Arctic Passion News

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First arctic LNG carrier in successful ice trials

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Are we on the verge of the arctic opening up to regular shipping?

We are all waiting for next winter, but can already conclude that 2017 will remain remarkable for arctic shipping development. In the past summer, we have witnessed several cross sailings on the main arctic routes, in addition to new speed records.

One of the major arctic projects ever, the Yamal LNG, will start with year around LNG shipments with a brand-new fleet of huge and capable ships, which once again will rely on Double Acting vessel technology which we developed decades ago. The first in the series of 15, *Christophe de Margerie*, sailed the entire Northern Sea Route and delivered LNG cargo from Norway to Korea. The Finnish icebreaker *Nordica* also set the record as the earliest ship to sail through the North-West Passage when it commissioned its Arctic 100- expedition, with a number of scientists onboard. On this route, already for the second year in a row, the *Crystal Serenity* will be undertaking a second commercial cruise voyage. The Russian nuclear-powered icebreaker, *50 Let Popedy*, also cruised to the North Pole. This voyage was remarkable for its record time and speed with which she was able to reach the pole. Although we know that technology, power and the size of ships have developed over the years, one reason for these records is the fact that ice conditions have become easier in arctic navigation.

Both the NSR and NWP have been known for centuries, but could it finally be the time for a significant increase and utilization of these routes? Many organizations, and nations, have shown interest and carried out their own studies into the matter. It seems that with new ship technology, improved arctic infrastructure and the change of ice conditions, this can now be more feasible. Already the transportation for major industrial production is starting and will add a significant number of shipments in the Russian arctic.

This sort of activity shows the path forward, and many other new projects may follow and open the routes to regular traffic. We have been preparing for this possibility for a long time already and have developed arctic ships for this purpose. The next few years will show how quickly shipments increase.

In this issue of Arctic Passion News, you can read about developments in various ice classed vessels, including Arctic and Antarctic.

I hope you enjoy the articles and look with great interest towards next winter and the opening of new arctic trades.

Reko-Antti Suojanen
Managing Director
Aker Arctic Technology Inc

Announcements

Sean Ireton has been appointed Sales and Marketing Manager for North America. He has previously worked for Lloyd's Register and the Canadian Navy, and more recently has been freelancing providing on-site management for new ship construction projects.

Joakim Konsin has joined Aker Arctic as a Naval Architect, specialised in ship design. He started at the Turku office with concept design. Since graduating in 2003 with a M.Sc. in Naval Architecture, he has worked for two large marine equipment producers for 14 years.

Jukka Salminen has joined Aker Arctic as Sales Manager. Jukka graduated as a master mariner from Turku Maritime College (Aboa Mare) in 2006. He previously worked for over 11 years with the Finnish icebreaking company Arctia Ltd., first as a navigating officer onboard the conventional icebreakers Otso and Kontio and then onboard the multipurpose icebreakers Nordica, Fennica and Botnica. During his last years at Arctia, he was the chartering manager responsible for chartering Arctia's icebreakers globally.

Björn Schönberg joined Aker Arctic in May 2017 as a Naval Architect to work in ship design and engineering. In the past, Björn was a naval architect at the Masa-Yards Helsinki shipyard and at NAPA Ltd. Björn has a special focus on ship theory and his main responsibilities at Aker Arctic are related to ship stability calculations.

Petri Tolonen has joined Aker Arctic as Director of Sales and Marketing. Previously Petri has worked at Wärtsilä Marine Solutions as the director of the thruster and PCS product line. Before Wärtsilä, he worked at Steerprop Ltd. and was President and CEO of the company. Petri has more than 25 years of experience in international business, mainly concerning sales and marketing, and has additionally worked in companies such as Metso Paper (known nowadays as Valmet) and UPM.

