Aker Arctic
The Ice Technology Partner

Arctic Passion News

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- Aker Arctic 20 years
- Ice load monitoring for Canada's MPVs
- Le Commandant Charcot traverses Arctic poles
- Propulsion delivered for Finnish Navy Corvette

In this issue

Page 4
Twenty years of ice expertise

Page 9
ILMS for Canada's MPVs

Page 10
Le Commandant Charcot traverses Arctic poles

Page 15
Propulsion for the Finnish Navy

Table of contents

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Front cover

In September 2024, the luxurious icebreaking exploration cruise ship, *Le Commandant Charcot*, made history by becoming the first vessel to reach the legendary North Pole of inaccessibility, as well as the magnetic and geographic North Poles, during a transpolar traverse from Alaska to Svalbard. Aker Arctic developed the vessel concept together with Stirling Design International and the exploration cruise company Ponant Explorations. Photo: Antoine Le Guen/ PONANT.

Read more on page 10.

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Meet us at these events in 2025

April	6 – 9.4. Sea-Air-Space, Washington, USA
May	21.5. Wind Finland Offshore 2024, Helsinki, Finland
June	1 – 6.6. ISOPE, Seoul, South Korea
	2 – 6.6. Nor-Shipping, Oslo, Norway
	22 – 27.6. OMAE, Vancouver, Canada

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Dear Reader,

Over the past year, global geopolitical tensions have intensified, leading to an increasingly polarised world. This division affects all sectors, including Arctic technology development and icebreaker design.

The rising tensions highlight the need for resilience and adaptability in our industry. As divisions between nations and regions deepen, cooperation and innovation in Arctic operations become even more crucial.

Recently, United States, Canada, and Finland signed a Memorandum of Understanding (MOU) on icebreaker collaboration, the ICE Pact. This initiative formalises cooperation between the three nations, aiming to strengthen the shipbuilding industry's role in enhancing NATO's Arctic capabilities.

The ICE Pact represents a significant step forward in improving our collective ability to operate in extreme Arctic conditions, while ensuring regional security and stability.

In the Baltic Sea, damages to subsea cables and pipelines have emphasised the need for robust security measures to protect maritime infrastructure. The Finnish Navy's new corvettes under construction will improve NATO's capability to increase security also during wintertime, when the Gulf of Finland may be frozen.

While the winter of 2025 appears mild, the previous one was a stark contrast. A relevant question is today's capability to protect our waters under normal winter conditions, let alone during severe winters. In 2010/2011, ice covered nearly the entire Baltic Sea. How many naval vessels are able to operate even in relatively easy ice conditions or a cold environment?

At Aker Arctic, we continue to advance icebreaker design and ice technology expertise. Our knowhow is our contribution to solve maritime challenges in icy waters. Through our commitment to innovation and excellence, we have introduced many pioneering icebreaker concepts tailored to our clients' needs, and our work continues.

Recent efforts also include contributions to the structural dimensioning in the Finnish-Swedish Ice Class Rules, an example of our exceptional understanding of ice and how operations in ice influence the technical solutions of ships.

Our commitment to energy efficiency improvements continue to shape the environmental impact of shipping in icy waters. We have a long tradition of developing solutions that require less energy to get the work done.

Since power demand accounts for the majority of icebreaking costs, reducing this consumption lowers both construction and operational costs. Additionally, it decreases emissions, and enables the use of greener fuels.

Having served as CEO for over a year now, I find our current environment both dynamic and fascinating. The focus has shifted from commercial winter navigation to governmental projects, reflecting the evolving nature of our business landscape. The challenges we face are complex, but they also offer opportunities for growth and innovation.

Our exceptional team, driven by their passion for overcoming obstacles, continues to be our greatest asset. Their dedication and motivation are the driving forces behind our success, enabling us to push the boundaries and achieve remarkable results.

Sincerely yours,

Mika Hovilainen
Managing Director

Twenty years of icebreaking expertise

Over the past two decades, Aker Arctic has designed and developed proven concepts for 59 built vessels in our highly specialised segment. These vessels are capable of independently breaking ice and operating in freezing regions, underscoring the company's unparalleled expertise in this niche.

The company's model testing background traces back to the late 1960s when Exxon Mobile's tanker the SS *Manhattan* was modified for the Northwest Passage with the assistance of the Finnish shipbuilding company Wärtsilä, renowned for its icebreaking experience. This pivotal milestone in Arctic shipping sparked the idea of creating an ice model basin in Finland to evaluate the performance of ice-capable vessels.

The Wärtsilä Icebreaking Model Basin (WIMB) was inaugurated in 1969, laying the foundation for Finland's cutting-edge ice expertise. Fourteen years later, a new facility was built and named the Wärtsilä Arctic Research Centre (WARC), serving also universities and research institutions alongside the shipbuilding industry. Although ownership and the name of the research centre evolved over time, its core functions remained steadfast.

Turbulent times

The 1990s brought challenges, including the dissolution of the Soviet Union and the end of long-running joint projects. However, renewed interest from Western oil companies in Arctic oil and gas reserves created demand for Finnish ice expertise. During this period, a new kind of electric azimuthing propulsion unit – Azipod® was developed in Finland. This in turn led to the revolutionary Double-Acting Ship concept (DAS™) invented for ice navigation.

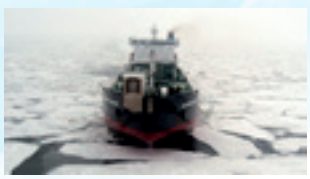
A historical moment for Aker Arctic came when Aker Group acquired ownership and separated the ice technology expertise from Helsinki Shipyard, establishing a new dedicated research facility in Vuosaari, Helsinki. Mikko Niini, managing director for Aker Arctic from 2005 to 2014, underlines the foundational role played by the original owners Aker Group, Wärtsilä, and ABB, in supporting to shape the company's successful identity.

"They trusted our expertise and helped us establish ourselves as an independent global ice partner, enabling us to engage with international clients," Niini says. "Our first complete ship design project, an Arctic container ship, included an extraordinary clause that allowed the client to cancel the order if ice performance targets were not met. This successful reference was a game-changer."

Major milestones








Technical excellence from the start

Niini also credits the initial team, comprising experts from the Arctic Research Centre and seasoned designers from Helsinki Shipyard, with ensuring the company's technical excellence from the outset.

According to Niini, developing new technology and new operations jointly with the owners was key in the growth process, mentioning the DAS™ principle and the vision of Arctic liquefied natural gas (LNG) tankers as examples. He also remarks on the oblique icebreaker as a special design project, which showed that even the wildest innovations can become successful.

"Overall, all our successes were the result of cooperation; with the owner, with the customers, and with the shipyards constructing the vessels."

Strategic growth

Reko-Antti Suojanen, managing director from 2014 to 2024, highlights the company's strategic decision to remain focused on icebreaking ships, while expanding services from model testing and consultancy to complete ship design projects.

"This required recruiting more experts and systematically developing our portfolio of services for icebreaking and ice-strengthened vessels," Suojanen explains.

Innovative milestones

Suojanen reflects on several pioneering projects that defined the company's first decades and gave way to new innovations and business areas.

The development of 300-metre Arctic LNG tankers with groundbreaking features that enabled year-round Arctic operations set new standards for the industry. The project evolved through collaboration with end customers, equipment suppliers, and constructing shipyards.

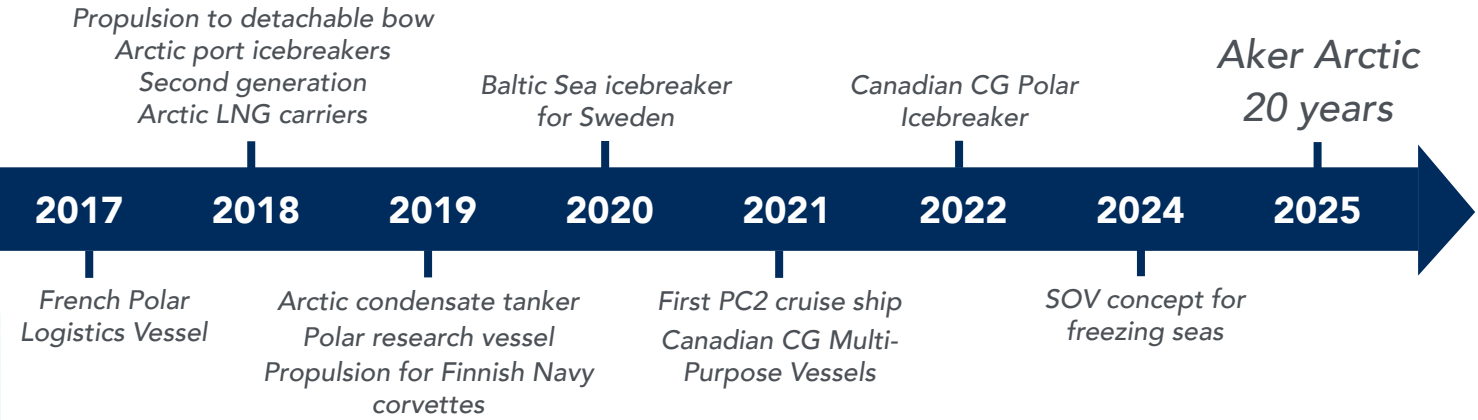
"The Arctic module carriers were exceptional with their high Polar Class 3 ice class and traditional shaftline propulsion," Suojanen says. "This opened the need for Arctic propellers, which relied on our engineering expertise, and was a new market segment for Aker Arctic. Many successful propulsion deliveries have been made since."

