load sensors are located.

"Our aim was to artificially create the worst types of manoeuvres and measure the effects on the ship to draw an upper limit, all within the parameters of safety, naturally. All of this will help to establish the operational limitations," Hindley adds.

Propeller-ice interaction

Complementary to these tests, Lloyd's Register was also on-board and had instrumented the two propulsion shaft lines with strain gauges to measure torque, thrust and the shaft line dynamic response.

"This information supported the performance testing and gave an insight into the magnitude of the load on the propeller indirectly through the responses measured on the propeller shaft," Hindley says. "Ice ridges and ice channels are typically the worst conditions for propellers."

Ice load specifications

RRS *Sir David Attenborough* is not an Aker Arctic-designed vessel. However, during the design phase, Rob Hindley helped BAS with their Polar Code compliance and supported them on the ship specification review while working for his previous employer, Lloyd's Register. After BAS decided on an ice load monitoring system, Hindley teamed up with Ville Valtonen from Aker Arctic and continued to consult BAS on the system development.

"Our work on this trip was the complementary side to the specification and installation: to evaluate the instrumentation when in ice, check that it was giving reasonable results and ensure that the data is usable for the crew onboard," Hindley says.

Translating ice load data

RRS *Sir David Attenborough* is a multipurpose research ship with long transits in open water from the UK to Antarctica and back. It brings supplies to Antarctica and the islands and conducts scientific research.

"The ship is bigger than the two previous vessels, more capable in ice but with a different ice class. The operator therefore needs to understand how cautious to be when moving in ice areas. We are consequently translating the data from the ice load monitoring system and developing a set of operational lim-

In December 2022, a week of follow-up ice trials are planned, where direct ice loads on the propeller blades will be measured. Photo courtesy of BAS.

itations and boundaries for the ship to operate safely. This concerns the whole package, including both the hull and the propellers. It will help the operator to understand how hard the ship can be pushed and what the consequences will be," Hindley explains.

"An ice load monitoring system is extremely useful but requires detailed engineering to enable the system to work properly and also to give information that is useful for the operator," Hindley emphasises. "If the system never alarms the operator may get a false feeling of security. There needs to be an understanding of what a red alarm or yellow alarm means. Hence, it is essential to calibrate the system."

Full potential of the ship

Additionally, the Polar Code now requires ships to have operational limitations in ice stated on the Polar Ship Certificate. An approved methodology of evaluating risks is mandatory, one being POLARIS (Polar Operational Limit Assessment Risk Indexing System). POLARIS itself is fairly simplified to enable codifying and sets operational risk levels based on the ship's assigned ice class. However, by using data from full-scale measurements and ice load monitoring systems the Polar Code allows more ship-specific operational limits to be set.

Hindley and his team are helping BAS to refine their operational limitations, both from the operational and safety side, in addition to the regulatory side, to get the full potential out of the ship.

Follow-up trials

In December 2022, a week of follow-up ice trials are planned, where direct ice loads on the propeller blades will be measured. Aker Arctic, BAS, Lloyd's Register and Kongsberg have partnered up and invested in instrumenting one of the ship's propellers blades directly. "The propeller is designed to be the weakest link in the propulsion train and can become the limiting factor for operation of the ship.

Thus, the operational limitations do not concern only the ship's hull but also the propeller strength. We want to find out more on what is happening on the propeller itself," Hindley says.

One of the aims of these trials is to evaluate how accurately ice loads on the propeller can be inferred indirectly from measurements on the propeller shaft. Instrumenting propeller blades directly is expensive and not practically possible for most ships, but mounting gauges on the propeller shaft is relatively inexpensive and robust.

"Data from direct propeller blade ice loads will help us refine our ice load monitoring tools further and will hopefully ensure such systems are more accessible to operators in the future," Hindley says. ■