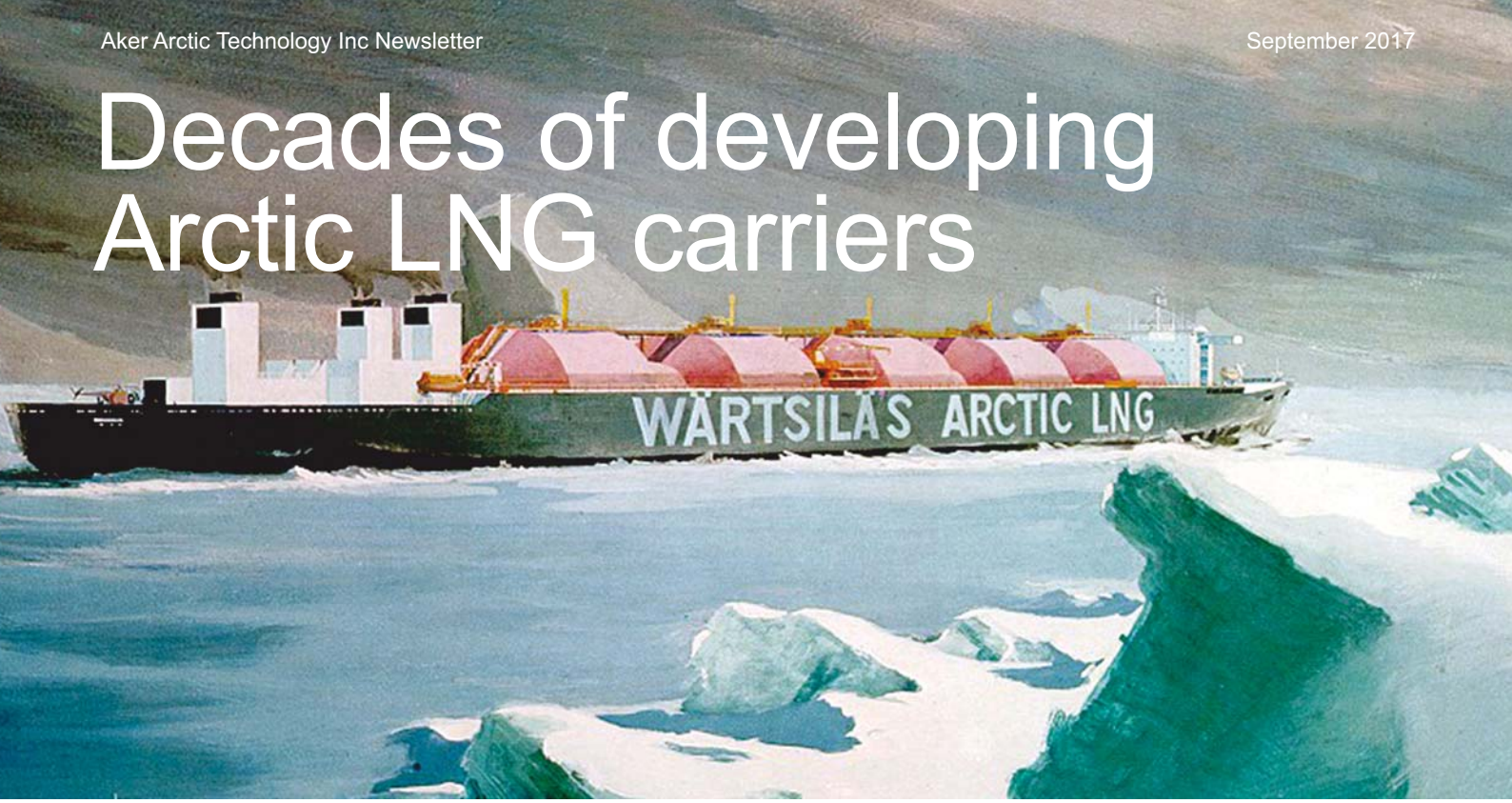
Front cover:

Christophe de Margerie, the world's first icebreaking LNG carrier, successfully completed ice trials in March 2017. Aker Arctic developed the concept design for the gas carrier and has been deeply involved in the entire logistics project for Yamal LNG.

Roumen Tzvetanov joined Aker Arctic as Head of Business Development for Oil and Gas. Roumen graduated from the Moscow Power Engineering Institute with an M.Sc. in Instrumentation and Automatic Control of Nuclear Power Plants. He holds a Ph.D. in Technical Sciences from the Institute of Control Sciences, Russian Academy of Sciences. Roumen has extensive international experience in petroleum and power engineering and has worked in companies such as Chevron, Shell, Worley Parsons, Wood Group, Maersk on large projects including LNG Sakhalin II, Wheatstone and Browse. He has a multidisciplinary career background and a solid portfolio of design studies, management and coordination in oil and gas projects.

Risto Kurimo retired from Aker Arctic in June 2017. He worked in the industry for almost 40 years (since 1978), mainly as a hydrodynamic specialist and project manager, first at Wärtsilä Helsinki Shipyard, Valmet Helsinki Shipyard, Aker Finnyards (earlier Masa-Yards and Kværner Masa-Yards) before joining Aker Arctic Technology in 2006. In the 1990s he was also responsible for the hydrodynamic development of the novel "Azipod" propulsion device in a joint venture project between ABB Industry and Kvaerner Masa-Yards Inc. We wish Risto a happy retirement!