The Finnish icebreaker *Polaris*, designed by Aker Arctic and built in Finland, showcased innovative features, including a third azimuthing main propulsion unit in the bow thruster and LNG fuel. The project was important from many aspects.

"Using LNG as fuel in icebreaking was a novelty together with the triple-azimuth propulsion configuration, allowing significantly improved manoeuvrability and efficiency in both icebreaking and assistance work," Suojanen notes. "Also, the vessel was built at Helsinki Shipyard, with its close ties to Aker Arctic, proving yet again the well-functioning cooperation between the designer and the Finnish shipyards."

Delivering on promises

Recent highlights include designing Canada's new Polar Icebreaker and Multi-Purpose Vessels (MPVs), featuring cutting-edge technologies such as the Ice Load Monitoring System for real-time structural load analysis in ice-covered waters.










"*Le Commandant Charcot*, the combination of a heavy icebreaker with a luxury exploration cruise ship, was an extremely interesting engineering project. It has proven highly successful, offering safe travelling to remote areas in the Arctic, Antarctica, and Greenland," Suojanen adds.

"Aker Arctic has earned a strong reputation for its deep expertise, inspiring confidence in its ability to deliver on promises."

Model testing continues

In addition to advanced ship design projects, Aker Arctic has maintained its commitment to model testing for 56 years. The current ice basin, inaugurated in 2006, is located in the same building as the main office in Helsinki.

"The ice and the testing techniques are continually updated with the latest technology and uses state-of-the-art computers, instruments, and equipment for the model tests. For example, autonomous models were introduced some years ago," Suojanen notes.

Adapting to change

The geopolitical shift, following Russia's invasion of Ukraine in 2022, prompted Aker Arctic to cease all activities with Russian customers and projects. The company strengthened its focus on likeminded international partners through initiatives, such as the ICE Pact signed by Canada, Finland, and the United States in November 2024.

Mika Hovilainen, managing director since 2024, emphasises the company's forward-looking vision: "We will continue to advance our expertise and leadership in the icebreaking sector by developing solutions that utilise our extensive experience and meet customer expectations."

Today, Aker Arctic is the only organisation in the world specialising exclusively in icebreaking vessels. With a team of 56 employees and a turnover of over €15M (2024), it continues to lead in innovation and technological advancements. ■

A journey of growth

The Aker Arctic team on a trip to Åland in 2016.

Ann-Cristin Forsén, Kirsi Rosenström, and Sami Saarinen have been with Aker Arctic since the beginning, witnessing its transformation from a small model testing firm with 12 employees to an international engineering company with a staff of 56 from eight different countries.

Ann-Cristin Forsén joined the ice model testing laboratory in 1982 and has worked in all three ice laboratories (WIMB, WARC, and Aker Arctic's current laboratory). She started as a trainee, preparing ice for tests, measuring ice properties, and equipping models before progressing to conducting tests herself. She has dedicated her entire career to model testing, as she has enjoyed the diversity of tasks, opportunities to expand her skills, and limited desk work.

"Model testing was very different in the early 1980s," she recalls. "The first tests were conducted using an integrator, which generated a graph that we then calibrated. Reports were handwritten in pencil and later typed by our secretary."

Establishing the new company

Kirsi Rosenström joined the finance department at Kvaerner Masa-Yards Helsinki New Shipyard in 2003. Amid turbulent times at the shipyard, she learned about the development of Aker Arctic and approached Mikko Niini, who was tasked with establishing the new company.

Rosenström became responsible of setting up the company's financial and accounting systems, which she continues to manage today, alongside the human resources function. As the workforce has expanded, her HR responsibilities have grown significantly over the years.

A wide range of responsibilities

In 2000, Sami Saarinen joined the ice laboratory, then known as the Masa-Yards Arctic Research Centre (MARC). Over the years, he has taken on a variety of roles, starting with model testing, before moving on to hull strength calculations, customer support for large projects, and developing solutions to meet client needs. More recently, he has been consulting on major development projects.

In addition to his core responsibilities, Saarinen began participating in Arctic ice expeditions and full-scale ice trials early in his career.

"My first longer expedition was to the Barents Sea in 2005 with Göran Wilkman, who was in charge of the ice laboratory at that time. During this trip we assessed ice conditions, measured ice thicknesses, and analysed environmental factors for international oil companies," he recalls.

Memorable ice expeditions

Since then, Saarinen has participated in numerous expeditions, many of which have lasted several weeks. While he has enjoyed each one, two stand out: his two-month voyage to Antarctica in 2019 onboard a research icebreaker, and a reconnaissance mission to Baffin Island in northern Canada in 2007, where he conducted aerial surveys to identify icebergs.

"The ice in Antarctica is vastly different from Arctic ice, but with our innovation, the double-acting ship (DAS™) hull, the research icebreaker was able to navigate the heavy ice stern-first, Saarinen says."

"On Baffin Island we encountered an extreme blizzard. It was impossible to see anything from the hotel room window due to snow piling outside and all flights were cancelled. Yet, venturing outside, I was amazed to see a local man casually driving past on a snowmobile, wearing only a cap and no gloves. The blizzard didn't bother him," he adds.

Sami Saarinen on a reconnaissance mission to Baffin Island in northern Canada in 2007.

Balancing work with fun events

Rosenström, Saarinen, and Forsén agree that working at Aker Arctic has always been a blend of hard work and enjoyable experiences. Their roles have evolved continually, presenting new interesting challenges that have fostered their personal growth and motivation to stay with the company.

The entire team has travelled extensively, participated in sport events, and enjoyed social activities such as restaurant dinners, wine tastings, and cooking classes. Rosenström recalls particularly memorable trips to Murmansk, Norway, Vyborg, St. Petersburg, Tallinn, and Åland, where they had the pleasure of meeting customers and learning about their history.

Forsén and Saarinen highlight the company's long tradition of participating in rowing competitions at Sulkava and Kulosaari every summer for 30 years. Aker Arctic even had its own rowing club and church boat, which was maintained every spring, with practice sessions twice a week during the ice-free season.

Continuous growth

Rosenström notes that Aker Arctic has hosted many distinguished visitors, which has been a great honour. She also reflects on the company's continuous growth over the past two decades.

"When the building was completed, the ice model testing staff and designers from Helsinki Shipyard moved in, doubling our workforce. Initially designed for 25 persons, our facility now accommodates 56, and space is becoming increasingly scarce," she observes.

Saarinen and Forsén share a final anecdote from their last day at the old model testing laboratory before relocating to Vuosaari:

"As the building was set to be demolished, we decided to have a paintball game and conduct an oil spill recovery test in model-scale. It turned out to be a rather messy affair." ■

Navigating the future of icebreaking design

Finnish icebreaker Kontio at work. Photo by Topias Lehtonen, courtesy of Arctia Ltd.

Aker Arctic's Managing Director, Mika Hovilainen, reflects on how evolving market demands and emerging trends are increasing vessel complexity and reshaping icebreaking ship design through new areas of technical proficiency.

Modern ships incorporate intricate systems to meet today's energy efficiency and emission requirements, including emission reduction systems, energy storage solutions, and alternative fuel options.

Compliance with stricter regulations requires more intensive technical work, such as analyses, calculations, and investigations. Optimising hull forms, machinery, and overall design to improve energy efficiency and safety have become the new standards.

"Technologically, vessels are becoming increasingly complex and even small gains in energy efficiency are valuable to save costs," Hovilainen says. "The fact is, we can no longer build the same ships as we did 20 years ago."

