Aker Arctic
The Ice Technology Partner

Arctic Passion News

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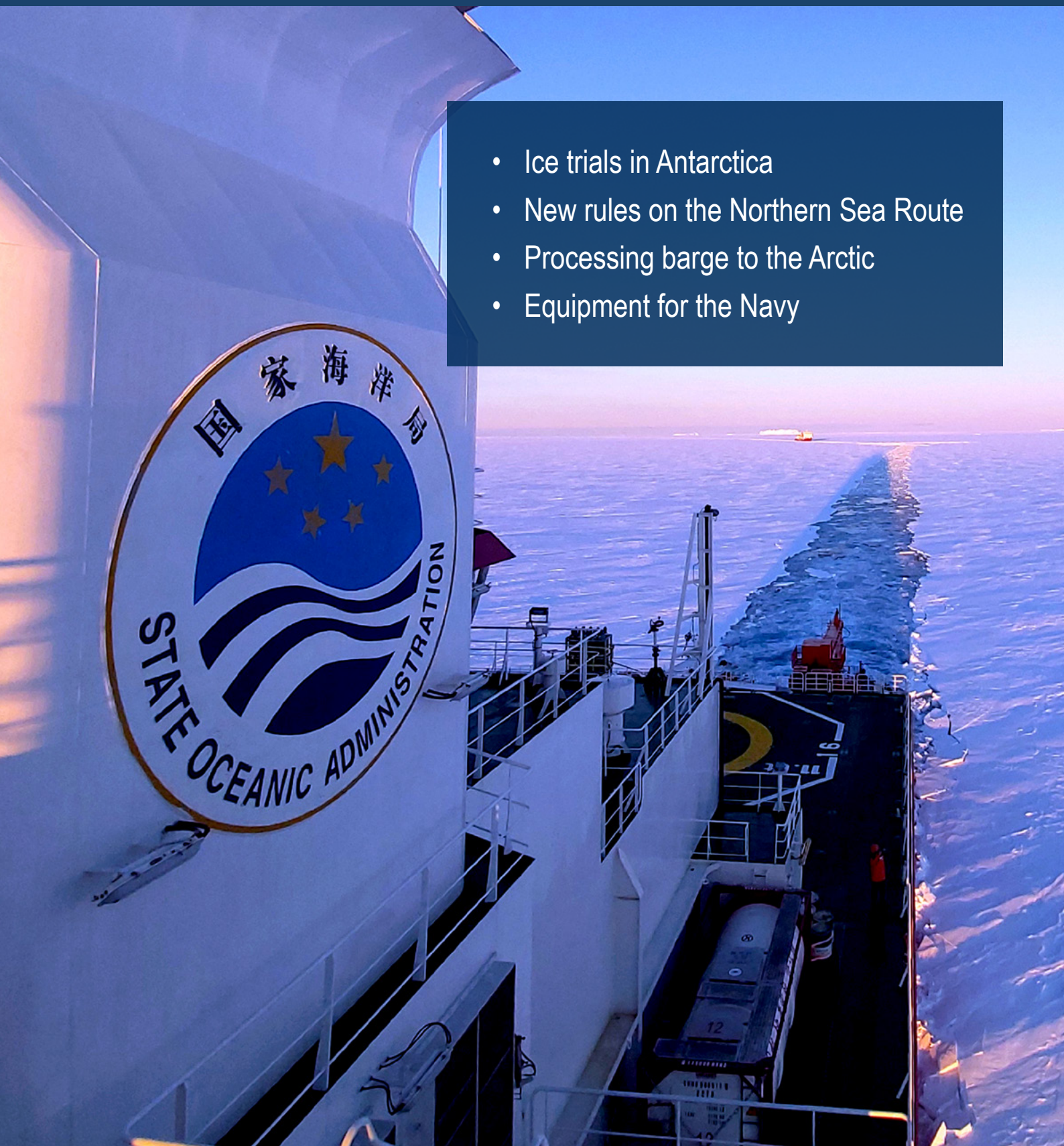
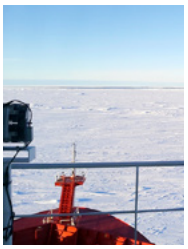
- Ice trials in Antarctica
- New rules on the Northern Sea Route
- Processing barge to the Arctic
- Equipment for the Navy



In this issue

Page 4
New rules on the Northern Sea Route



Page 8
Xue Long 2 in ice trials

Page 11
Equipment for the Navy

Page 16
Barge for mining project

Table of contents

Front cover

Sami Saarinen spent six weeks travelling to Antarctica and back, onboard both of China's icebreakers *Xue Long* and *Xue Long 2*. Read about his voyage and *Xue Long 2's* ice trials on page 8.

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We are participating in the following events

20 – 23 April	Seatrade Cruise Global, Miami, USA
21 – 24 April	Arctic Shipping Forum, Helsinki, Finland
14 – 15 May	Åland Maritime Day, Mariehamn, Finland
8 – 11 September	SMM, Hamburg, Germany

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Arctic Passion News 1 / 2020

Dear Reader,

At Aker Arctic, we work with icebreaking ships. Our mission is to provide high-quality icebreaking ship designs and various services to streamline the construction projects of these ships.

Therefore, we follow with high interest the development of global environmental conditions, especially in respect of ice circumstances. It is well known that climate change is affecting ice conditions, mostly making shipping and sea operations easier in such areas where waters freeze.

This winter has been unusually warm

in Scandinavia and all of Europe. In southern Finland, we feel that winter has actually not arrived at all. Ice cover in the Baltic Sea may reach its lowest since records began. Daily ice charts become uninteresting to read; the only ice is located in the northernmost part of the Bothnian Bay.

According to meteorologists, this winter has been exceptional and can be explained as natural variation. Nevertheless, the long-term trend is clear, and we can expect milder winters more often in the future than previously.

A similar trend

has also been observed on the Arctic shipping routes. However, it is intriguing to observe that the Arctic ice cover is actually larger this winter than in previous years at the same time. This is due to large-scale, polar-weather patterns. While large low-pressure areas are travelling in the Northern Atlantic, the Arctic region is holding the colder air in the north. This results in warmer weather in the subarctic regions, such as the Baltic Sea, and colder conditions in the high Arctic.

Having said that, the increased shipping traffic, mainly on the Northern Sea Route (NSR), continues to experience high ice requirements. Ships have to be able to survive in heavy Arctic ice while trying to maintain good speed in order to make transportation economically viable.

The recently-started shipping activities

from the Gulf of Ob have proven that independent icebreaking vessel designs are working. Future expectations are that shipping will increase, requiring a higher number of nuclear-powered icebreakers as well as ice-capable transportation vessels.

This development is now ongoing. The Russian government has a clear strategy for it, and recent decisions to build more icebreaker capacity are an implication of that. I hope you will find our article explaining these developments and the new organization of NSR governance useful.

Last year, two new icebreakers

were delivered from the shipyards and we can take credit for designing both. The Chinese *Xue Long 2* was delivered in June 2019 and, for the time being, the world's newest icebreaker *Ob* was delivered from Vyborg shipyard in October 2019.

Both icebreakers are showcases of modern, state-of-the-art ships with unique technical capabilities, beginning their long service time in their respective duties.

Sincerely yours,

Reko-Antti Suojanen
Managing Director

New regime and regulations on Northern Sea Route

All designs of modern Arctic cargo vessels are unique and were developed for specific transportation schemes with prior feasibility studies determining their optimal characteristics.

In December 2018, the State Duma in Russia transferred the powers of operator of the Northern Sea Route to Rosatom. Changes in regulations are currently taking place and Alexey Shtrek at Aker Arctic is following what will change and how this will impact design work.

The main regulatory documents that concern new high-ice-class vessels or existing low-ice-class transport in the Arctic are the: Rules of Classification and Construction of Sea-going Ships by the Russian Maritime Register of Shipping (RS); and Rules for Navigation in the Water Area of the Northern Sea Route by the Northern Sea Route Administration (NSRA).

Risk-based approach

A new challenge for designers is the recently introduced change to the Rules for the Classification and Construction of Sea-Going Ships.

Previously, there were very descriptive RS rules for ships intended for operation in Arctic seas, containing detailed information on the possibilities and limitations for different ice classes. Following the basic ideology and approach of the international Polar Code, RS removed tables that contained information on allowable areas of navigation and ice conditions, and permissible speeds at corresponding operating modes (independent or icebreaker assisted) for ships, depending on their ice classes.