Decades of developing Arctic LNG carriers



An artist's impression of an early Arctic LNG carrier design from the mid-1970s: Finnish shipbuilders' proposal for gas turbine powered ships capable of crossing the Northwest Passage. Aker Arctic's predecessors participated in many such LNG trade and ship studies related to the Canadian Arctic.

The use of liquefied natural gas (LNG) has been steadily growing. LNG, which consists mainly of methane, provides cleaner energy with less harmful emissions compared to oil fuel, and with current environmental concerns the need for clean options continues to grow. When vast gas resources in cold areas were found, it was essential to start developing systems to explore and transport these resources successfully, economically and safely to the market. Finnish engineers have been involved in developing transportation solutions for LNG for a long time.

The oversea transportation of LNG requires dedicated ships both in terms of size, as LNG is a light-weight cargo, and in terms of how the gas is stored on-board the vessel in its cryogenic liquid form. In fact, LNG 'exists' and is produced only for storing and transporting natural gas feasibly in its densified form: One cubic metre of LNG becomes 600 cubic metres of natural gas when vaporized back to its gaseous form.

Today there are almost 450 LNG carriers in service, the majority of which are large size ships. Some 110 such ships are currently on order. In the mid-1960s, the first commercial LNG carriers were developed and taken into use in Europe. In the early 1970s, LNG deliveries expanded to Japan. The two main LNG carrier types used today are derived from those ships. These are the so-called membrane- and Moss-type ships, which have both later developed sub-types and improved versions.

LNG carriers for cold environments

Early Arctic pilot projects in the mid-1970s aimed at transporting LNG from the Canadian Arctic to elsewhere in North America and to Europe. Relatively large and high ice class ships were designed and proposed by Finnish companies. In the beginning of the 1980s, some US companies issued plans even for Arctic submarine LNG vessels. None of those plans came true and the development for arctic LNG vessels was halted for decades.

During the 1980s and 1990s, LNG shipping continued to grow steadily, but it took place in warm waters and concerned Middle East gas production. Slowly, however, LNG production began to expand north towards colder regions.

A breakthrough for LNG transportation in cold areas came when two production projects for LNG shipments began: the Snöhvit project in Norway (2007) and the Russian Sakhalin II LNG project on the island of Sakhalin (2009). Both were the first large-scale national LNG projects in areas with winter conditions. As a result, several ice class 1C Moss-type LNG carriers were built to serve the projects.

In the early 1970s, some of the first LNG carriers built in Norway also had the same ice class 1C, as did the first two PSB-type ships that were built in 1993 in Japan and sailed for a long period on the Alaska-Japan route.

An LNG carrier at Sakhalin gas terminal (Photo courtesy: Sovcomflot)

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First Arctic LNG designs with the double acting icebreaking concept

For a long time, it has been known that there are vast natural resources of oil and gas in the Arctic regions.

Apart from the earlier Canadian LNG projects, a new era of interest in Arctic gas resources arose at the beginning of this century. The first concept ideas were drafted for Moss-type Arctic carriers in early 2000, but eventually the growing interest in LNG exports from the Arctic stimulated Aker Arctic to start developing a solution for LNG shipments. The first Arctic class DAS™ ship *Norilsk Nickel* was designed and built in Helsinki while large LNG Carriers were on the drawing board.

"In 2004, Aker Arctic kicked-off a large development programme which aimed to introduce a vessel design that would be able to bring LNG from the Arctic to the markets," says Mr Reko-Antti Suojanen, Managing Director, for Aker Arctic. The final outcome was a three-propeller double acting vessel concept, which also utilised the special new solution of the Integrated Hull Structure (IHS), which provided easy winterisation solutions as well as a stronger hull and savings in the steel weight.

"As the double acting concept was already a proven solution, we decided to use a bulbous bow form for these vessels and thus provide the maximum effectivity in open sea navigation, which in any case is used in many of these carriers," says Suojanen.

The design was called the Aker Arctic 206,000m³, and it was equipped with five tanks (see picture below). Cost estimates for the vessel and economic calculations showed that the transportation cost and the reliability of LNG shipments would be highly suitable for the markets. The average speed of the vessel would be sufficient even in the harshest mid-winter conditions from the Kara Sea to the European or North-American markets.

The Yamal peninsula was known for its vast gas reserves, and at that time Khrasevey was considered the best place for a port and LNG liquefaction facility.