Growing importance of technical expertise

Hovilainen emphasises the growing importance of advanced technical expertise. With an expanding array of design options, selecting the optimal solution for each ship requires in-depth knowledge and experience.

"At Aker Arctic, completing multiple icebreaking ship design concepts annually ensures we remain at the forefront of the industry. Every project has novel features and demands which challenge us every day," Hovilainen explains.

For shipyards, streamlining the construction process will remain vital to control costs. Cooperating with an experienced ship designer helps to reduce risks related to rapid changes in technology and regulations.

"The shift to goal-based regulations will also add new aspects as requirements can be achieved with alternative technical solutions," Hovilainen says.

A lifecycle approach to cost management

Icebreakers typically have long lifespans and investment decisions consider far more than just the initial acquisition price.

"Taking into account the costs and emissions for a vessel's entire lifetime already in the concept design has become common practice," Hovilainen observes. "This requires a new approach to ship design where the operational understanding is highlighted."

Toward a fossil-free future

As emission regulations continually tighten to combat greenhouse gas emissions, fossil-free fuels are essential in the long-term. Through improved energy efficiency, negative impacts of alternative fuels, such as lower energy density, are reduced.

Hovilainen expects rising fuel prices to influence transportation economics. "Ships are already operating at slower speeds to comply with EEDI regulations, reduce emissions, and save fuel, and this trend will increase," he says.

Hovilainen also anticipates ship sizes to grow while transporting greater cargo volumes to achieve lower fuel consumption per cargo unit.

He points to an alternative approach: deploying small nuclear reactors. Though costly to install, they enable an opposite optimisation of marine transportation systems, as operational costs do not depend heavily on the power used.

A reliable winter navigation system

Aker Arctic is keen on addressing emissions in winter navigation, particularly for commercial shipping in the Baltic Sea.

"Finnish exports and imports rely on a smooth winter navigation system. Our mission is to ensure it continues to be efficient, sustainable, and safe," Hovilainen says.

Ice load monitoring for Canada's MPVs

Aker Arctic has been chosen to supply a state-of-the-art ice load monitoring system for the Canadian Coast Guard's Multi-Purpose Vessels (MPVs) programme. Aker Arctic designed the hull form and contributed to the development of the vessel concept.

The contract includes the delivery of Aker Arctic's ARC ILMS ice load monitoring measurement and analysis system for the initial six MPVs, which are a key part of Canada's National Shipbuilding Strategy (NSS). These vessels will be constructed at Seaspan Vancouver Shipyards in Canada.

"The ARC ILMS is our platform for measuring loads that the ship's structure experiences when operating in ice-covered waters," says Rob Hindley, head of consulting and technology development at Aker Arctic.

"It utilises strain gauge sensors, specifically fibre optic gauges, to measure the hull's response when impacted by ice. Using our analysis algorithms, developed from decades of similar measurements on icebreakers, the system provides feedback to the operator on the safety level of the ship," he adds.

Fleet renewal programme

The MPVs form part of the Canadian Coast Guard's fleet renewal programme and will mainly replace the Type 1100 class built in the late 1970s and 1980s, doing the day-to-day work of supporting shipping, maintaining fairways, aids to navigation, and icebreaking.

In addition, they will perform cargo missions, bringing supplies to northern communities, carry out search & rescue, and patrol missions.

Collaboration to develop vessel concept

Aker Arctic completed the hull form and contributed to the concept development for the MPVs, using a collaborative model involving the operator and the shipyard, working jointly on creating the concept from day one. Following the conclusion of the concept development, Aker Arctic has continued to provide expert technical support to the project, especially advising on ship performance related aspects.

"We are thrilled that our Ice Load Monitoring System has been selected for implementation on the MPVs and look forward to working with Seaspan and the Canadian Coast Guard also on this project," Hindley says. ■

The Baltic icebreaking fleet will require replacement within the next decade, and Aker Arctic is ready to support the development of next-generation designs for Finland, Sweden, and Estonia.

Hovilainen also stresses the need to improve the energy efficiency of cargo ships without increasing icebreaking demands, which would shift the burden onto icebreakers.

Tools for optimisation and safety

In addition to designing icebreakers and ice-capable vessels, Aker Arctic is developing tools to optimise routes and transportations in icy conditions as part of its transit simulation services. This can help both in early decision-making and in operations.

"We are looking to integrate real-time environmental data with specific vessels to optimise routes for each transportation task. The same tools also help to identify the best vessel design for a specific route," Hovilainen explains.

Recently, several new contracts for Aker Arctic's Ice Load Monitoring System (ARC ILMS) have been published.The key know-how lies not in the actual measurements but in understanding how structures respond to ice loads and calibrating the system correctly.

Strengthening leadership

Over the past two decades, Aker Arctic has designed a significant portion of the world's icebreaking vessels, each constructed and proven effective in operation.

"Our plan for the coming decade is to continue to advance our expertise, strengthening our leadership in this niche, and deliver solutions that prioritise sustainability and safety for all vessels navigating icy waters," Hovilainen summarises. ■

Le Commandant Charcot completes historic journey across the three Arctic poles

Photo: Antoine Le Guen/ PONANT.

In September 2024, the luxurious icebreaking exploration cruise ship, *Le Commandant Charcot*, made history by becoming the first vessel to reach the legendary North Pole of inaccessibility, as well as the magnetic and geographic North Poles, during a transpolar traverse from Alaska to Svalbard.

Captain Étienne Garcia and Director for Newbuilding and R&D Mathieu Petiteau, from the cruise company PONANT EXPLORATIONS, shared their experiences and the meticulous preparations required for such a special voyage during a recent visit to Helsinki, Finland.

"Since beginning operations with the remarkable *Le Commandant Charcot* three years ago, we have sailed an average of 200 days per year in ice, exploring the highest latitudes in both the Northern and the Southern Hemispheres," Captain Garcia says.

"Each voyage enhances our understanding of the vessel and our ability to navigate polar ice conditions."

Two years of planning

Two years ago, Captain Garcia proposed the ambitious transpolar traverse, aiming not merely to set a record but to conduct a journey with a scientific purpose. Preparations included expeditions to the North Pole in 2021, 2022, and 2023, and transits through the Northwest Passage aboard *Le Commandant Charcot* to study the region's complex and challenging ice conditions.

The planning process involved a multidisciplinary team of 20 specialists at PONANT EXPLORATIONS, responsible for route planning, navigation, logistics, cruise planning, as well as coordinating scientists selected through an application process managed by the external scientific organisation ARICE.

Historical ice charts from the past decade at the time of the planned voyage were utilised to plan the route, identifying paths with minimal ice pressure and multiyear ice. During the journey, satellite imagery was utilised daily to adjust the route in response to shifting ice conditions and weather changes.

"Although *Le Commandant Charcot* is an exceptionally capable vessel, we always proceed with humility and caution," Captain Garcia emphasises. "We never take the shortest route, opting instead for paths with the least ice to optimise fuel consumption, passenger comfort, and environmental protection. The drifting ice is always in movement, and after we pass through, it closes behind us. We only break ice when it is necessary."

A successful traverse

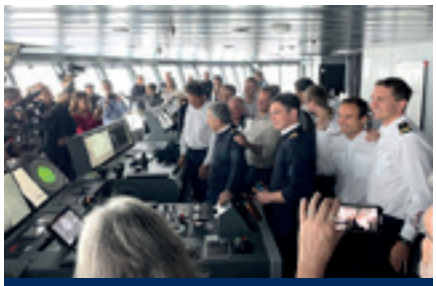
In September 2024, *Le Commandant Charcot* completed its 20-day transpolar traverse from Nome in

Alaska to Longyearbyen in Svalbard, with a near-full complement of 150 guests, 22 scientists, and 200 crew members.

"It was an extraordinary and highly successful expedition, with favourable conditions for a vessel of this strength," Captain Garcia remarks.

The voyage was conducted at a deliberately slow pace, allowing daily stops of four to five hours. Guests engaged in unique Arctic activities such as snowshoeing, polar hikes, skiing, and even plunging into icy waters. Meanwhile, scientists from around the globe gathered critical data in previously unexplored regions, contributing to significant advancements in climate and environmental research.

"When we planned this trip, I intentionally calculated a slow pace to let everyone enjoy the experience," Captain Garcia explains. "Taking time is part of the luxury of the cruise, to savour the breathtaking Arctic scenery and fully immerse oneself in the sense of being at the edge of the world.