The new version of the rules, available on the RS website (rs-class.org), now contains only one table with reference descriptions of ice classes of the Register. According to RS, the determination of the permissible ice class, based on the specific ice conditions in the area of operation, is the prerogative of the Harbour Master, the NSRA, or the ship operator. Additionally, the choice of the ice class of the designed ship should be justified by its owner or designer.

"Designers will now have to define the risks themselves, depending on the area of navigation or tasks," says Development Manager Alexey Shtrek.

Ice class	Description
Arc9	In summer/autumn navigation – voyage in all areas of the World Ocean. In winter/spring navigation in Arctic – voyage in very close floating ice and in compact multi-year ice of up to 3.5 m thickness and in freezing non-arctic seas without restrictions.
Arc8	In summer/autumn navigation – voyage in all areas of the World Ocean. In winter/spring navigation in Arctic – voyage in close floating second-year ice up to 2.1 m thickness and in freezing non-arctic seas without restrictions.
Arc7	In summer/autumn navigation – voyage in all areas of the World Ocean. In winter/spring navigation in Arctic – voyage in close floating first-year ice up to 1.4 m thickness and in freezing non-arctic seas without restrictions.
Arc6	In summer/autumn navigation in Arctic – voyage in open floating first-year ice up to 1.3 m thickness. In winter/spring navigation in Arctic – voyage in open floating first-year ice up to 1.1 m thickness. Year-round voyage in freezing non-arctic seas.
Arc5	In summer/autumn navigation in Arctic – voyage in open floating first-year ice up to 1.0 m thickness. In winter/spring navigation in Arctic – voyage in open floating first-year ice up to 0.8 m thickness. Year-round voyage in freezing non-arctic seas.
Arc4	In summer/autumn navigation in Arctic – voyage in open floating first-year ice up to 0.8 m thickness. In winter/spring navigation in Arctic – voyage in open floating first-year ice up to 0.6 m thickness. Year-round voyage in freezing non-arctic seas in light ice conditions.

Recent changes to the section on the Rules for the Classification and Construction of Sea-going Vessels of the Russian Register.

Designers will now have to define the risks themselves, depending on the area of navigation or tasks.

Polar Code ideology

In general, these changes are within the framework of the Polar Code ideology, and aimed at unifying ice class descriptions. They should allow designers and operators greater choice when deciding on the most appropriate level of strengthening to the hull, propulsion parameters and other required vessel characteristics.

"At the same time, it is important to maintain a correct understanding of how a vessel in the design stage will comply with the operating conditions," Shtrek highlights. "From the new table, it can be concluded that RS has tightened the limitations for its own Arctic ice classes. The mode of icebreaking assistance is now moved beyond the scope of classification and is entrusted to the designer's or operator's decision."

"Therefore, it is essential that the Polar Ship Certificate issued by a classification society, in accordance with the requirements of the Polar Code, should clearly indicate the actual operational limitations when navigating in ice for a specific ship design. It is also valuable to have the designer involved in the operational assessment."

Rules for Navigation

Ship designers will need to study the navigation rules even more carefully for those areas in which the polar-class vessel is intended, that is, the Rules for Navigation in the Water Area of the Northern Sea Route available on NSRA's website (nsra.ru), which are also being prepared for changes.

The draft of these changes has been submitted for discussion to all interested parties and is currently in the approval process of the Russian Government.

"From the published materials it seems, especially, to ease the requirements for the admission of vessels of ice classes Arc4 and Arc5 when operating under icebreaking assistance," Shtrek continues.

These proposals are based on the experience gained from the operation of powerful nuclear icebreakers assisting relatively small vessels, in particular using close towing in the most severe ice conditions.

"This method is unacceptable for large cargo vessels requiring special methods when escorted by icebreakers," Shtrek says.

Ice class	Mode of ice navigation	South-west part of Kara sea			
		DRAFT of new edition		Current edition	
		winter	summer	winter	summer
		HMEO	HMEO	HME	HME
Arc4	Independent	- - + +	- + + +	- - +	- + +
	IB escorted	+ + + +	+ + + +	- - +	+ + +
Arc5	Independent	- - + +	- + + +	- - +	+ + +
	IB escorted	+ + + +	+ + + +	- - +	+ + +
Arc6	Independent	- + + +	+ + + +	- - +	+ + +
	IB escorted	+ + + +	+ + + +	- + +	+ + +
Arc7	Independent	+ + + +	+ + + +	+ + +	+ + +
	IB escorted	+ + + +	+ + + +	+ + +	+ + +

'+' – navigation is allowed; '-' – navigation prohibited
+ - more easy requirement; - more strict requirement

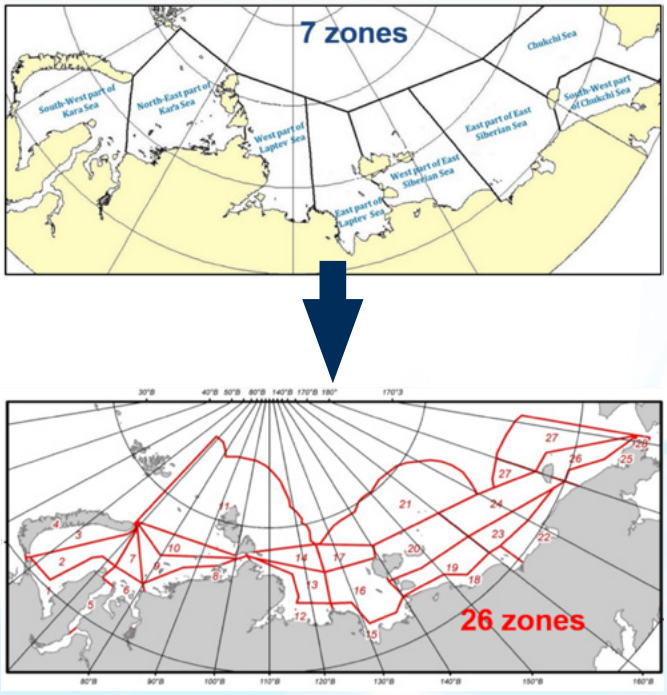
Types of ice conditions: H – heavy; M – medium; E – easy; O – open water

Comparison of the changes to the Rules for Navigation on the Northern Sea Route that are currently being prepared.

More navigating zones

Another important change in the draft of the new rules is an increase in the number of Northern Sea Route zones for assessing the severity of ice conditions.

Currently, there are seven zones, each defined according to specific ice conditions. In the future, the number of zones will increase to 26, each with its own type of ice conditions and limitations on passage. This will allow the use of low ice-class vessels in more areas and assist in optimising logistic schemes.



Currently, there are seven zones defined according to specific ice conditions. In the future, the number of zones will increase to 26, each with its own type of ice conditions and limitations for passage.

Responsibilities

Rosatom is now responsible for developing the infrastructure, the creation of a fleet, icebreaker assistance or certain services, structure development, as well as traffic control services.

Two state organisations are subordinate to Rosatom though the Directorate of the Northern Sea Route: Atomflot and Hydrographic Enterprise.

Atomflot traditionally operates an icebreaking fleet, provides navigation on the NSR, and is responsible for the building of new icebreakers. Last year, Atomflot's fleet was extended with its first non-nuclear icebreaker *Ob*, a port icebreaker based on the Aker ARC 124 design and intended for operation in the Sabetta LNG terminal.

Example of modern arctic cargo fleet: Polar Class 3 module carriers Audax and Pugnax began in 2016 to deliver construction modules to Sabetta. Photo by Red Box Energy Services Ltd.

