Baltic Sea icebreaker sets new benchmark

The new energy-efficient vessel for the Baltic Sea represents a new generation of icebreakers. Utilizing the newest design tools and incorporating the latest innovations has once again enabled Aker Arctic to push modern icebreaking forward.

The final vessel design fulfils all operational specifications and performance demands in all kinds of Baltic Sea ice conditions. In addition, it incorporates new technology which improves energy efficiency in icebreaking tasks.

"Many of the innovations used in the 2016-built *Polaris* have been developed further to achieve even higher efficiency, anticipating future environmental regulations," says Project Manager Maximilian Vocke from Aker Arctic.

The challenging design project has been completed successfully in close cooperation with the Swedish Maritime Administration and the Finnish Transport Infrastructure Agency.

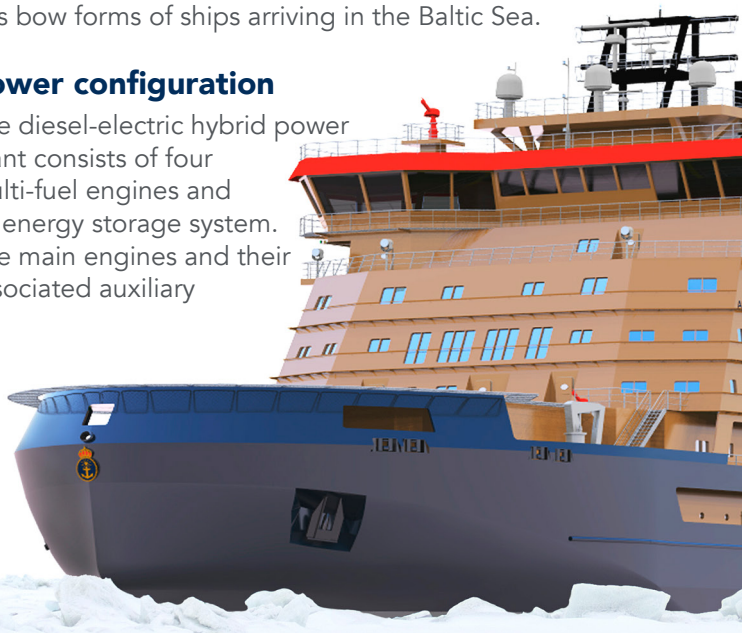
Assistance tasks

The icebreaker is designed for Baltic Sea icebreaking operations and escorting large commercial vessels arriving at and departing from harbours in Sweden and Finland. It is about 126 metres long and 28 metres wide, with a design displacement of 15,400 tons. Commercial vessels up to Panamax size can be escorted by widening a channel in ice with its azimuthing propulsion units turned outwards.
"We tested the channel widening on icebreaker *Polaris* in winter 2021," explains Tuomas Romu, naval architect and chief designer of the IB2020 project at Aker Arctic. "The flushing effect clears ice from the channel behind the icebreaker, reducing the need to tow smaller vessels.

The new icebreaker is nevertheless equipped with a specially-designed towing notch, tailored to fit the various bow forms of ships arriving in the Baltic Sea.

Power configuration

The diesel-electric hybrid power plant consists of four multi-fuel engines and an energy storage system. The main engines and their associated auxiliary



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systems have been divided into two engine rooms to increase redundancy.

"The energy storage system (ESS) can be used to balance power variation, offering lower fuel consumption and emissions. It can also be used while the icebreaker is in waiting mode between icebreaking duties, for instance, when there is not a high-power demand, " Romu says.

Development leap

The vessel has been designed with the possibility of using various fuel alternatives: hydrotreated vegetable oil (HVO), liquified biogas (LBG), and, with modifications, also fossil-free bio-methanol.

"However, regardless of choice, it uses less fuel overall for all its icebreaking tasks, compared to our reference vessel," Vocke highlights.