The planning of *Le Commandant Charcot* began with a meeting at Aker Arctic on October 15, 2015. Five years, eleven months and five days later, the vessel reached the North Pole for the first time.

Three poles and three suns

During the expedition, *Le Commandant Charcot* became the first ship to reach the northernmost point of inaccessibility, an isolated location farthest from any landmass and subject to extreme Arctic conditions. One day later, the vessel reached the Magnetic North Pole, followed two days later by the Geographic North Pole.

"Upon arriving at the Geographic North Pole, we were treated to an extraordinary surprise, a rare atmospheric phenomenon known as a sundog," Captain Garcia recounts. "This creates the illusion of three suns connected by a luminous halo."

The phenomenon, caused by light reflecting off ice crystals in frigid air, typically lasts only briefly. However, the passengers and the crew enjoyed the spectacle for an incredible five hours, a rarity that made the experience even more striking.

"Three poles and three suns – it is an unforgettable memory for everyone on board," Captain Garcia reflects.

During the transpolar traverse, the passengers, the scientists and the crew were rewarded with the rare atmospheric phenomenon called sundog. Photo: Étienne Garcia.

Safety measures

Safety was a top priority when *Le Commandant Charcot* was being planned and constructed. Petiteau, who led the project and supervised the construction, was instrumental in developing an innovative safety model, including a specialised container deployable on ice, water, or land. The container is equipped with rescue shelters, food, water production tools, medical supplies, and other essential gear to sustain 160 passengers for up to five days in extreme conditions. Each passenger is also provided with a polar immersion survival suit.

"In addition to the equipment, we have established clear safety protocols and created a dedicated on-board role responsible for deploying the survival container and setting up the shelters," Petiteau explains.

During cruises, the Polar camp is regularly partially assembled on ice, allowing the crew to practice and giving passengers an opportunity to observe the safety systems in action. Search-and-rescue drills are also conducted in collaboration with the United States and Canadian Coast Guards.

"These safety measures were finalised already before *Le Commandant Charcot's* maiden voyage three years ago and is part of our standard procedures. Therefore, no special amendments were required for the transpolar traverse," Petiteau notes.

Remote Arctic beauty

For Captain Garcia, serving as one of *Le Commandant Charcot's* lead captains, is a career highlight.

"*Le Commandant Charcot* is the only cruise ship in the world with a PC 2 ice class, enabling her to access places no other vessel can," he emphasises. "She is uniquely designed for observation, with panoramic windows allowing passengers to enjoy the breathtaking scenery from the warmth of the interior if it is too cold outside. No other ship compares."

Of all the remote destinations Captain Garcia has travelled, his favourite is East Greenland with its pristine winter landscape, drifting sea ice, sunny spring days and encounters of polar bears.

"Antarctica is also extraordinarily beautiful with its towering tabular icebergs and abundant wildlife, including whales and penguins," he adds. ■

Ice Load Monitoring System validates operational insights

In February 2024, during a planned dry-dock in Brest, Aker Arctic Technology installed a version of its ice load monitoring system ARC ILMS on *Le Commandant Charcot*. The ARC ILMS uses a series of strain gauges mounted to the internal hull structure to measure the structure's response to ice loads, both when operating ahead and when operating astern in 'double-acting' mode.

Recognizing the truly unique nature of the vessel and the trans-Arctic voyage completed in September 2024, PONANT EXPLORATIONS, Aker Arctic and ABB Marine agreed to cooperate on measuring the ice loads on the vessel's hull and propulsion system. The intention of the cooperation is to support operations and decision making, while using *Le Commandant Charcot* as a unique platform for ice loads research.

Loads from the trans-Arctic voyage are now being analysed by Aker Arctic and ABB Marine, with the first results presented to *Le Commandant Charcot's* senior officers when the ship called in to Helsinki at the end of November 2024. At the same time, Captain Étienne Garcia and Mathieu Petiteau shared their firsthand experiences of navigating the vessel through challenging ice conditions. They noted that the physical data recorded by the sensors aligned with their observations.

"Having tangible data is reassuring, confirming that we are operating the vessel correctly," Captain Garcia explains. "In particularly demanding areas, such as East Greenland in spring or the Northwest Passage near multiyear ice in the extreme north of Canada, we experienced high loads. However, the results show that we were operating at 50–60 % of the vessel's maximum capacity, well within its limits."

Safe use of the ship

After three years of operation, the hull remains intact, with no incidents of overload recorded.

"Given the extent of our operations, spending a significant number of days in ice, navigating various ice types, and venturing deep into polar regions, the results are remarkable and reassuring," Captain Garcia says. "We now have clear evidence that we are using the ship safely and in line with design recommendations."

Future opportunities for optimisation

While discussing potential improvements for ice load monitoring, Captain Garcia emphasises *Le Commandant Charcot's* robust design.

"The ship is engineered for heavy ice loads, with significant overcapacity to ensure safety. As we continue to accumulate experience in navigating ice, the Ice Load Monitoring System can guide us toward even greater efficiency while maintaining safe operations."

Rob Hindley, Head of Consultancy and Technology Development at Aker Arctic, adds that this is the first time that ice loads on the hull and podded propulsion units have been measured simultaneously.

"The cooperation continues, with ice load data being continuously gathered as *Le Commandant Charcot* operates in these extreme environments, and Aker Arctic and ABB Marine working together on a joint review of the data," he says. ■

Mathieu Petiteau and Captain Étienne Garcia visited Helsinki with *Le Commandant Charcot* in November 2024.

Le Commandant Charcot at the magnetic North Pole. Photo: Antoine Le Guen.

Canadian Polar Icebreaker advances

Since 2021, Aker Arctic has been engaged in updating and improving the design of the Polar Icebreaker for the Canadian Coast Guard, which will be constructed at Seaspan's Vancouver Shipyards.

The new Polar Icebreaker will replace the Canadian Coast Guard Ship *Louis S. St-Laurent*, making it the most powerful conventional icebreaker in Canada and among the most capable in the world. The Polar Icebreaker is expected to be delivered by 2030.

The construction engineering of a vessel project consists of two main phases: functional design and production design. The final phases of the functional design were completed last year, concurrently with the initial steps of the production design, expected to be concluded by the end of 2025 or the beginning of 2026.

Expertise in ice

The Polar Icebreaker project for the Canadian Coast Guard resumed in 2021 with a comprehensive design update, integrating the latest technological advancements and optimising the design for construction. Aker Arctic has been part of the design team since the project began in 2012.

The company's responsibilities have encompassed the icebreaker's hull form, ice strengthening of the hull structure, performance, stability, and winterization. In addition, Aker Arctic has provided ongoing support for Seaspan's design team.

Ice-strengthened propeller delivery

As part of the design update, the hull form was further refined, and different propulsion options were evaluated. The performance of the selected hybrid propulsion configuration with two azimuthing propulsion units flanking a centre shaftline was verified with model tests in both ice and open water.

Aker Arctic has designed and delivers the ice-strengthened Polar Class 2-rated stainless steel propeller, which has a diameter of six metres, for the icebreaker's 12-megawatt centre shaftline. Delivery of the propeller to the shipyard in Vancouver is scheduled for 2025.

Verifying the design

In spring 2024, design propeller model tests were conducted to verify that the hull and propulsion unit configuration design produces the required thrust to meet the open water and icebreaking performance criteria, and that the vessel is capable of performing its intended operations in the Canadian Arctic.

"Once we received the final propulsion measurements, we were able to confirm that the hull form was correctly designed. These tests are crucial as they finalise the hull design and complete one of the fundaments of the design project," Project Manager Jukka-Pekka Sallinen explains.

Auxiliary systems enhance performance

Several auxiliary systems have been designed to enhance the vessel's performance, including a roll stabilisation system to reduce wave-induced motion, and an air bubbling system to minimise friction between the hull and the ice. Aker Arctic has also been responsible for preparing the design documentation and ensuring that the systems function correctly.

"The performance of these systems will be confirmed in the various commissioning tests during the building phase and also in sea trials," says Sallinen.

3D modelling review in progress

The 3D modelling process for production is currently underway. Aker Arctic is reviewing all design elements under its responsibility to ensure accurate representation in the model. The finalised 3D model is expected to be completed by late 2025.

According to Sallinen, the most intensive phase of Aker Arctic's design work is now completed. "When construction begins, we will continue supporting the shipyard throughout the building process."

Technical authority support role

Aker Arctic has also assumed a technical authority support role to ensure adherence to high-quality design principles and compliance with standards and regulations to support the shipyard's Technical Authority team. This has included thoroughly reviewing design documents to confirm that requirements for operation in extreme cold and ice-covered waters are properly incorporated.