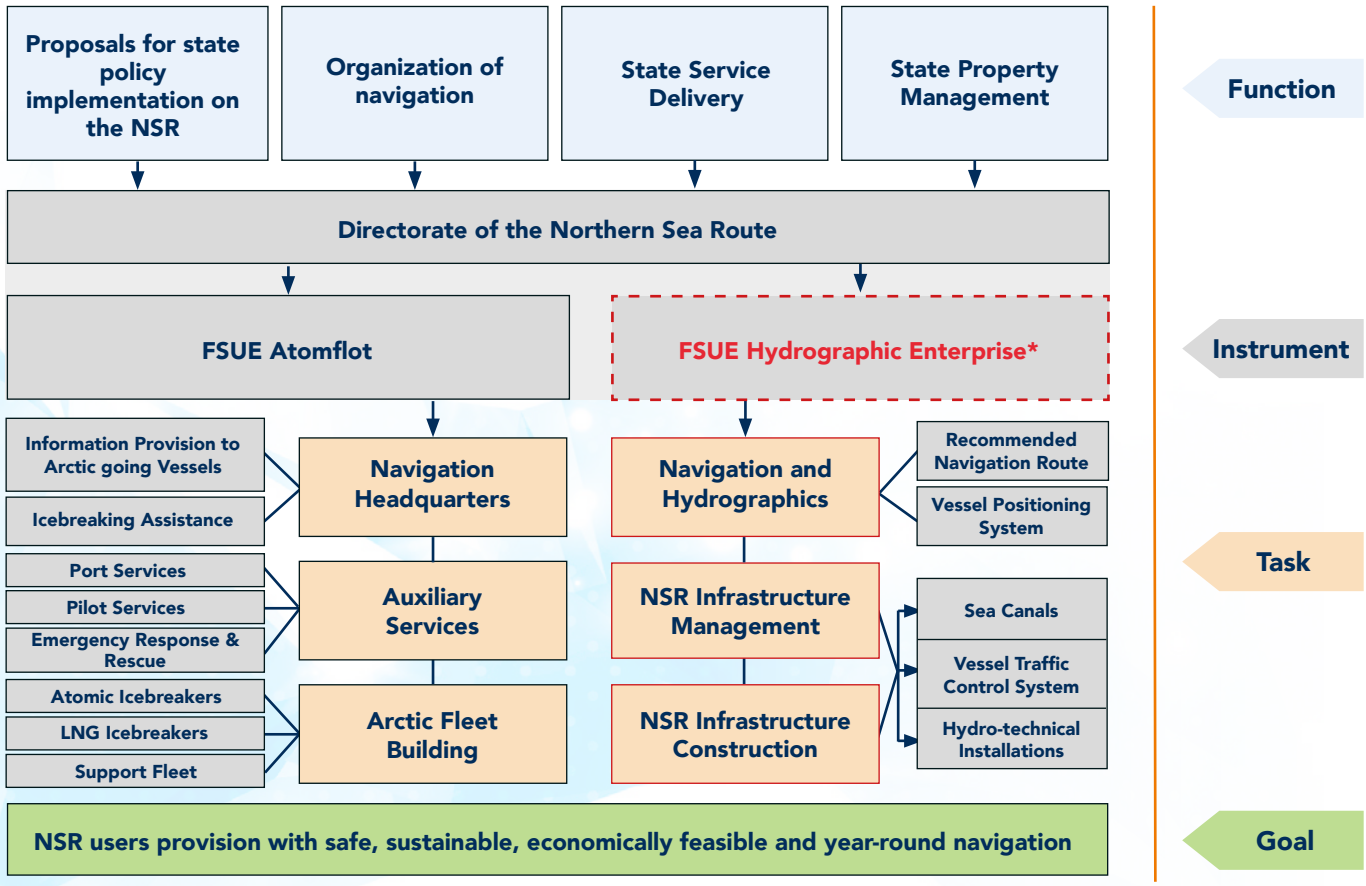
Hydrographic Enterprise provides navigational and hydrographic support, and is responsible for the appropriate infrastructure. It performs water depth surveys on the navigation routes on the NSR, owning a fleet of specialised hydrographic vessels.

Permissions as before

NSRA, being under the Ministry of Transport, is responsible for legal regulation of shipping, fulfilment of international obligations of Russia, as well as state port supervision of ships and fees. It continues to issue permissions for vessels entering the NSR water area, as before.

According to a previous agreement with Rosatom, the Ministry of Transport of the Russian Federation approves rules for navigation on the NSR, compulsory regulations in seaports at the NSR, a list of port fees and decisions on opening sea ports, among others.

"It is assumed that, in the future, Rosatom and the Ministry of Transport will work according to the so-called two-key approach: complementing each other in their functions and responsibilities in order to ensure the necessary level of safety and efficiency of the Northern Sea Route as a sustainably-developed transport corridor," Shtrek explains.



NSR organizational chart

Two Arc7 gas condensate tankers were delivered in 2018 and 2019.

Safe shipping in the Arctic

The development of oil and gas projects in the Russian Arctic basin has led to the creation of principally new types of large Arctic cargo vessels for ice navigation, significantly surpassing traditional icebreaking transport vessels in their operational capabilities.

Example of modern arctic cargo fleet: Two Arc6 shuttle tankers of Kirill Lavrov type were delivered in 2010

Five Arc7 container carriers for Norilskiy Nickel were delivered in 2006–2009.

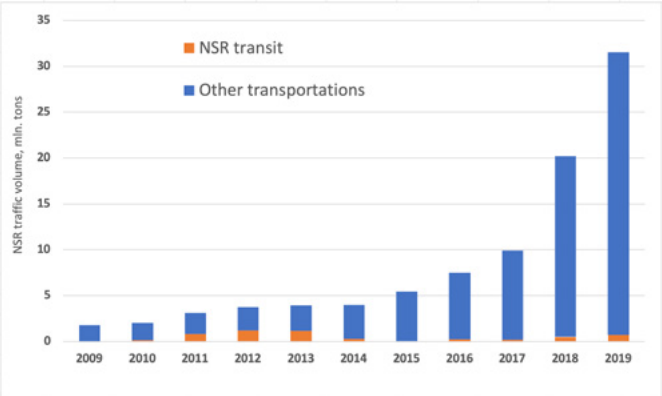
Further increases in export volumes, new plans for organising year-round eastward navigation along the Northern Sea Route, as well as new environmental requirements, all pose designers with new challenges to create cargo vessels capable of providing reliable, cost-effective and safe shipping in the Arctic.

Optimal design path

The selection of optimal parameters and the further design of future Arctic cargo vessels should be based on the results of a comprehensive feasibility study, tailored for each specific shipping project.

It should cover the detailed assessment of ice and navigation conditions in the areas of operation, the estimated traffic volumes and the use of different possible transportation schemes, the availability and capabilities of icebreakers, and all the issues related to operating a vessel in ice.

"In accordance with the ideology of Aker Arctic, we prefer to be involved in Arctic projects from the earliest stages. Then we can understand all the challenges that may arise in the process of designing icebreaking vessels for our clients and come up with the most optimal and effective design solutions," Shtrek underlines.



Cargo volumes on the Northern Sea Route are expected to grow up to 80 million tons in the future, mainly related to new hydrocarbon export projects. Transit volumes remain more or less the same, as these are still occasional voyages and not scheduled.

Xue Long 2 in successful ice trials

Sami Saarinen from Aker Arctic spent three weeks onboard *Xue Long 2* to observe and assist with the full-scale tests in Antarctica, as well as to ensure that the vessel meets all the client's expectations.

China's new polar research ice-breaker, *Xue Long 2*, was delivered at Jiangnan Shipyard in China in July 2019. Her maiden voyage took the vessel to Hobart, Australia, from where she continued on her first ice mission to Antarctica together with China's other polar research vessel, *Xue Long*, delivering equipment and supplies to the Chinese research stations.

Saarinen boarded *Xue Long 2* in Hobart on the 7th November 2019 for the two-week-long journey to Prydz Bay where the tests were performed near the Zhongshan research station. Close to Prydz Bay, where the ice conditions became more severe, *Xue Long 2* sometimes assisted *Xue Long* in ice.

Heavy ice conditions

Most of the journey was sailed in open water until a few days before arriving at the destination, when the scenery changed to an icy one with snow-covered ice fields and icebergs.

At Prydz Bay, the level ice measured 1.4 metres thick with a dense, 35 to 40-cm-thick cover of significantly packed snow. Tests in both ahead and astern directions showed that the vessel fulfils its design targets.

In addition to testing, *Xue Long 2* assisted *Xue Long* in reaching close to the research station. During previous years, this logistics operation had taken place 6 to 8 weeks later when the ice situation became

Xue Long and Xue Long 2 in Antarctica. Photo courtesy of PRIC.

At Prydz Bay, the level ice measured 1.4 metres thick with a dense, 35 to 40-cm-thick cover of significantly packed snow.

easier. This year, with the help of the new and extremely-capable polar-research icebreaker, the operation could be performed much earlier in the season.

Capability validated

The cargo was unloaded by helicopter from *Xue Long* and, by reaching close to shore already at this time of the year, the distance was shortened. The results were improved efficiency and fuel savings.