Aker Arctic 206,000m³ IHS design for Arctic LNG transports from 2006.

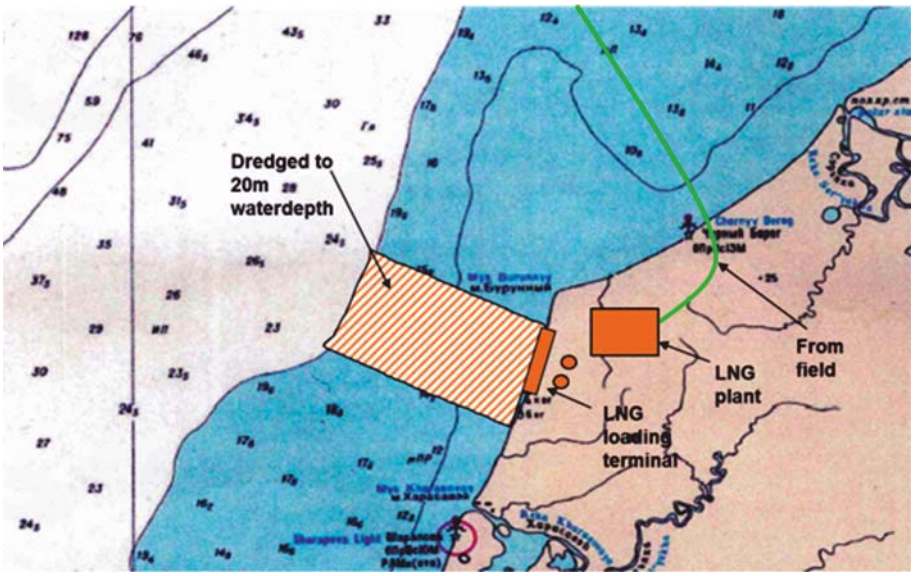
Alternative design with the GTT No-96 tanks with a large capacity of 224,000m³. The same propulsion principle with three propellers was used.

The complete transport solution

To solve the transportation problem, the carrier design is not the only issue. Successful operation also requires the appropriate route selection, the LNG loading solution in a cold environment, specific safety measures, overall port and terminal planning, supporting port ice breaker fleet and tug assistance, as well as various emergency precautions with the escort icebreakers. All these differ considerably from the traditional solutions used in LNG terminals in warm waters around the world.

The entire harbour area needs to be planned so that it can accommodate large cargo vessels. This includes the port icebreakers, support vessels and tugs, which all need to be designed specifically for the Arctic conditions. Loading and off-loading areas, including ice management procedures for removal of ice, are also essential.

"Safety requirements in all Arctic vessels are equally strict to those of other vessels, but are of a wider scope due to the cold environment," Suojanen adds. Apart from requirements related to safety as a gas carrier, safety plans have to be raised to a completely different level. Risk evaluation, risk management procedures, evacuation plans, the distance to habitation or to a safe haven and 'what to do in the case of an emergency' are all extremely important elements to consider to minimise risks.



Plan for the Kharasevey Arctic LNG terminal.
(Source: Aker Arctic presentation in Quebec 2008)

Water depth in the Arctic varies from deep to very shallow and this poses additional challenges in designing large ships, including risks of grounding and bottom damage to vessels. Navigators need to be alert when sailing in such regions and should be aware of unsurveyed areas in Arctic waters with the risk of icebergs and multi-year ice.

Arctic LNG carrier "Christophe de Margerie" advancing in the Arctic ice.

Arctic LNG carriers for Yamal LNG
During the past years, the works related to Arctic LNG Carriers have focused on making plans become reality. From 2010, Aker Arctic has worked for the Yamal LNG company supporting its development project to design LNG-carriers and related port infrastructure and a port fleet for transporting natural gas from Sabetta to the markets elsewhere in the world.

"We have been extremely happy to see our long-term development, persistent work, new ideas and ships finally come true. It has been fantastic to work with our clients who have displayed an innovative attitude and the rock solid expertise, which will make LNG transports from the Arctic happen," says Suojanen.

Regarding ships for the Yamal LNG project, a series of 170,000 m³ sized Arctic LNG carriers that will carry gas to Europe and the Far East from the Yamal peninsula was proposed. The project stakeholders made the selection for the potential builder and the membrane tank concept.

The carriers need to be large so that they can transport a substantial amount of cargo – 16.5 million tons a year. The new, but today very common, size class of 170,000 m³ was also favoured, as it would allow transhipment operations to similarly sized ordinary open water LNG carriers that can transport gas cargoes further to overseas destinations more economically than the Arctic ships.