"A large part of our work in this role is now also complete," says Naval Architecture Team Leader Jillian Adams. ■

ICE Pact formalises collaboration on Arctic icebreakers

In November 2024, the governments of Canada, Finland, and the United States of America signed a Memorandum of Understanding (MOU) establishing a trilateral framework for the production of icebreakers and maintaining Arctic capabilities.


Photo Riikka Hietajärvi/ Finnish Embassy in Washington

The MOU outlines a jointly developed framework aimed at enhancing the collective ability to design, manufacture, and maintain icebreakers. By fostering information exchange, industrial collaboration, and operational expertise, the agreement seeks to strengthen the icebreaking capabilities of all three nations.

Each participating country recognises the urgent need to modernise icebreaking fleets to ensure a continued presence in the Arctic and Antarctic regions. Increasing the pace, scale, and cost-effectiveness of icebreaker construction is a shared priority to uphold safety and security in these strategically important areas.

Leveraging expertise

The agreement enables deeper collaboration within the maritime cluster, facilitating knowledge, and resource sharing that could lead to high-quality job creation in the shipbuilding sector. The ICE Pact is expected to provide stability and long-term support for the participating nations' shipbuilding industries.

The ICE Pact includes four key components:

1. Enhanced information exchange.
2. Workforce development collaboration.
3. Engagement with allies and partner nations.
4. Innovation, research, and development.

National coordination

Each country has designated an ICE Pact coordinator to oversee its implementation. In Finland, the collaboration is managed by the Ministry of Economic Affairs and Employment and led by Reko-Antti Suojanen, who has a solid background in the Finnish icebreaking sector.

"Canada and the US face a situation similar to Finland and Sweden, where icebreakers built in the 1970s and 1980s are nearing the end of their operational lifespan," Suojanen explains.

Icebreakers are unique ships, and the market consists of a limited number of vessels and specialised companies. Finland has succeeded to continue uninterrupted icebreaker design and construction, and Finnish expertise is widely recognised as a global standard in the field.

"All icebreakers around the world rely heavily on Finnish know-how, regardless of construction country, and Finland is therefore eager to support Canada and the US in acquiring modern icebreakers quickly and cost-effectively," Suojanen emphasises.

Advancing acquisitions

Suojanen's role is to facilitate cooperation and address potential challenges, such as Canada's national content requirements. He believes that the most effective way to develop icebreaking expertise, is through concrete acquisition projects, where clients can observe, oversee, and learn from the process in real-time.

"Ordering icebreakers from Finland would be the fastest and most efficient way for the US to modernise its fleet," Suojanen highlights.

The Finnish maritime cluster consists of hundreds of specialised companies with extensive experience in the particular components and requirements needed in icebreaker construction. The proximity of these experts to Finland's shipyards allows for seamless communication, decision-making, and delivery processes, ensuring efficient and timely production.

Meanwhile, Canada's National Shipbuilding Strategy aims to develop domestic shipyards, particularly for government projects. Canada has already engaged leading industry players, such as Aker Arctic, to support this initiative.

"While political priorities favour domestic shipbuilding, given the current security landscape, expediting icebreaker production should be the top priority for all three nations," Suojanen concludes. ■

Propulsion delivered for Finnish Navy Corvette

The Aker Arctic delivery of shaftlines and propellers for the Finnish Navy's first Pohjanmaa-class multirole Corvette was successfully completed at the end of 2024.

The construction of Pohjanmaa -class multirole Corvettes under the Finnish Navy's Squadron 2020-project is progressing at Rauma Marine Construction's shipyard. Aker Arctic has completed the delivery of shaftlines, including controllable pitch propellers, bearings, shaft seals, and the shaft torque monitoring system, for the first vessel.

Initial operational capability of the first Corvette will be reached in 2027, and full operational capability as Squadron, in 2029.

Ten years of development

Aker Arctic's scope of delivery encompasses the design, material supply, and commissioning of ice-strengthened controllable pitch propellers and shaftlines for all four corvettes. The company has also developed the hull shape and ice strengthening for the vessel, tailored for all Baltic Sea conditions. The shipyard has finalised the vessel's design to reflect the final specifications.

Since 2015, Aker Arctic has collaborated closely with the Finnish Defence Forces to develop a propulsion line that ensures the new multirole Corvettes meet rigorous operational performance requirements. A critical element of this development process has been the optimisation of the propeller and hull interaction to achieve high open water speed, ice-going capabilities, and low underwater noise levels.

Unique collaborative model

Kari Laukia, head of Aker Arctic's equipment and special projects, highlights the company's distinctive collaborative business model, which has been instrumental in supporting the Finnish Defence Forces to achieve their objectives.

"Our approach involves close collaboration with our clients to ensure their goals are met," Laukia says. "It is a step-by-step process that begins with establishing the customer's specific needs and evolves into a final product through continuous dialogue. This method enables us to address and resolve design challenges that inevitable arise in every project."

Hull and propulsion interaction

Aker Arctic's core expertise lies in developing ship designs that are excellent in ice conditions while maintaining their open-water performance. All design phases are managed in-house, ensuring seamless integration of capabilities.

"Our understanding of how the hull form interacts with propulsion in both ice and open water forms the basis for our development work," Laukia notes. "Additionally, the know-how of integrating the shaftline interface with the ship hull, including appendages, to optimise the hydrodynamics of the ship's stern is critical in seasonally freezing waters."

Designed for Finnish weather

Finland's challenging weather conditions have necessitated developing a vessel design capable of navigating various ice conditions and harsh maritime environments.

The Northern Baltic Sea frequently experiences gale-force winds, with wave heights exceeding six metres. Icy conditions, snow, sleet, rain, and fog – often resulting from temperature fluctuations – pose further challengers to vessel operations and the performance of surveillance and weapon systems.

During a typical winter, Finnish harbours and the archipelago freeze, while much of the Baltic Sea remains unfrozen. Wind pressure on the ice cover can create ice ridges, which are difficult for vessels to penetrate.

With these advanced Corvettes, the Finnish Defence Forces will be able to conduct year-round surveillance, safeguard maritime connections vital to Finland, and ensure Finland's territorial integrity more effectively.

Aker Arctic has been chosen to supply the state-of-the-art ARC ILMS ice load monitoring, measurement and analysis system for the four Pohjanmaa-class multi-role Corvettes.

Icebreaking needs grow despite warmer winters

In Finland, 96 % of all transported goods depart or arrive by sea. Photo courtesy of FTIA.

Estonian, Finnish, and Swedish exports and imports rely heavily on maritime transportation. The Estonian State Fleet, Finnish Transport Infrastructure Agency, and Swedish Maritime Administration share some perspectives on the future of winter navigation and the measures required to ensure the continuity of maritime transport in the Baltic Sea.

Head of Maritime Transport unit Helena Orädd from the Finnish Transport Infrastructure Agency (FTIA) and PL5 Project Manager Jorma Kaldasaun from the Estonian State Fleet anticipate an increasing need for icebreaking assistance due to evolving ice conditions and the growing number of large commercial vessels with limited ice-going capabilities entering the Baltic Sea.

"Ice conditions around Finland are becoming more unpredictable, varying significantly from year to year and creating more dynamics in the ice fields," Orädd explains. "During mild winters, wind-driven ice forms slush barriers that are difficult for commercial vessels to navigate. Simultaneously, wide open water areas between ice fields pose challenges for an aging icebreaking fleet that is not optimised for such conditions."

Average winters will persist

Kaldasaun refers to research conducted by Tallinn University of Technology in 2023, predicting how winters will evolve over the next 25 years. Despite climate change, Estonia's ice conditions are expected to persist. While only 3 % of winters will be classified as severe, 70 % will remain average, continuing to impact commercial traffic.

Orädd adds that one of the key challenges of changing winter patterns is the difficulty of forecasting weather beyond a few days. When a sudden icebreaking need arises in the Bay of Bothnia, it takes days to transfer, with possible stormy weather causing further delays.

Sweden expects a surge in traffic

Head of Icebreaking Operations Amund Lindberg, from the Swedish Maritime Administration, highlights that, while much discussion centres on larger and wider commercial vessels, the increase in regular traffic should not be overlooked.

"Industrial investments in northern Sweden are expected to increase traffic only to Luleå by 300 %, raising the number of vessels from 700 to approximately 2000 per year," Lindberg says.