"Our client could immediately appreciate the benefits of the new vessel," says Project Manager Kari Laukia. "*Xue Long 2* performed splendidly at the actual task she was designed and built for, which is an excellent validation for the vessel's operational capability."

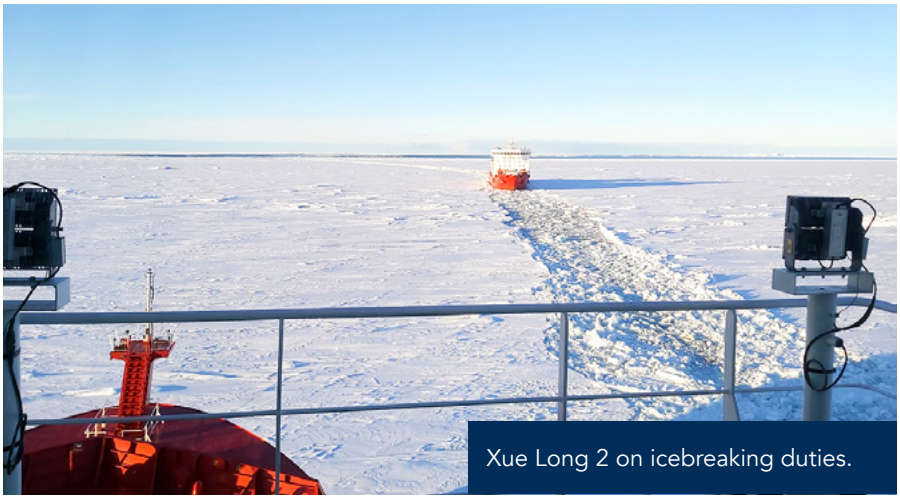
Climate research

During the two weeks at Prydz Bay, Saarinen also had a chance to visit the Antarctic continent and the Zhongshan Station, China's second Antarctic research station opened in 1989. Zhongshan Station is a base for research into marine, glaciological, geological, and atmospheric sciences, and for expeditions inland.

"The comfortable research station is equipped with impressive research equipment, such as high antennas over a large area. There are narrow roads and even an airstrip, which small planes can land on," he says.

Nearby is also the Russian research station Progress.

After the unloading and testing was finished, Saarinen returned back to Hobart onboard *Xue Long*. He reached Helsinki just in time to celebrate Christmas with his family.



Xue Long 2 on icebreaking duties.

State-of-the-art equipment

Xue Long 2 continued onwards along the Antarctic coast to the south of the African continent to perform ocean science measurements, another of her design missions. The team of scientists on-board have access to the most modern scientific equipment currently available.

"The laboratory and moonpool areas are remarkable. Additionally, the propulsion system with two Azipod units is exceptional for an ice-going research vessel," Saarinen adds.

The next ice-covered destination will be the Arctic area.

Successful project

"The new ship allows a new dimension of flexibility in terms of scheduling and areas of operation, as the icebreaking capability of *Xue Long 2* is much higher than that of the old vessel," Laukia highlights. "*Xue Long 2* can reach considerably closer to the research stations earlier than previously. This was the design target, which was also achieved." *Xue Long 2* additionally showed her manoeuvring capability while dislodging *Xue Long* stuck in ice en route, and assisting the other vessel during the cargo unloading.

"This successful project is a good base for continued cooperation with our Chinese partners," Laukia says. ■

Zhongshan Research Station is a base for research into marine, glaciological, geological, and atmospheric sciences, and for expeditions inland.

Sami Saarinen travelled six weeks from Hobart to Antarctica and back.

Propellers and shaft lines to Finnish Navy corvettes

In September 2019, The Finnish Defence Forces Logistics Command and Aker Arctic signed a contract for the design, delivery and integration of complete propulsion lines to four Pohjanmaa-class multi-role corvettes for the Finnish Navy. The development work already began in 2015.

The Navy's new Pohjanmaa-class multi-role corvettes have been designed to meet the performance requirements set by the Finnish Defence Forces for service in the area of the Baltic Sea.

With these corvettes the Finnish Defence Forces will be able to conduct daily surveillance all-year round, repel attacks from the sea, defend maritime connections vital to Finland, and secure Finland's territorial integrity, all more effectively.

Photo courtesy of Finnish Defence Forces

Challenging weather

Finland's demanding conditions require the ability to navigate in different ice conditions, as well as in any kind of weather on the Baltic Sea.

Gale-force winds and the resulting wave heights restrict the operation of light naval units on the open sea. The significant wave height may reach above six meters in the northern part of the Baltic Sea. High waves, icy conditions, snow and sleet, and the rain and fog caused by temperature fluctuations may weaken the performance of surveillance and weapons systems, or even hinder their use.

The extent of ice cover on the Baltic Sea varies considerably from year to year but the severity of the ice-covered period does not entirely account for the difficulties caused to maritime transport. Pressure from gale-force winds on the ice cover forces layers of ice to form on top of each other and, eventually, form ice ridges. In a typical winter, our own harbours and the archipelago freeze while the rest of the Baltic Sea is unfrozen.

Multiple tasks

The vessels of the Squadron 2020 project will, in addition to surveillance and territorial duties, take part in safeguarding maritime transport in cooperation with national and international authorities.

Pohjanmaa-class ships are purchased and manufactured in Finland for the Navy to fulfil its duty to ensure safety in Finland for its citizens during normal and emergency conditions.

Construction to begin

Construction of the vessels is scheduled to begin in 2022 and the four-strong squadron will achieve operational readiness in 2028.

Rauma Marine Constructions (RMC Oy and RMC Defence Oy) based in Rauma on the western coast of Finland will build the vessels for the Squadron 2020 project. The Swedish aerospace and defence company Saab AB was selected as the supplier of the vessels' combat systems.

Aker Arctic's role

Aker Arctic's scope of delivery includes ice-strengthened controllable pitch propellers and their pitch control mechanisms, propeller shafts, bearings and shaft seals. In addition to complete design, calculations and material supplies, Aker Arctic will be responsible for installation supervision, and commissioning of the propulsion lines.

Aker Arctic has been developing the propulsion line in co-operation with the Finnish Defence Forces since 2015 to ensure that the new multi-role corvettes will meet the demanding operational performance requirements of the Finnish Navy. An essential part of this development is matching the propeller with the hull to achieve high open water speed, ice-going capability and low underwater noise levels. ■

Safe and reliable shipping of crude oil

Mastera is a double-acting ship which can manage independently in all Baltic ice conditions. Photo by Neumann Horst.

Neste Corporation ordered two Aframax-size crude oil tankers from Hyundai Heavy Industries in South-Korea last year. Aker Arctic has assisted in the acquisition process to help Neste find the optimal solution for their transport needs.

A few years ago, the Finnish fuel company Neste began to plan for the future of their crude oil shipments. The main question was to decide what kind of vessels they want to use in the coming decades when their current fleet reaches the end of its lifecycle.

Neste is currently using two different tankers for shipments from Primorsk and Ust-Luga harbours in Russia to their refineries in Porvoo and Naantali in Finland. *Mastera* is a double-acting ship which can manage independently in all ice conditions. *Stena Arctica* is a conventional tanker which has good general performance in ice, but needs icebreaker assistance in hard-ice conditions.

Feasibility study

Having had positive experiences from previous projects, Neste decided to order a feasibility study from Aker Arctic with the aim of evaluating which ship type would be optimal for their crude oil transportation in the Baltic Sea, what capacity the vessels should have, and how many ships would be most efficient to use.

In the study, three ship concepts were compared: a double-acting ship, a conventional ice class 1A vessel and a new Aframax vessel concept with an icebreaker bow. The analysis focused on use in three different winter conditions: mild, severe and average winter. Additionally, an evaluation was made of which type of these vessels would be optimal for the amount of oil shipped to the two refineries, as well as an analysis of acquisition costs and operational costs.

"The results of this study formed the base for our decisions on how to continue with the project," says Paavo Kojonen, Head of Fleet Operations at Neste.

Improved ice capabilities

Neste decided to proceed with a conventional ship of ice class 1A but with improved ice capabilities and with important technical requirements especially suited for operations in the Baltic Sea. At the same time, they opted to modify an existing vessel model instead of designing a completely new vessel.

"When deciding on which shipyard would build our desired ship, a few aspects were essential," Kojonen highlights. "We wanted the shipyard to be a reliable constructor of quality ships and have previous references of building ice-going vessels. Additionally, we wanted the shipyard to be prepared to work not only with us, but also with Aker Arctic."