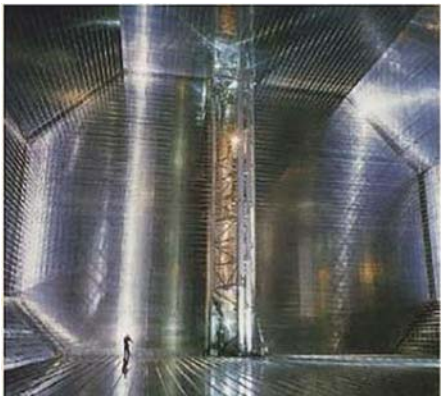
In addition to the Far East destinations, the ships will call on a regular basis at the Zeebrugge LNG terminal in Belgium where the transhipment of cargoes via onshore storage will also take place.

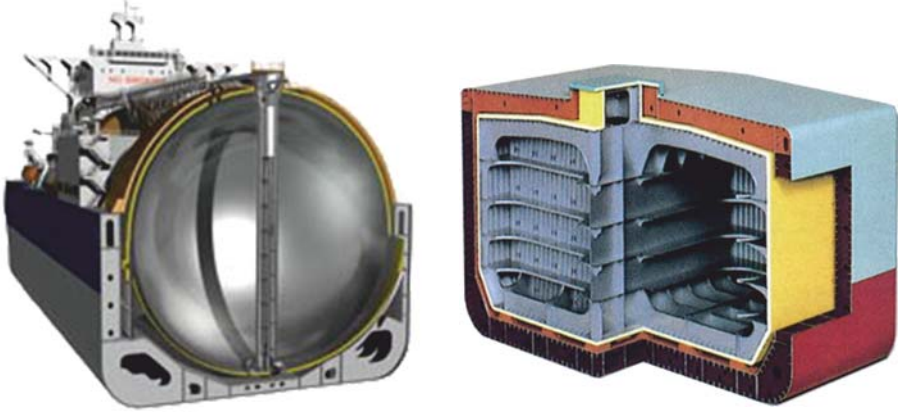
The first Arc7 Arctic LNG Carrier "Christophe de Margerie"
The first real Arctic LNG carrier, the *"Christophe de Margerie"*, is currently in service and will start regular LNG shipments later this year from Sabetta port in the Yamal peninsula. Her sister ships will join the fleet of 15 ships, one by one as they are completed and the LNG plant has reached its full capacity of 16.5 million tons of LNG a year. Read more about the *Christophe de Margerie* in its full-scale ice tests last winter on page 9.

Different cargo containment systems for LNG Carriers

The selection of the LNG cargo containment systems has a large effect on the ship design. Therefore, two to three of the most common LNG tank concepts are usually studied and regarded as potential alternatives for Arctic LNG carriers.

The developed LNG carrier is significantly larger than any previous vessel for the Arctic: An 80,000 dwt LNG carrier, 70,000 dwt oil tanker and 15,000 dwt multi-purpose cargo vessel.





The cargo containment types for large LNG carriers: Membrane, Moss- and SPB type tanks.

Today, the so-called **Membrane**-type ship concepts are used for the majority of large LNG carriers. Specific to the membrane tank system are the prismatic shape of the cargo tanks and the double internal tank insulation system with thin fluid tight layers.

Moss tank ships are distinguished by their robust, spherical, self-supporting, cargo tanks that extend halfway above main deck and are covered by similarly shaped tank covers.

A third containment type suited for larger ships is the SPB tank that resembles the membrane tank concept in shape, but is another self-supporting and robust tank type, which has become successful only recently. However, the first two SPB concept based ships were built already in 1993 in Japan.

"The main LNG cargo containment types differ from each other quite much although they all serve the same purpose," says Senior Designer Mauri Lindholm. "During transportation LNG is kept at atmospheric pressure in well insulated tanks. The cargo is slowly boiling and will maintain its low boiling temperature during the entire voyage. The vaporized gas, the boil-off, is utilised as gas fuel for propulsion. More fuel gas can be generated from the ship's LNG cargo with heat. Or, the rest of the required energy comes from oil fuel, as usual."

Any new LNG carrier builder needs to choose their own or their client's favourite tank concept and will thereafter usually stick to it.

Tank stretching: Moss cargo tanks made larger by inserting a vertical extension in the middle. The ship's steel hull remains almost unchanged.

"Seri Campaka" – The third ship in a series of five IHS-Moss type LNG carriers for a Malaysian owner built by Hyundai Heavy Industries. The hull design with its continuous tank cover is based on Aker Arctic's "IHS" concept with improved hull strength and reduced steel weight.