To accommodate Panamax-sized vessels year-round, the Swedish government is widening the seaway to Luleå as part of the Malmporten project.

"The shift toward just-in-time deliveries has reversed the impact of less severe ice conditions. In addition, potential offshore wind investments and total defence requirements add to the demand for icebreaking services," Lindberg notes.

Close cooperation

As close neighbours, Finland, Sweden, and Estonia collaborate on winter navigation, for example, through initiatives such as the EU funded project WINMOS (Winter Navigation Motorways of the Sea). Finland and Sweden have a strong operational partnership in the Bay of Bothnia, which freezes over annually.

The shifting geopolitical landscape has further strengthened cooperation, bringing new considerations to discussions on winter navigation safety, reliability, and military mobility.

Orädd highlights that Finnish military transports partly utilise vessels well-equipped for winter conditions already trading in the area, whereas Kaldasaun anticipates increased demand for assistance due to the presence of NATO vessels, which are not ice-classed. Lindberg underlines the critical importance of safeguarding exports and imports, particularly in times of crisis.

All three countries are also exploring offshore wind investments. As part of WINMOS III, researchers are studying how ice dynamics change as ice moves through turbine areas, deforms and refreezes, and how this affects icebreaking and winter navigation.

A versatile future fleet

When discussing a potential future icebreaking fleet, Orädd, Lindberg and Kaldasaun emphasise that their views are purely operational, as they do not have decision-making authority regarding acquisitions.

Finland's icebreaking fleet currently comprises ten icebreakers, owned by Arctia and Alfons Håkans. Nine operate regularly in the Baltic Sea, most classified as A-class icebreakers. Finland's only B-class icebreaker, *Voima*, is over 70 years old, and the government has decided to replace her with a new B+ icebreaker. Over the next decade, the icebreakers *Sisu* and *Urho*, built in 1976 and 1977, will also need replacement.

Orädd, who supervises the WINMOS III project, states that the future Finnish fleet should be more versatile, consisting of icebreakers of various sizes and capabilities to adapt to changing conditions.

"I believe the future fleet should include several smaller B+ icebreakers, a stronger version of B, alongside our newest A-class icebreakers *Polaris*, *Fennica*, and *Nordica*," Orädd suggests. "This approach would be more cost-efficient for tasks, such as opening the season in the Bay of Bothnia, while preserving A-class icebreakers for when they are most needed."

Estonia to replace Tarmo

Estonia currently operates three icebreakers: two in the Gulf of Finland and one in Pärnu, a region with the challenge of shallow waters freezing easily. *Botnica* is Estonia's largest and newest icebreaker, whereas *Tarmo* is 62 years old.

Estonia has decided to replace *Tarmo* with a completely new design, capable of both shallow-water operations in Pärnu and regular icebreaking duties in the Gulf of Finland. Photo: Robert Markus Liiv

EVA 316, converted into an icebreaker in 2005, serves Pärnu Harbour. All three icebreakers were built in Finland.

Estonia has decided to replace *Tarmo* with a completely new design, capable of both shallow-water operations in Pärnu and regular icebreaking duties in the Gulf of Finland. *EVA 316* is also nearing the end of her operational lifespan and will require replacement within the next decade.

"We are grateful for Aker Arctic's comprehensive feasibility study for a new combination icebreaker, supporting our acquisition process," Kaldasaun says.

Sweden requires multiple icebreakers

Sweden's fleet consists of six icebreakers: three A-class icebreakers of the *Atle/Urho*-class, which have kept Swedish harbours open for 50 years, the Polar Icebreaker *Oden*, the mid-sized icebreaker *Idun* (recently acquired from Norway), and the smaller icebreaker *Ale*, which serves the Bay of Bothnia and Lake Vänern.

Lindberg anticipates Sweden will need to acquire two to three new *Atle/Urho*-class sized icebreakers over the next decade to support increasing demands in northern Sweden. The country's current acquisition project, now named *Project New Icebreakers*, is progressing, though a final decision on construction has yet to be made.

"Simultaneously, we must replace our aging icebreakers, potentially acquiring one to three additional smaller icebreakers to minimise fuel and operational costs," Lindberg says.

He acknowledges that investing in icebreakers is a significant financial commitment, requiring careful deliberation. However, the lengthy acquisition process necessitates timely decisions to ensure the continued security of maritime transportations.

"We cannot design our fire brigade based on the assumption that nothing will catch fire. The same principle applies to icebreaking," Lindberg concludes. ■

R&D guides ship design and operations

Aker Arctic has a strong focus on Research & Development, particularly from a winter navigation perspective. The primary goal is to support reliable winter navigation in the Baltic Sea and ensure the security of supply.

Aker Arctic's research work encompasses a wide range of activities, including research to support authorities, confidential projects for customers, internal development initiatives, and collaborative projects with universities and research institutes. Additionally, the company offers multiple master's thesis research opportunities to university students every year.

"Research and development are extremely important for us, as they ensure we remain at the forefront of our field and continuously implement new ideas to improve operations in ice," says Head of Sales and Marketing Arto Uuskallio.

Research supports authorities

Over the past decade, many of Aker Arctic's public research activities have focused on the Energy Efficiency Design Index (EEDI) -related aspects in winter navigation, the impact of brash ice channels on vessel resistance, and structural improvements in vessel hull design. These efforts have been part of either the EU-funded WINMOS (Winter Navigation Motorways of the Sea) initiative, or the Finnish-Swedish Winter Navigation Research Board.

WINMOS III aims to modernise the maritime winter navigation system and safeguard icebreaking resources in the EU's northernmost waters in a cost-efficient and environmentally sustainable way. By ensuring sufficient icebreaking capacity, winter traffic becomes predictable, an essential factor for imports and exports.

"In all essence, icebreaking and commercial vessel assistance are crucial to Finland to ensure that products reach our shops and that industries can deliver their goods to the market," notes Uuskallio.

Finnish-Swedish cooperation

The Winter Navigation Research Board, a Finnish-Swedish cooperation established in 1972, is funded by the maritime administrations of both countries. It oversees a joint winter navigation research programme aimed at developing and improving services and technologies that enhance the winter navigation system in the Baltic Sea and Gulf of Bothnia. A key outcome is the development and ongoing refinement of the joint Finnish-Swedish Ice Class Rules (FSICR) for merchant ships.

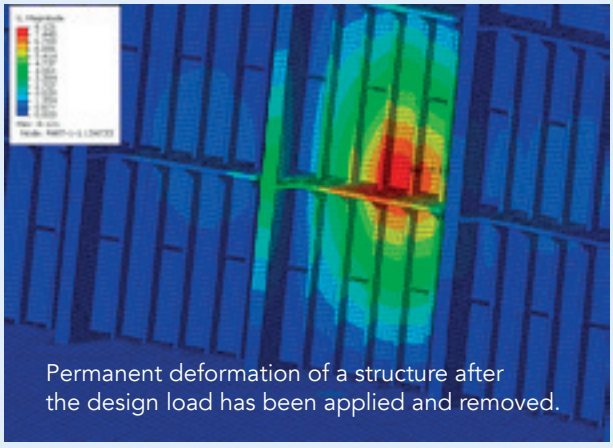
"Research supports authorities' decision-making and helps to determine the types of vessels needed. Understanding operations in ice is essential for designing suitable ships," Uuskallio highlights.

HULLFEM allows alternative hull structures

A few years ago, Structural Engineer Ville Valtonen led a group investigating excessively heavy primary structures in ship designs. The group developed a new, robust and simple-to-use assessment methodology and acceptance criteria by using the finite element method (FEM), showing that a nonlinear analysis provides better insight into the behaviours of a structure, giving designers the tools to reduce weight while simultaneously improving safety.

Valtonen has continued to develop the tools as an alternative methodology for structural dimensioning for the FSICR. This development has been funded by the Winter Navigation Research Board under a series of projects called HULLFEM. The Finnish Transport and Communications Agency is now looking forward to applying the new standard, which classification societies have evaluated during the development, into the FSICR.

"We have been at the forefront of developing this methodology, which classification societies have been involved in," Valtonen says. "For shipyards, this will allow more freedom to try new, innovative ways to construct vessels, while ensuring that safety persists."



Permanent deformation of a structure after the design load has been applied and removed.