Four shipyards submitted vessel proposals which Aker Arctic then evaluated for their ice performance. *Stena Arctica* was used as a reference vessel. Aker Arctic also provided advice on possible modifications to each vessel in order to improve ice performance.

Verification with model tests

"We evaluated different designs together with Aker Arctic and listed the requirements for ice performance to be included in the contract," says Project Manager Antti Kettunen from Neste.

"Part of the deal with the shipyard was that ice model tests were to be done at Aker Arctic, so that they could verify that requirements were fulfilled. We also wanted the shipyard to collaborate with Aker Arctic during the design phase, especially regarding the bow."

The contract with Hyundai was signed in June 2019 and ice model tests were performed in Aker Arctic's test basin in August to verify the design. Construction will begin in summer 2020 and the delivery of the first vessel is planned for September next year. The second vessel will be ready at the end of 2021.

Comparing ice performance

When the current ships *Mastera* and *Stena Arctica* were on order, Aker Arctic performed ice model tests on them. As an additional service,

Neste received an ice-performance comparison for these two ships and the newbuilds.

"We are very happy with the results," says Kojonen. "The new vessel will have many technical improvements compared to *Stena Arctica*, though both are conventional vessels. *Mastera* was built with a different technology and is in a class of her own."

Custom features

The operational profile and the area of operation are very specific and, as a result, Neste wanted to customise critical parts of the vessel and not stay within standard requirements. Safety has been a top priority.

"Good ice capabilities are above all a safety feature for Neste," Kettunen adds. "We could have used the shipyard's standard 1A or 1A Super bow form, but we decided to look at things from a new perspective and optimise the bow for our area of operations. For example, breaking out from an ice channel would not have been possible with a typical 1A bow design."

The hull structure will be reinforced, bow thrusters will improve manoeuvrability, and custom-designed winterization features have been planned according to wishes from end users and harbours. Selected equipment is heated or protected properly and safe to use in all weather conditions.

"One particular feature of our ships is that they spend more time in harbours than out at sea because the transport distances are short," Kettunen says. "Therefore, energy efficiency both at sea and during harbour operations has been emphasised."

Excellent partners

Kettunen and Kojonen are extremely pleased with Aker Arctic's work. "All schedules were kept to and our questions were answered promptly, even at short notice when we needed information or advice during negotiations with the shipyards."

They noticed that shipyards all over the world see Aker Arctic as a reliable and recognised cooperation partner. Working with Hyundai Heavy Industries has also proven efficient.

"At Neste, we need good ships in our toolbox which we can rely on to work properly at all times. We believe we have realized a ship which will fulfil our needs extremely well and be a pleasure to work on. Safe, sustainable and reliable shipping of crude oil; that is what we strive for."

ABOUT NESTE

Neste creates sustainable solutions for transport, business, and consumer needs. With a wide range of renewable products, Neste enables their customers to reduce climate emissions.

Neste is the world's largest producer of renewable diesel refined from waste and residues, introducing renewable solutions also to the aviation and plastics industries.

In 2018, Neste's revenue stood at EUR 14.9 billion. In 2020, Neste placed 3rd on the Global 100 list of the most sustainable companies in the world.

> Good ice capabilities are above all a safety feature for Neste.

Photo courtesy of Neste Oyj.

Feasibility study for Qilak LNG

Alaska-based Qilak LNG Inc., a subsidiary of Lloyds Energy, is planning a new liquefied natural gas (LNG) export project in the Alaska North Slope. Aker Arctic has completed a pre-feasibility study for the project.

The Qilak LNG 1 project seeks to capitalise on recent developments in Arctic LNG technology allowing natural gas to be directly exported from the Alaska North Slope. This concept would significantly reduce the capital cost compared to projects that require a long-distance pipeline and a large minimum LNG order.

Delivery to Asia

Phase 1 of the Qilak LNG project will have an export capacity of 4 million tonnes per year (MTPA) with additional capacity planned to come online in future phases, as determined by gas supply and global demand.

The project targets delivery of natural gas to Asian markets, including Japan, at a more competitive shipping cost than many other sources of LNG.

Economically viable

The pre-feasibility study, completed by Aker Arctic in 2019, examined the technical challenges of shipping directly from an offshore facility in the Beaufort Sea. Based on this process, Qilak LNG concluded that with the available gas supply, competitive project economics and a partner willing to utilise Alaska's gas for power and city gas use in Asia, the Qilak LNG 1 project can be economically and technically viable.

An extensive feasibility study will begin in 2020, with the target of reaching an investment decision by 2022. The first gas shipments could begin in 2026 or 2027.

Agreement with ExxonMobil

In October 2019, Qilak LNG Inc. announced that a Heads of Agreement (HOA) was entered with ExxonMobil Alaska Production Inc. regarding the potential supply of natural gas from the Point Thomson field to Qilak LNG's proposed Alaska North Slope liquefied natural gas export project.

The HOA foresees ExxonMobil providing at least 560 million standard cubic feet of natural gas per day to Phase 1 of the Qilak LNG 1 Project. This first phase will have an export capacity of 4 million tonnes per year of LNG over a 20-year term, utilizing offshore liquefaction and loading, and icebreaking LNG carriers.

Double-acting LNG carriers

Icebreaking LNG carriers are currently successfully employed to carry natural gas from the Russian Arctic through the Yamal LNG plant in Sabetta. These carriers use Aker Arctic - developed design and patented technology, with a bow tailored for sailing in open water and moderate ice conditions, and a heavy stern for icebreaking in astern mode using three azimuthing propulsion units. Similar icebreaking carriers could be used for Qilak LNG.

The offshore LNG plant is planned to be equipped with LNG storage facilities, a liquefaction plant, and offloading arms to serve the ships. A gas conditioning plant to remove CO_2 would be located onshore at Point Thomson. ■

More information about the project:

- www.qilaklng.com
- www.alaskapublic.org
- www.petroleumnews.com

Aalto Ice Tank opens

A trial test was held in January 2020 in order to calibrate the instrumentation, validate test results, and check the quality of ice.

The square-shaped ice tank at Aalto University has been revamped and upgraded with new modern equipment. Aker Arctic carried out the first tests at the Aalto Ice Tank in January 2020.

The Aalto Ice Tank is a multipurpose basin: while mainly used for ice model tests, it can also be employed for other tests. The unique 40 x 40 m square shape allows for different testing than Aker Arctic's 75-metre-long and 8-metre-wide basin. The two test facilities are a perfect combination and their best characteristics can be used to complement each other.

Benefits for customers

"There is plenty of space available around the test model, making the Aalto Ice Tank especially well-suited for turning and manoeuvring tests where it is necessary to check a wider turning circle of a new vessel design," explains Topi Leiviskä.

In ice management tests, a large basin is practical as interaction between multiple ships can be studied. In situations where ice drift and changes in the ice drift directions are important, such tests can be carried out in the wide basin. It is additionally possible to model ice pressure conditions in the basin, and therefore provide valuable information on these conditions. "For projects where fixed or moored structures are planned, ice loads and ice piling behaviour can be determined," Leiviskä adds. "For example, some years ago an island was built in the middle of the basin to research how ice piles up against the shoreline."

New machinery

The ice tank was originally built in the 1980s and has been used mainly for research at Aalto University (Helsinki University of Technology until 2010) which is prominent for investigating natural ice behaviour through various modelling methods.

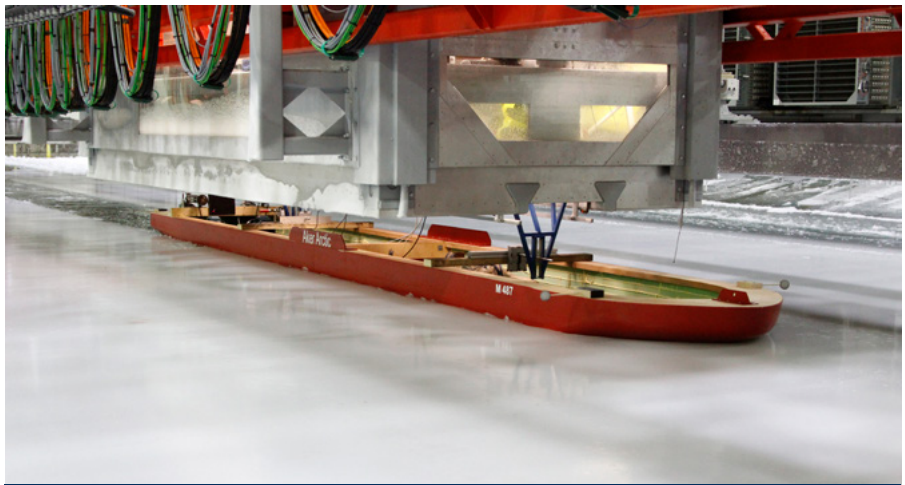
The cooling machinery has now been upgraded with modern technology for preparing model ice and a new towing carriage has been installed beneath the rail-bound bridge spanning over the entire basin. The basin additionally features a 40-metre-wide segmented wedge-type wave maker which can generate both regular and irregular waves.