While the icebreaker is larger and more powerful than the *Atle*-class icebreakers it will replace, it is also more efficient, using less energy to perform the same duties compared to the older generation of vessels. Technological advancements, such as a modern hull form, propulsion system, and higher performance result in increased efficiency in all possible ways.

"There has been a huge development leap," says Romu.

Innovative design tools

New design tools developed at Aker Arctic in recent years have played an important part in the design. For instance, the hull structure has been designed with the non-linear finite element method developed by Structural Engineer Ville Valtonen and his team.

Simulation tools for machinery systems combined with life cycle costs (LCC) and life cycle assessment (LCA) have been essential in evaluating costs and emissions over the entire anticipated lifetime of fifty years. The icebreaker's expected emissions are calculated to be 70% lower than *Atle*-class vessels carrying out the same icebreaking operations.

"Yet, the new icebreaker can perform much more, bringing icebreaking to an entirely new level," Vocke underlines. "From a performance perspective, it will be the best and strongest Baltic Sea icebreaker ever built."

Wide range of model tests

To ensure that the design meets all the stringent requirements of the customers, a wide range of model tests was performed. Ice model tests, open water performance tests, seakeeping tests and manoeuvring tests confirmed that all obligations have been fulfilled. Additionally, wind tunnel tests were carried out in Denmark to examine, for example, how wind conditions affect the helicopter landing area.

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The flushing effect for widening a channel in ice was tested on icebreaker Polaris in winter 2021.

A supplementary close-towing test was completed in the ice model test basin to investigate how the vessel can manoeuvre while towing a large commercial vessel. The results also confirmed this capability.

Plans forward

The tender design documentation is soon ready to be sent out to shipyards to invite construction quotations. An initial request for information was already completed in autumn 2021.

The cooperation agreement regarding icebreaker design between the Swedish Maritime Administration (SMA) and the Finnish Transport Infrastructure Agency (FTIA) will change its form when the design project is finalized, into a cooperation based on information sharing. Sweden is hoping for a construction decision by June 2022, to begin the acquisition process.

"If all goes according to plan, we hope to begin building the first icebreaker in 2023, with delivery in 2026, and commissioning for the season 2026/27," says Dan Broström, project manager at SMA. "The following two could be ready a year later."

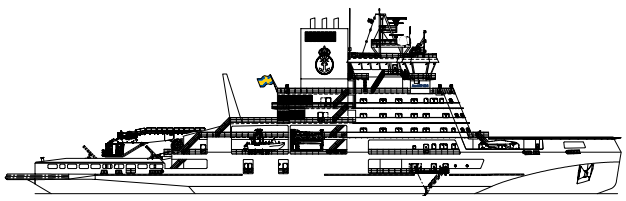
Helena Orädd, project manager at FTIA, says that Finland will follow the Swedish construction closely and support SMA in the acquisition process.

Meets expectations

Both Orädd and Broström are very pleased with the final icebreaker design. "We have learned tremendously during the process, both from each other and from Aker Arctic," Orädd underlines. "Initially, we had a pile of requirements which were translated into a design after a huge amount of work. First, we needed to understand the differences in Swedish and Finnish operations and what implications this had for the icebreaker. Then Aker Arctic developed the technical solutions."

"I believe it has been a challenge to have two cooperating clients who wanted to participate actively in the entire process," Broström reflects. "However, Aker Arctic humbly responded to every change and demand in order to perfect the design as our learning increased."

"The final icebreaker design meets all our expectations and will be efficient in escorting large commercial vessels arriving in the Baltic Sea, while lowering emissions from icebreaking operations," they add. ■



Technical details of the Aker ARC 130 S design:

Length overall (incl. towing notch): about 126 m
Beam: 28 m
Design draught: 8 m
Displacement at design draught: about 15400 t
Ice class: Polar Class 4 Icebreaker (+)
Power plant: multi-fuel hybrid diesel-electric; four main generating sets
Propulsion system: three azimuthing propulsion units; about 21 MW
Operational endurance and autonomy time: 28 days with 54 persons onboard