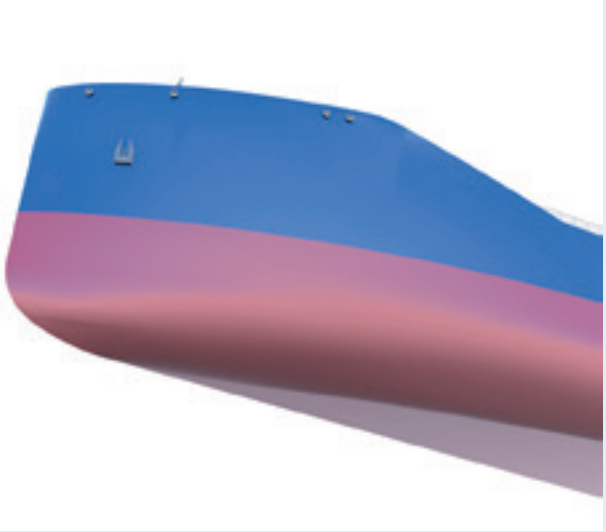
Environmental efficiency research prepares for future ice navigation

Development Engineer Teemu Heinonen has researched how the Energy Efficency Design Index (EEDI), introduced by the International Maritime Organisation (IMO), has affected winter navigation on the northern Baltic Sea and how the new merchant vessels built in compliance with EEDI perform in ice conditions in the Baltic Sea.

His previous work highlighted how the power-to-deadweight ratios of the ice-classed merchant vessel fleet have diminished and how this has affected their need for icebreaker assistance. In addition, the bow shapes of the current fleet are often highly optimised for open-water operation, significantly limiting the vessels' ability to operate independently in ice and increasing their need for icebreaker assistance.

The current research for the Finnish Transport and Communications Agency focused on the functionality and applicability of the EEDI ice class power correction factors, which are based on data from 2006 to 2016. As EEDI phases are tightening, the research concluded that the applicability of the current power correction factors for future EEDI phases is limited, which would further reduce the ice-going capability of the ice-classed fleet. Therefore, alternative methods to compose the ice class power correction factors were investigated and new correction factors were proposed in the research.

"Through our research, we support authorities in making informed decisions about future icebreaking needs and optimising their fleet," Heinonen says.



The bow shapes of the current fleet are often highly optimised for open-water operation, significantly limiting the vessels' ability to operate independently in ice and increasing their need for icebreaker support.

Brash ice channel research introduces changes to ice classification

Senior Research Engineer Riikka Matala has been investigating winter navigation in brash ice channels since 2018 through both full-scale and model-scale tests. Her research culminated in a doctoral thesis at Aalto University School of Engineering in 2023.

Merchant vessels can obtain ice classifications specified in the FSICR through model-scale testing in ice. In the Baltic Sea, these ice classes are applied during the winter season to establish traffic limitations, ensuring safety in ice navigation. Recent environmental regulations have led to changes in the merchant fleet, introducing new hull shapes to meet compliance requirements. However, previously used model-testing approaches could be improved for modern bow forms, as they resulted in unrealistic minimum engine powers.

Through her research, Matala proposed a new approach for conducting model-scale tests in an unconsolidated brash ice channel. This method has now been successfully applied in ice model testing for a client to apply for ice classification. The authorities have started the process of integrating the method into the FSICR.

"We aim for a situation where the ice capabilities of merchant ships with any bow shape align with their ice class as expected. This is crucial for an efficient and reliable winter navigation system, as it relies on the assumption that every ice class corresponds to specific performance capabilities in ice," Matala says.

Chief Inspector Ville Häyrynen from the Finnish Transport and Communications Agency comments: "The maintenance and enhancement of the winter navigation system and its related components is a long-term undertaking that maritime authorities have managed for decades. I hope that our recent joint development projects with Aker Arctic will add value to the entire system. Looking ahead, it would be beneficial to continue leveraging the expertise of leading maritime professionals in the further development of winter navigation." ■

Ice-going SOV concept for offshore wind farms completed

Featuring a combination of open-water capabilities and ice strengthening, the ice-going service operation vessel is designed to reliably reach turbines in all prevailing weather conditions, ensuring safe service throughout the year.

Aker Arctic's design team has finalised the concept for the first year-round service operation vessel (SOV) for seasonally freezing seas. The concept design can be tailored to a specific operational area and facilitates wind farms' investment calculations.

The ice-going SOV is designed to reliably reach turbines in all prevailing weather conditions, ensuring safe service throughout the year. Estimating maintenance and investment costs for wind farms in seasonally freezing seas is now easier.

Aker Arctic's proven Double Acting Ship (DAS™) principle combines operational capability in both open water and ice in an efficient design that minimises both construction and operational costs of the vessel. Clarksons Offshore & Renewables Ltd has supported the design work in areas specific to SOVs.

Energy-efficient design

The primary objective was to develop a vessel concept that is as close as possible to an open-water service vessel, but also capable of safe, independent, year-round operations without incurring high additional costs or increased fuel consumption.

According to Chief Designer Lars Lönnberg, employing the DAS™ principle – where the vessel advances bow-first in open water and light ice, and stern-first in heavy ice – has been crucial in creating an energy-efficient design.

"With our experience in designing efficient ice-going hulls, we have developed a stern form that breaks ice without using unnecessary power, thus avoiding excessive fuel usage," adds Project Manager Juuso Lindroos.

The vessel's ice strengthening and ice class are suitable for operations across the entire Baltic Sea, including the Bay of Bothnia, where winter conditions are the most severe. The final ice-going capability will be determined based on the operational conditions in the target area, with the design tailored accordingly.

Maintaining position ensures safety

Dynamic Positioning (DP) and seakeeping have been special focal points, as the vessel must remain stationary when servicing the turbines. A motion-compensated gangway is the safest means of accessing the turbines, and features such as midship location and winterisation have been included.

A passive roll damping system will ensure calm vessel movements in waves, enhancing safety and comfort for the crew.

Internal logistics and material handling on the vessel were thoroughly assessed. To minimise exposure to harsh environmental conditions, such as wind, rain, and the cold, indoor areas are utilised for movement and material transfer as much as possible.

Stepless logistics is part of the solution, allowing forklifts to carry and move service tools and spare parts without obstruction. There is also a lift for gangway access, with stairs as a back-up for safety.

Innovative options

Choices in propulsion and fuel significantly affect energy costs, but also crew well-being. Using a battery-operated electric system reduces noise and engine resonance. A plug-in hybrid system with charging capabilities at the wind farm allows for operations to be powered by batteries day or night.

For longer transfers, engines running on either marine diesel or alternative fuels, such as methanol or ammonia, are essential. Optional space has been allocated for the larger fuel tanks necessary for alternative fuels.

A retractable thruster, quieter than fixed tunnel thrusters, is also part of the low-noise solution. Furthermore, cabins are located high in the superstructure to reduce noise from ice interaction.

Estimates of costs

Maintaining reasonable construction costs has been a significant focus.

"The vessel is not an icebreaker, but tailored for independent operations and optimised for the area it will serve, ensuring that both construction and operational costs remain controlled," Lönnberg highlights.

Lindroos adds that preliminary estimates suggest the construction cost is about 5–10 % higher than a similar-sized open-water vessel. This increase accounts for additional steel weight, propulsion power, and winterisation.

"The hull form, the DAS™ principle, and other innovative solutions play a significant role in keeping the price down," says Lindroos.

Prioritising staff well-being

An SOV can remain at the wind farm up to a month before returning to shore for supplies. The crew works in multiple shifts and is rotated back to the mainland every two weeks using smaller vessels. In winter, the frequency of harbour

calls may increase due to the ice conditions.

"The vessel is essentially a second home for the staff and should be comfortable both during their shifts and their downtime," explains Lindroos.

In addition to other amenities, a sauna and gym area with unobstructed sea views have been included on the top deck, along with an outdoor terrace furnished with an optional hot tub.

Support for investments

Aker Arctic's expertise in ice operations and dynamic ice fields, combined with the specialised requirements of service operation vessels has resulted in a highly successful concept design. This design has been showcased at trade fairs and has attracted considerable interest.

"Wind turbines out of service can lead to financial losses of up to tens of thousands of euros and power grid imbalances," emphasises Lönnberg.

"Therefore, a service operation vessel capable of operating in all weather conditions and throughout all seasons is essential to support investments in wind energy in seasonally freezing regions," he adds.

Technical details

Length:	84.4 m
Beam:	19.2 m
Draft:	5.2 m
Warehouse:	400 m^2
Working Deck:	300 m^2
Gangway:	16–22 m LAT (height about 25 m)
Boat landing:	yes
Daughter craft:	yes
Cabins:	70
Sauna:	with sea view

Shallow-draught icebreakers present unique challenges

The Mangystau-series of five vessels, designed by Aker Arctic, were constructed in 2010 and 2011.