Comprehensive testing services

Aker Arctic and Aalto University already had a long history of close cooperation before a formal co-operation agreement was signed in 2017.

"The university focuses on research while we can rent their basin for commercial projects," Leiviskä says. "Now that the Aalto Ice Tank is ready, our cooperation work can formally begin."

"Apart from complementing tests in a different sized basin, in some development projects it is valuable to run tests in a basin other than our own just to get a second result. We can now offer this option to our clients." ■



The cooling machinery has been upgraded and a new towing carriage installed

Photo courtesy of First Ore Mining Company

Innovative solutions for Pavlovskoe mining project

The Pavlovskoe lead-zinc project in the Novaya-Zemlya archipelago in the Arkhangelsk region is classified as one of the biggest mines in Russia. Aker Arctic has been involved in planning how to construct a processing plant in this northern location far from any infrastructure and characterised by severe arctic conditions.

First Ore Mining Company, a subsidiary of ARMZ Uranium Holding, represented by Executive Director Igor Semenov, is developing the Pavlovskoe project, which is estimated to have an output capacity of up to 2.6 Mt of ore per year. The deposit is expected to contribute resources sufficient for up to twenty years of production of mainly lead and zinc.

Barge-mounted plant

As the Novaya-Zemlya archipelago is far away from any infrastructure in harsh arctic conditions, it is not an easy place to build a processing plant. The barge-mounted process plant concept was proposed by First Ore Mining Company to minimise the effect of the short shipping season and the high cost of labour.

Aker Arctic has subsequently been involved in developing outline solutions for the entire life-cycle from construction, transportation and installation to production and finally decommissioning. Environmental factors such as low ambient temperatures, ice loads and wind have been taken into consideration for all stages.

Equipment installed at shipyard

Aker Arctic has prepared an outline design of a special floating barge for this project. The processing plant, designed by Outotec, and power station, designed by Wärtsilä, as well as other equipment needed for production, are planned to be installed at a shipyard during the construction of the barge.

Once everything is ready and commissioned, the barge will be towed by sea to the area of production, and then fitted on land.

Igor Semenov, Executive Director of the First Ore Mining Company

"The area is remote with no infrastructure, so the idea is to build everything on the mainland and then transport it to the final production place," says Pavlovskoe Project Manager Igor Semenov from the First Ore Mining Company. "Everything will already be assembled, connected, tested and ready to use."

The barge needs to be large enough to accommodate everything needed for stand-alone production,

but at the same time as small as possible so that the fitting operation at the site will not become demanding or expensive. The dimensions of the barge designed by Aker Arctic is 176 metres long and 32 metres wide.

Towed to the site

The fully equipped barge will be towed to the region, where it will be floated into an excavated place, stabilised with gravel and be ready for immediate use.

According to Igor Semenov, on top of other targets, the First Ore Mining Company put a priority to avoid any impact on the environment of the Novaya-Zemlya archipelago.

"The ground in this area has permafrost, which is important not to disturb during the installation," Alexey Dudal, Project Manager from Aker Arctic explains. "In order to mitigate the human impact on the fragile Arctic environment, heat from the barge should also not affect the permafrost. After twenty years, the barge will be removed in reverse procedure. The land area should then be restored to its original condition."

Once the lead and zinc production is finished, there are two options: the barge may be either towed to a shipyard for complete decommissioning or it can be used in another project for ore processing.

Principal arrangement

The barge is divided into three parts, with the largest part used for the processing plant. Outotec has designed the processing plant including all equipment and its arrangement for efficient production of the lead and zinc concentrates from the ore.

The second part of the barge contains the power plant, which provides electricity to all facilities on the barge itself, the processing plant, the port constructed for transportation of the final products, and also the mine and accommodation complex. Wärtsilä has been responsible for designing the power plant.

The third part is the workshop block needed for maintenance and repair. In addition, there are offices, meeting rooms and lounge areas for the staff.

First step

Igor Semenov was satisfied with the results of the project carried out by the Aker Arctic team. He added that this was only the first step on the way of cooperation between the First Mining Company and Aker Arctic in the creation of innovative process concentrators for working in the Arctic.

The Aker Arctic team involved in the project comprised Project Manager Alexey Dudal, Development Manager Alexey Shtrek, Senior Naval Architect Lars Lönnberg and Naval Architect Aaron Tam. ■

Photo courtesy of First Ore Mining Company

Meet Alexey Dudal

Alexey Dudal, Deputy Head of Consultancy & Technology at Aker Arctic

In 2007, Alexey graduated from the State Marine Technical University of Saint Petersburg, Russia as a naval architect specialising in hull structures. Before moving to Finland and joining Aker Arctic, he spent eight years in Paris working at Bureau Veritas as a research engineer.

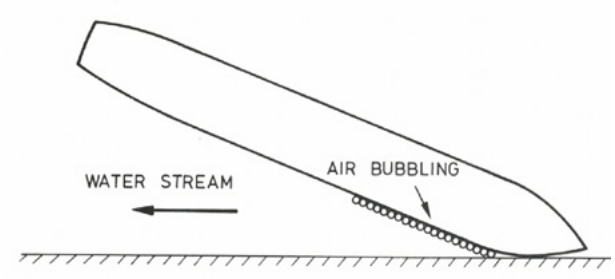
Alexey joined Aker Arctic in 2016 as a structural engineer. He is currently working as Deputy Head of the Consultancy & Technology team, providing assistance in tasks related to feasibility, pre-FEED studies, work during the FEED and consecutive stages of the project to match the needs of clients. This includes definition of the project requirements, design criteria, fleet composition studies, cargo loading and discharging in challenging conditions, port layout studies, transportation studies, ice management studies and risk control methodology. ■

Reducing ice friction since 1969

An extensive range of both model tests and full-scale tests were made in the 1960s and 1970s to establish the optimal flow rates and dimensioning of the air bubbling system.

Air bubbling was developed by Wärtsilä Icebreaking Model Basin in the 1960s as a means of reducing friction between the hull surface and the ice, and as a result improves efficiency of operation in ice. With the growing demand for energy-efficiency in ships, similar methods have been introduced for open water ships in recent years.

The interest in using air bubbling technology as a friction reduction device both in icebreakers and open water ships has been increasing lately as shipowners and operators strive to meet the IMO's energy-efficiency design index (EEDI) in different ways.



Manoeuvring with air bubbling.
Air bubbles flush the ice away between the ship hull and the quay while mooring.

Lubricating layer

The technology is based on large volumes of low-pressure air pumped out through holes (nozzles) in the hull along the ship. As these bubbles rise along the hull towards the surface, they expand and create a strong current of water and air between the hull and the ice, reducing the friction. For open water ships, a similar method, usually at lower air volumes, creates a lubricating layer between the hull and the water surface.

"Air bubbling improves the efficiency of operation in ice, as you can either use less propulsion power for the same job, or you gain performance in ice with the same propulsion power," explains Rob Hindley, Head of Machinery and Structural Design at Aker Arctic.

Extensive testing

In the 1960s, when the air bubbling system was developed at the Wärtsilä Icebreaking Model Basin and named WABS, model tests and full-scale trials were performed to determine the correct flow rate for optimised effect. The volume of air and the size and location of the nozzles were established by repeated testing in various ice conditions.

"The system is basically very simple with a large air compressor, a series of distribution pipes and valves carrying the air to the channels feeding the submerged nozzles," Hindley says.

"However, the amount of testing we have done to achieve the right calibration cannot be under-estimated. The system has to be dimensioned correctly in order to reach the required performance."