"The reason is that the different tank concepts have totally different and specific materials, production, assembly and quality assurance methods, and the building yard needs to make large, long-term investments. Additionally, the tank concepts are licensed by their developers," adds Lindholm.

Interest towards smaller sized LNG feeders and bunker ships has grown rapidly in line with the growing use of LNG as ship's fuel. Pressure vessel type tanks have proven be the most feasible solution. Similar tank types have been used for decades in transporting other gas cargoes that are in refrigerated or pressurized form. Smaller LNG ships with a cargo capacity from 1,000 to 35,000 m³ fitted with such tanks are becoming more common.

Finnish designs

At the beginning of the1990s, Finnish engineers in Turku began further developing the well-known Moss-tank and ship concept in order to create improved solutions; ships with fewer but larger tanks and based on new tank production methods.

Four Moss-type vessels built in 1996/1997 are still delivering LNG from the United Arab Emirates to Japan on a long-term basis. They were the first larger carriers with only four spherical cargo tanks.

Somewhat later, the experiences from the modern Moss ship design process produced two new Finnish innovations related to the Moss cargo containment system.

Aker Arctic is marketing an Integrated Hull Structure (IHS) concept – an extension to the Moss ship concept that is especially favourable for Artic trade with several advantages compared to conventional gas ship concepts. In the IHS concept the individual tank covers are constructed into one continuous hull element for improved hull strength and reduced steel weight.

The other innovation is "tank stretching" meaning the spherical tanks are fitted with an extension ring in the middle for increased cargo capacity. By now the present Moss ship builders have constructed tens of such ships.

"Mitsubishi Heavy Industries in Japan and Hyundai Heavy Industries in Korea have been using our patented IHS-technology in their building projects for years," says Suojanen.

"It is worth mentioning that both inventions can be utilised in the same ship design as is the case with the Japanese 'Sayaendo' concept, an unusual Moss-type ship series built lately," Lindholm adds.

Integrated Hull Structure: Moss cargo tanks are covered by a structurally continuous cover, common to all cargo holds, which improves hull strength.

Polaris' unique concept shines in ice trials

The world's first LNG fuelled icebreaker, *Polaris*, was officially tested in full-scale ice trials towards the end of her first icebreaking season, in March, in the Bay of Bothnia.

A team of four experts from Aker Arctic: Topi Leiviskä, Toni Skogström, Tuomas Romu and Juha Alasoini, joined the vessel for five days to supervise the trials. The purpose of the ice trials was to ensure that the *Polaris* fulfils all design requirements.

"On the first day, after we left from the port of Oulu, we went looking for a demanding ridge field," explains Head of Research and Testing Services Topi Leiviskä. "We found one ridge that we measured to be 10 metres thick and 95 metres wide, which *Polaris* penetrated easily going forward."

The other ridge found, was measured to be 13.6 metres thick and 50 metres wide.

"Moving astern through the second ridge, the captain wiggled the Azipods slightly, and jointly with Arctech Helsinki shipyard, the shipowner's representatives and the captain we concluded that the ridge penetration capacity was excellent. This was one of the original requirements of the vessel," says Leiviskä.

Closer to Kemi, tests were performed in an ice channel. This ice channel stays broken all winter, but is filled with brash ice, which was measured to be 174 cm thick. *Polaris* reached a speed of 14 knots in the channel without any trouble.

For the level ice tests, the ice strength was measured to be 600 kPa. Moving forward the speed was 12 knots in 81 cm thick ice, and through 72 cm thick ice it was 12.7 knots. Moving astern the speed in 77 cm thick ice was 11.2 knots, and in 72 cm thick ice it was 12.2 knots.

Polaris is able to turn 180° on the spot in ice in one minute and 15 seconds. Her turning ratio (= turning diameter per ship length) is approximately 1, meaning she can make a circle her own length.

▶

Extremely agile

This ice channel close to Kemi stays open all winter, but is filled with brash ice, which was measured 174 cm thick. Polaris managed 14 knots in the channel without any trouble.

Toni Skogsröm cutting out blocks of ice for measurements.

Turning tests were performed in 60-90 cm thick ice and went extremely well.

"*Polaris* is able to turn 180° in ice on the spot in one minute and 15 seconds. It is almost unbelievable how agile and easy she is to manoeuvre," Leiviskä says.

"Her turning ratio (= turning diameter per ship length) is approximately 1, meaning she can make a circle her own length, which is quite impressive for a vessel her size."