The design of icebreakers, characterised by a relatively small draught in proportion to their main dimensions, requires particular attention.

In naval architecture, certain fundamental principles guide the correlation between a vessel's external dimensions and its draught for an optimal design. However, practical constraints in the intended operational area often impose limits on one or more dimensions, for example breadth in the Panama Canal, length limitation of a harbour, or draught to match water depth in the area of operation.

Shallow waters in freezing seas offer particular challenges for icebreaker designers. Here, the vessel's primary dimensions must be adjusted beyond optimum configurations to meet the intended tasks, equipment, and endurance. These adjustments affect essential characteristics, including operability, manoeuvrability, open water speed, and icebreaking capability.

Every design choice matters

In Aker Arctic's projects, icebreaking capability typically forms one of the foundations of the vessel's design. The outline design then proceeds to defining the size, propulsion, and equipment to fulfil the specified level of performance criteria and other agreed tasks. Each decision in this process influences others, creating a delicate balance.

Senior Naval Architect Lars Lönnberg from Aker Arctic underlines that when designing shallow-draught icebreakers, even minor modifications can have significant effects.
"For instance, a shallow draught means that the propulsion system components must be relatively compact to fit the hull correctly and remain submerged. However, a smaller propeller diameter provides less thrust, which is a key feature in icebreaking," he explains.

In shallow water, the vessel's weight control is a crucial aspect of the design. It determines the equipment selection, endurance, and crew size; every feature that adds more weight. Also, the displacement relative to the vessel's underwater side profile area can become substantial, impacting manoeuvrability.

"As a result, turning and other manoeuvres can be more challenging and must receive special attention during the design phase," Lönnberg adds.

Providing space for ice rubble

Icebreaking in shallow water involves more than just breaking the ice, the draught and inertia; it also requires managing the ice rubble. Once the ice is broken, the resulting rubble needs adequate space to disperse. As the vessel moves in the channel, it pushes the ice blocks under the hull and in shallow waters the ice mass, though loose, may even reach to the bottom.

"Without sufficient space, the ice rubble can pile up on the seabed, potentially blocking the route and trapping the icebreaker," notes Lönnberg.

Strong winds can exacerbate this issue by moving the broken ice, which may accumulate into ice jams and dams, or deep ice ridges, hindering traffic.

"Ensuring sufficient ice-clearing capabilities is therefore essential. Azimuthing propulsion has proven effective for clearing ice rubble and enhancing manoeuvrability, and recently developed azimuthing contra-rotating pro-

pellers (CRP) can further improve efficiency in shallow waters," Lönnberg highlights.

Brash ice grows with increased traffic

Part of the design process includes planning for adequate space to operate, for instance through dredging or creating passing lanes for traffic.

Aker Arctic has, over the years, conducted numerous studies on channel operation and brash ice formation since ship traffic in the Baltic Sea is partly in channels and, especially in the Saimaa Channel, much of the traffic is in restricted water areas.

In a channel, each passing vessel breaks the insulating ice shield, leading to a heat loss from the water mass. This heat loss intensifies the ice formation as it increases the thickness of the ice sheet or the brash ice layer and creates even larger ice blocks hindering the flow of the traffic.

According to studies, the passing of four vessels a day may increase the ice formation five times higher than without any traffic. A snow cover adds the influence of navigation, since snow easily turns into slushy ice once it gets in touch with cold water.

"Thick brash ice in connection with shallow water can dramatically reduce propulsion efficiency, which results in poor vessel performance," Lönnberg adds.

Half a century of expertise

The first shallow-draught river icebreakers designed by Aker Arctic's predecessor were built in the 1970s. A more recent example is *Röthelstein*, delivered in 1995, a river icebreaker used on the Danube in Vienna, Austria, to ensure that water flows freely to the local hydro-power station. Her operational draught is only 2.0 metres, with excellent icebreaking capabilities and manoeuvrability.

The river icebreaker *Röthelstein* opening a channel and managing brash ice on the Danube in Austria.

In the mid-1990s, the two sister ships *Arcticaborg* and *Antarcticaborg*, were developed for the shallow Caspian Sea. Their draught is 2.9 metres, full speed over 13 knots with a bollard pull of 32 tonnes.

The two sister ships *Arcticaborg* and *Antarcticaborg* were developed in the mid-1990s for the shallow Caspian Sea.

The most recent shallow-draught icebreaker built is the Mangystau-series of five vessels, constructed in 2010 and 2011. They were fully designed for independent year-round operations in the Northern Caspian Sea, an extremely shallow area, and have a minimum draught of 2.5 metres. In 2022, *Mangystau-2* was sold to the Government of Canada and renamed CCGS *Judy Lamarsh*.

"The smallest draught we have designed so far is 1.5 metres, but depending on the specific requirements, we might be able to design fully capable vessels with an even shallower draught," Lönnberg notes.

Navigating shallow ice areas

Shallow-draught icebreakers are typically needed in specific areas where freezing conditions exist. Such areas include navigable rivers, shallow seas, estuaries, archipelagos, and lakes.

"These regions may not freeze every year but contain infrastructure that requires maintenance under all conditions, such as power stations or wind turbine installations," Lönnberg explains.

Customised solutions

As each operational area is unique, there are no off-the-shelf solutions. Furthermore, many features effective on other types of icebreakers may not apply in shallow water, where the seabed is closer to the hull. Detailed research on local conditions is therefore always necessary when developing a new vessel design.

"Shallow water presents an additional challenge in the same way as freezing temperatures and must be considered from the onset of the design process," Lönnberg underlines.

Head of Sales and Marketing Arto Uuskallio adds that Aker Arctic's expertise has evolved hands-on over the past five decades, based on extensive experience with shallow-draught icebreaker projects. ■

ANNOUNCEMENTS

Tomas Forsblom-Strand has joined Aker Arctic as a development engineer.

He graduated with a BASc. in Information Technology from Arcada University of Applied Sciences in 2014. Since then, he has worked with developing electronics and embedded software, as well as being a consultant focusing on Embedded Linux Systems. In the past, he worked as an electrician.

Hella Huttunen has joined Aker Arctic as a project engineer in the structures team.

In 2024, Hella graduated from Aalto University with a master's degree in mechanical engineering, after completing her master's thesis about ice behaviour in a tunnel thruster's tunnel. Along with her studies, Hella worked in the student pool at Aker Arctic's model testing facility from 2021 to 2023.

Esa Häkkinen has joined Aker Arctic as head of ship design.

Esa graduated with a master's degree in naval architecture from Aalto University in 2008. Before joining Aker Arctic, he worked at Elomatic, Wärtsilä, Traficom, and SRC Group in various specialist and management positions gaining a vast experience in ship design and regulations.

Inkeri Kemppinen has joined Aker Arctic's ship design team as a naval architect focusing on ship weight calculations.

Inkeri first started working at Aker Arctic as a trainee in the ship design team, in 2023. During the following year, she wrote her master's thesis titled: *Impact of ship speed on ice-induced loads on ship hull*. After completing her thesis, she graduated from Aalto University with a master's degree in mechanical engineering in 2024.

Aapo Käkilehto has joined Aker Arctic as a project engineer in the equipment business and special projects team.

Aapo graduated from the University of Oulu in 2024 with a master's degree in mechanical engineering, specialising in engineering mechanics. Before joining Aker Arctic full time, Aapo worked part-time for the company for 2 years. In his master's thesis, he studied the strength characteristics of a novel propeller concept.

Ivan Mazanikov has joined Aker Arctic as a project engineer in the consultancy and technology development team.

Ivan graduated from Aalto University in 2025, with a master's degree in mechanical engineering. He has previously worked at Aker Arctic as a trainee in naval architecture and structural design. After this, he wrote his master's thesis for the company on the topic of impact of energy efficiency regulations on ships operating in ice.

Miku Sevón has joined Aker Arctic as a machinery systems designer in the machinery team.

Miku graduated from Aalto University in 2024, with a M.Sc. degree in mechanical engineering, specialising in marine and arctic technology. During the spring of 2024, Miku wrote his thesis for Aker Arctic on the subject: *Estimation of propeller ice torque in preliminary design phase*. In his thesis, Miku developed a data-driven numerical model, utilising full-scale propulsion data and theoretical propulsion dynamics, to estimate propeller ice torque of both operational and concept ice-going ships. Before joining Aker Arctic, Miku worked as a junior designer in the machinery and deck outfitting department at Bluetech Finland for 2 years, alongside his studies. ■