Part of the toolbox

Air bubbling was very well received when it was first introduced and became an established part of the toolbox of auxiliary systems used to improve icebreaking. Through the 1970s and 1980s, it was installed on a number of Finnish and Soviet icebreakers built at Helsinki Shipyard, including the two nuclear-powered icebreakers Taymyr and Vaygach, as well as on a number of icebreakers built in Canada.

When the azimuthing thruster was invented, the interest in air bubbling faded away, as the same effect can be achieved from the azimuthing thruster when the ship turns stern-first using Aker Arctic's double-acting ship principle.

"The propeller wash creates a turbulent water flow between the hull and the ice resulting in the similar hull lubricating effect," Hindley adds. "This was in fact already known from the bow propellers installed on early icebreakers built in Finland."

With azimuthing propulsion, there is no real need to have an additional air bubbling system. However, if the choice is to use a conventional shaft line, auxiliary systems such as air bubbling, heeling and bow flushing are additional tools for operating in ice.

"When there is a risk of getting stuck in ice, the captain will use all the tools available to avoid that situation," Hindley underlines.

Extended equipment range

Recently, air bubbling has been included in projects where Aker Arctic has designed icebreakers with conventional propulsion, such as the Canadian Polar Icebreaker project.

Since there has been more interest in the last five years, Aker Arctic has reconnected with the main equipment suppliers, updated calculation tools in-house to be able to dimension and optimise the system correctly, and revisited old cases to transfer knowledge to a new generation of engineers.

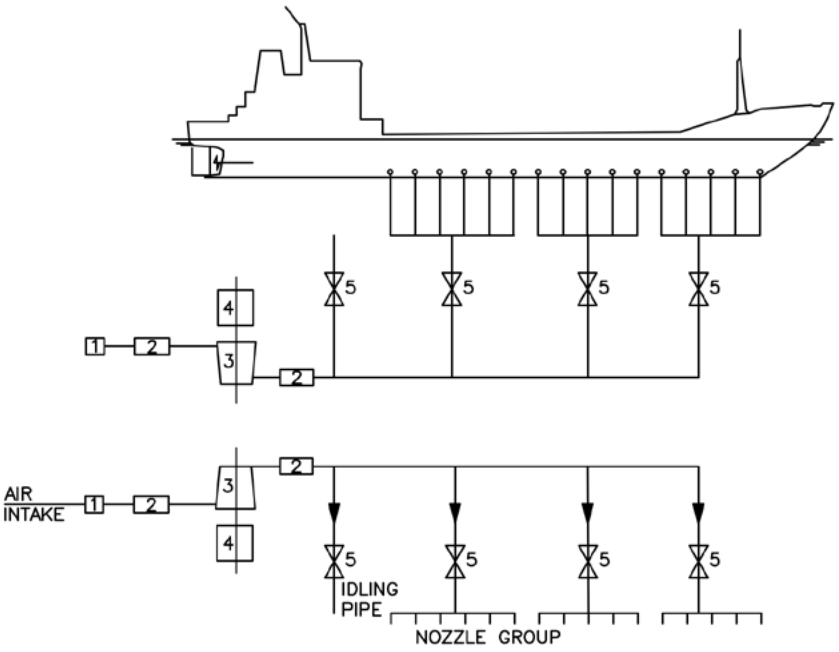
"With the experience we have in dimensioning these systems and with the refence cases we have of ships built with the system, we are in the position to offer a turn-key air bubbling system package to any interested shipyard," Hindley emphasises.

"The turn-key approach means that Aker Arctic ensure the compressor and all parts are sized correctly, the system is integrated effectively into the production design and the appropriate equipment is purchased. The equipment is delivered directly to the shipyard, but we can also be there to support the installation and commissioning."

Reduced fuel consumption

Presently air lubrication systems are installed into some open water ships in order to reduce fuel consumption. When needed, ice bubbling systems for icebreaking can also be combined into the air lubrications system, thus saving some cost in the compressors and providing a shorter return time for the additional investment. ■

You can either use less propulsion power for the same job, or gain performance in ice with the same propulsion power.



1 = AIR FILTER
2 = SILENCER
3 = COMPRESSOR
4 = DRIVE MOTOR
5 = REMOTE CONTROL VALVE

Basic components for the air bubbling system. One of the advantages with the system is its simplicity.

Active heeling systems improve ice capability

The study included ice model tests where the active heeling system was simulated with a sideways-moving mass that would induce a similar rolling motion to pumping water between tanks.

An active heeling system – a pair of water tanks located on each side of a ship where water is pumped back and forth to induce a forced rolling motion – was once a standard feature for icebreakers. However, these icebreaking auxiliary systems were largely forgotten. Johanna Marie Daniel from the Hamburg University of Technology is currently studying the effectiveness of active heeling systems as part of her Master's degree studies.

Through the 20th century, almost all icebreakers built worldwide were equipped with heeling tanks that could rock the ship back and forth should it become beset in ice. In addition to cracking and breaking the ice around the icebreaker's hull, the relative motion between the shell plating and the surrounding ice helped free the ship by transforming the friction from static to kinetic.

Auxiliary systems forgotten

However, these icebreaking auxiliary systems were largely forgotten following the development of low-friction hull coatings and the adoption of azimuthing propulsion for icebreaking applications.

With the hull-ice friction issue largely solved by better coating and a powerful flushing effect from the propellers, design efforts shifted towards minimising ice resistance using more efficient hull forms. As a result, various systems intended to improve ice-going capability without increasing the vessel's propulsion power were given less attention and became less the focus of systematic research.

An innovation nearly as old as the icebreaker itself, the active heeling system was devised by Admiral Stepan Osipovich Makarov and fitted on the world's first polar icebreaker, Yermak. Photo Source: Tyne & Wear Archives & Museums

Active heeling system in model test

Impact on new hull forms

In November 2019, Johanna Marie Daniel from the Hamburg University of Technology (Technische Universität Hamburg; TUHH) began studying the effectiveness of active heeling systems as part of her Master's degree studies.

The goal of this Aker Arctic-supported research project is to investigate the impact of forced rolling motion on the ice resistance of modern icebreaking bow geometries developed in recent years. One of the latest icebreaker designs developed by Aker Arctic was used to analyse the effect of a heeling system.

In addition to analytical calculations, the study included ice model tests where the active heeling system was simulated with a sideways-moving mass that would induce a similar rolling motion to pumping water between tanks. Tests were done both with and without the heeling system in the same ice conditions to find out the effect of the rolling motion on the vessel's performance.

System parameters such as heeling angle and rolling period were varied to gain further understanding of their impact on the system's effectiveness. The investigated ice conditions represented the most challenging obstacles that an icebreaker can encounter: thick multi-year ice and heavy ridges.

Better ice capability

The model test results already indicate that forced rolling motion can further increase the ice-going capability of an icebreaking vessel with a hull form of the latest design generation.

In addition, it was determined that the power required by a correctly-designed active heeling system can be less than what would be needed for achieving a similar performance gain by simply increasing the vessel's propulsion power.

The model test results were also used to validate the calculation method developed by Ms. Daniel for predicting the ice resistance of a vessel with an active heeling system.

Find out more about this research project in the next issue of Arctic Passion News.

NEWS IN BRIEF

Port icebreaker Ob begins work in Sabetta

The 12-megawatt diesel-electric port icebreaker Ob, designed by Aker Arctic and built by Vyborg Shipyard, was delivered to FSUE Atomflot at the Shipyard on 18 October 2019. The vessel is now at the Sabetta LNG terminal in the Gulf of Ob where she provides icebreaking assistance to LNG carriers transporting natural gas year-round from the Yamal Peninsula.

"We are moving to the operational phase of the port fleet on the Yamal LNG project for the next 25 years," said Vyacheslav Ruksha, Deputy General Director and Director of the Northern Sea Route Directorate of Rosatom State Corporation.

"I am sure that the Gulf of Ob is becoming a centre for the production of liquefied natural gas. This is the most dynamic market in the world in which the Russian Federation will take its rightful place."

Ob at sea trials. Photo courtesy of Vyborg Shipyard.

In November 2014, FSUE Atomflot signed an agreement for the provision of a range of port fleet services, providing pilotage and maintenance of the Sabetta port water area for the Yamal LNG project until 31 December 2040.

Today, the company provides a full range of port services in the waters of the port of Sabetta. The port fleet, together with nuclear-powered icebreakers, assists LNG carriers with a cargo capacity of over 170,000 m^3.