On the last evening, the icebreaker, *Sisu*, was assisting a merchant vessel stuck in the ice. The Aker Arctic team had the chance to see Polaris in real action, when she easily flushed and cleaned the ice away around the vessels so that they could move again.

Polaris is designed to use both LNG and MDO as fuel. The engines' normal mode is to use LNG until the power demand reaches a certain limit and then switches to MDO automatically.

The ice trials verified that *Polaris* fulfils all the design requirements.

Successful first season

"During the 2017 winter, *Polaris* turned out to be clearly the best icebreaker I have ever worked on," says Captain Pasi Järvelin about the first season with *Polaris*.

"Although the pack ice in the northernmost end of Bay of Bothnia was at times difficult to navigate, due to constant winds from southwest, I had at no point a feeling of not having enough power to manage. The most important difference to previous generations of icebreakers was, however, how the agility of the vessel brought so much pleasure in navigating. Dislodging commercial vessels stuck in the ice turned out to be fast and easy.

Apart from a few technical issues, the first winter was a real success."

On the last evening, the icebreaker, Sisu, was assisting a merchant vessel stuck in ice. The Aker Arctic team had the chance to see Polaris in real action, when she easily flushed and cleaned the ice away around the vessels so that they could move again.

Technical specifications

Tonnage	3,000 DWT
Length	110 m
Beam	24 m
Draught	8 m (design)
Draught	9 m (max)
Ice class	PC 4 icebreaker (+)
Installed power	2 x Wärtsilä 9L34DF, 2 x Wärtsilä 12V34DF, 1 x Wärtsilä 8L20DF
Propulsion	three ABB Azipod-units, 1 x 6MW (bow), 2 x 6.5 MW (stern)
Speed	17 knots open water, 4 knots in 1.8 m level ice
Endurance	10 days on LNG, 20 days on MDO
Crew	16

First icebreaking LNG carrier in ice trials

The *Christophe de Margerie*, the world's first icebreaking LNG tanker, has successfully completed ice trials and berthed at the gas terminal at Sabetta Port in the Yamal peninsula in Russia. Aker Arctic developed the Arctic LNG Carrier vessel concept, designed the final hull form together with Daewoo Shipbuilding & Marine Engineering (DSME) and assisted in developing the design of the entire logistics operations in Sabetta. In addition, a comprehensive model test campaign for the vessel was carried out at Aker Arctic.

The specifications of the *Christophe de Margerie* make her a unique vessel. She was assigned an Arc7 ice class, the highest ice class amongst existing merchant vessels. She is capable of sailing independently through ice up to 2.1 metres thick. According to plans, she will sail along the Northern Sea Route westward from Sabetta all year round and eastward for six months of the year (July to December). Previously, the summer navigation window on the Northern Sea Route was limited to only four months with an icebreaker escort.

The vessel can carry 172,600 m³ of LNG from Sabetta to markets in Europe and Asia. She is 299 metres long and 50 metres wide, which means that she is wider than any existing icebreaker. She is equipped with three 15 MW Azipod type propulsion units, which provide a high degree of manoeuvrability and allow the use of the double-acting principle in ice conditions.

The official ice trials took place from 19th February to 8th March 2017 in the Kara and Laptev Seas. They were attended by participating representatives of the shipyard (Daewoo Shipbuilding & Marine Engineering), key equipment suppliers, leading industry research and design organisations, both Russian and international. Teemu Heinonen and Artur Nermann represented Aker Arctic Technology during the trials. The nuclear icebreaker *50 Let Pobedy* assisted in the ice trials.

"It was a very international crowd on the vessel," says Development Engineer Teemu Heinonen. "We boarded the ship on the 12th February in Murmansk and left a few days later towards the Barents Sea, rounding Novaya Zemlya on the northern side. On the Barents Sea, we encountered rough seas and very hard winds with gusts over 30 m/s, but the vessel managed very well in these tough circumstances."

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Exceeding expectations
The official ice trials began on 19th February in the Kara Sea with vibration tests. Then followed the official performance tests in level ice ahead and astern. The vessel proved her capability to move stern-first in 1.5 metres thick ice at a speed of 7.2 knots and head-on at a speed of 2.5 knots.

In the turning tests, she managed a circle of 1,760 metres in 1.7 metres thick ice, against the planned 3,000 metres.

"On the last day of the trials, the ice ridge test was performed in an extremely heavy 15 metres thick ice ridge on the East Kara Sea, which the vessel was able to penetrate in her astern mode, demonstrating the benefits of the double-acting concept," Heinonen adds.