Ob is Rosatomflot's first non-nuclear-powered icebreaker, and was built by Vyborg Shipyard according to the Aker ARC 124 full design package.

www.rosatomflot.ru/press-centr/ ■

All 15 Yamal LNG Carriers in operation

When Yakov Gakkel loaded the 354th LNG cargo from the Sabetta LNG terminal in the Gulf of Ob in December 2019, almost a decade of technical development concluded. The world's first Arc7 ice class LNG carrier fleet had reached full operational status.

The fifteen 299-metre-long vessels, each capable of carrying 170,000 cubic metres of liquefied natural gas, are designed to operate year-round in the Arctic without the support of icebreakers. The LNG carrier fleet built specifically for this project is capable of shipping out all the natural gas produced from the Yamal LNG's Yuzhno-Tambeyskoye gas field.

With high ice class and independent operational capability in ice, the Yamal LNG's tanker fleet provides an opportunity to ship gas both west and east along the Northern Sea Route. Aker Arctic carried out long term development work to create this type of vessel and designed the final vessel concept as part of the entire logistics operation in Sabetta for Yamal LNG. All vessels in the series were built at Daewoo Shipbuilding & Marine Engineering (DSME) in South Korea.

Sabetta LNG terminal, located on the western coast of the Gulf of Ob in the Russian Arctic, has three operational LNG trains with a capacity of 5.5 million tonnes per annum (mtpa) each, with a fourth train under construction. Once the 900 mtpa Train 4 is in operation, the total capacity of the plant will increase to 17.4 mtpa.

Yamal LNG shareholders include PAO NOVATEK (50.1%), Total (20%), CNPC (20%), and the Silk Road Fund (9.9%).

www.yamallng.ru ■

TINT – a new map tool for ice navigation

Aker Arctic is developing a tactical ice navigation tool jointly with the Finnish Meteorological Institute. The aim is to create a tool which analyses an ice field using satellite information and predicts the best route through the ice.

"The initial step in the project is conducting a feasibility study where we research the viability and demand for this kind of service," says Project Manager Jukka Salminen. – The European Space Agency (ESA) is funding the project. ■

A feasibility study supports safe investments

A feasibility study gives a global view of a project in advance, and therefore allows for better planning of a project. The study provides a clear understanding of how many vessels are needed, what kind of vessels, the size of vessels and what the icebreaking capabilities should be.

In addition, successful operations also require the appropriate route selection, the correct cargo loading solution, port and terminal planning, knowledge of safety precautions, proper procedures, and other vital factors.

The optimal solution can be chosen from the start, leading to safe investments and lower operational costs once the project is ready.

Main steps

1. Analysis of the project's demands
2. Input data evaluation (e.g. type of cargo, volumes, transport period)
3. Analysis of ice and sea conditions on the routes
4. Vessel options, either for year-round or seasonal transport
5. Terminal and loading options
6. Definition of optimal solution

All calculations are based on Aker Arctic's own database, research and experience. ■

Christophe de Margerie was the first vessel in the series.

New method to test friction from paint

Nearly one third of a vessel's resistance in ice is due to friction. High quality paints not only protect the hull from corrosion, but also reduce friction between the hull and the ice. Last year, the Russian Register of Shipping introduced new regulations regarding hull coatings for ice going vessels. Aker Arctic has now developed the methods for testing friction from paint according to the requirements.

Which paint to use for an ice going vessel is surprisingly important. In addition to creating a smooth hull that can reduce overall ice resistance by more than 15 %, it protects the hull from corrosion for many years. As a result, thinner steel plating can be used in construction as the risk for corrosion is smaller; this will save money, weight and maintenance.

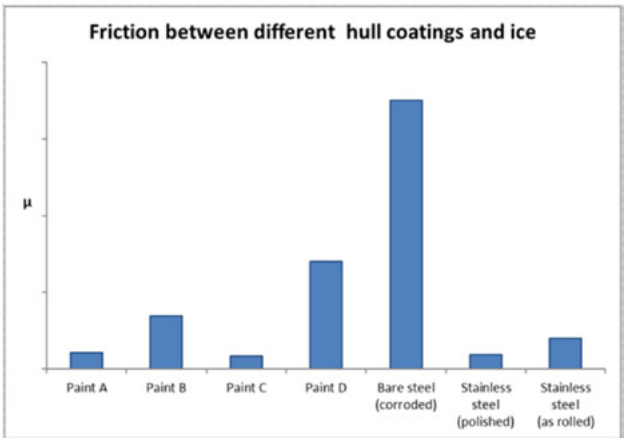
"Before protective paints for icebreakers were invented, the steel plating had to be several millimetres thicker," explains Structural Engineer Ville Valtonen from Aker Arctic. "Ordinary paint not intended for ice use did not last more than a few days and corrosion was a problem."

New rules for paint

In 2019, the Russian Register of Shipping (RS) changed their regulations regarding paint for ice-going ships. They now allow thinner steel plating on the ship hull if an approved protective hull coating is used. However, to qualify as an approved protective paint, a series of tests regarding hardness, durability and friction needs to be performed. Durability tests can be done at several paint laboratories around the world, but the ice-friction test is not readily available. Aker Arctic has therefore developed a testing method for friction according to the requirements of RS.

"Over the years, we have tested the various effects of hull-ice friction on ship performance. The same tools have been adapted for this test," Valtonen says.

RS has recently approved Aker Arctic's principles for the testing method and the first tests will be performed this spring.



ANNOUNCEMENTS

Miika-Matti Ahokas has joined Aker Arctic as a machinery systems designer in the Machinery and Structures team. He graduated in 2019 with a Nordic Master double degree in maritime engineering from Aalto University and Technical University of Denmark. In his Master's thesis, Miika-Matti studied the benefits of voyage optimization for different shipping stakeholders. Previously, he worked as a trainee at Helsinki Shipyard as well as onboard merchant ships and Finnish Navy vessels as a watchkeeping engineer apprentice.

Luigi Portunato has been appointed Naval Architect in the Ship Design department. He obtained his Bachelor of Science in Naval Architecture and Marine Engineering at the University of Genova (Italy) and his Master of Science in Marine Technology at TU Delft (Netherlands), specializing in ship design. During his studies, Luigi also attended Arctic courses at the University Centre in Svalbard (Norway) and he graduated with a Master's thesis covering the concept design of a drifting ice-research vessel. After working one year in Italy as project coordinator on a conversion project, he joined Aker Arctic in September 2019.

Aaron Tam has been appointed Naval Architect in the Ship Design department. He did his BSc in Naval Architecture and Marine Engineering at Webb Institute in New York, USA. Aaron has recently completed a Nordic Master's in Cold Climate Engineering, which included one year of joint study at the Norwegian University of Science and Technology (NTNU) and the University Centre in Svalbard (UNIS) in Norway, and one year of studies and research at Aalto University in Finland. In his Master's thesis, Aaron studied ship icebreaking patterns in model scale.

Study tour to Gothenburg

Picture: Göteborg , © Anders Wester/ Mediabank Goteborg & Co

In November 2019, the staff of Aker Arctic went on a study trip to Gothenburg, a vibrant city located on the beautiful southwest coast of Sweden.

The main purpose of the trip was to visit local companies representing the Swedish maritime industry as well as to celebrate pre-Christmas with work colleagues, a tradition in Finnish companies.

Maritime actors

SSPA and Bassoe Technology, the two companies visited, are both actors in the international maritime industry and cooperation partners of Aker Arctic.

SSPA is a consulting company operating worldwide within fields of maritime engineering and related sciences. Their towing tank, cavitation tunnel and seakeeping basin are used in testing and developing ships, and they have performed open water model tests for a large number of Aker Arctic's designs and clients.

Since beginning testing in 1940, more than 8,000 ship hull forms have been tested at SSPA, including both merchant and naval vessels.

Bassoe Technology, established in 2007, is a designer of advanced mobile offshore units such as semi-submersibles and drillships. They also provide basic design, FEED and engineering services.

Perfect for engineers

In addition to its delicious seafood, the city is famous for the vehicle manufacturer Volvo. Although production takes place in 18 countries all over the world, the headquarters of Volvo Group is located in Gothenburg.

Therefore, one of the must-do things is a visit to Volvo museum where we had a guided tour through Volvo's history and heritage from 1927 to today. The collection encompasses a wide range of passenger cars, buses and heavy trucks as well as marine engines and construction equipment – a perfect place for any engineer!

The day was rounded off with a fun evening among colleagues. ■