"The last leg of the journey back to Murmansk was through the Kara Gate on the south side of Novaya Zemlya."

The vessel's exceptional ice passing and manoeuvring qualities were fully confirmed by her ice trials and exceeded expectations. She was delivered to Sovcomflot after the trials and undertook her maiden voyage to Sabetta Port using the seaway canal,
built to allow large capacity vessels to cross the shoal at the river mouth, and the Arctic basin, both intended for operation in difficult conditions of constant ice drift.

The *Christophe de Margerie* is the first of a series of 15 gas carriers, which are planned to be constructed for the Yamal LNG project.

A unique concept
Aker Arctic developed the concept design for the gas carrier. The hull form was developed in cooperation with Daewoo Shipbuilding & Marine Engineering and an extensive number of model tests were performed at Aker Arctic's ice laboratory. Multiple studies on how to optimally design Sabetta harbour, and how to take care of the logistics in the harbour as well as how to best transport the LNG have been conducted over the past ten years.

"The LNG tanker is unique in many ways and has special features, which are completely new," Heinonen says. "She is exceptionally large for an ice-going vessel, but still manages well in the areas she is planned for. She is wider than any existing icebreaker. The propulsion solution with three Azipods is also new for a tanker and increases her manoeuvrability and ice-going capabilities. Also, great attention to the open-water performance was paid during the design process and the unique bow form ensures good open water features for an ice vessel. Additionally, her machinery is of dual-fuel type, using LNG boil-off along with traditional fuels. Using LNG reduces emissions considerably."

The *Christophe de Margerie* was designed and built according to all the requirements set by the Polar Code and is notable for her environmental safety.

Read more about the *Christophe de Margerie's* ice trials in the official press release www. scf-group. com /en /press_ office/ press_ releases / item86398.html

Photo: DMSE

From left: Won-Seok Bae (DSME), Sahng Hyon Lee (DSME), Teemu Heinonen (Aker Arctic), Artur Nermann (Aker Arctic) and Jae-Man Lee (DSME).

Meet Teemu Heinonen

Teemu joined Aker Arctic in 2008 as an assistant at the model testing facility, while he was still studying. He wrote his master's thesis about icebreaking at high speeds and graduated from Aalto University in 2010. During his studies, Teemu also spent time in Svalbard and received valuable field experience. After graduating, Teemu's work in testing continued on a permanent basis with model tests, full-scale trials and ice measurements, among other things. Today he also contributes to vessel design and works for improving vessels' ice-going performance.
Teemu enjoys sailing, climbing and playing drums to chill.

The *Christophe de Margerie* transits in record time

The LNG (liquefied natural gas) tanker *Christophe de Margerie* finished her transit passage via the Northern Sea Route (NSR) with 75,656 tons of LNG onboard in record time.

On 31st July 2017 at 04:30 Moscow time, the tanker crossed meridian 68 35 E (Zhelaniya cape) and started her passage. On 6th August 2017 at 17:00 Moscow time, the LNG tanker left the NSR area by crossing line 66 05 N (Dezneva cape).

This passage took 6 and a half days, which is a record for transiting NSR.

www.nsra.ru/en/glavnaya/novosti/n13.html

Baltika proves her capability in arctic ice management

Photo: Gazprom Neft

The world's first asymmetrical icebreaker has successfully been serving as an ice management vessel at the Arctic Gates oil terminal in the Gulf of Ob for two years.

The *Baltika* was designed to operate in Baltic Sea conditions. However, after she was delivered in 2014, she was taken to the Gulf of Ob for ice trials, and surpassed all expectations. Gazprom Neft then chartered her as an interim standby vessel for their Arctic Gates terminal, while waiting for two Aker Arctic designed high capacity icebreakers currently under construction at Vyborg Shipyard.

Three icebreakers

There are currently three icebreakers supporting oil tanker operations in the Gulf of Ob: the nuclear escort icebreaker, *Vaygach,* the icebreaking supply vessel, *Vladislav Strizhov,* and the oblique icebreaker, *Baltika*. The *Vaygach* takes care of breaking the ice, which can be up to two metres thick Arctic ice, and escorts tankers to the terminal. The *Vladislav Strizhov* supports the tankers in mooring. The *Baltika,* which is extremely easy to manoeuvre, keeps the ice channel, the tanker mooring site, and all the icebreakers' parking sites clear of brash ice and ice rubble. She uses her vertical side to push the ice away, her inclined side to smooth the frozen edge of the channel and can also flush brash ice around a vessel while remaining stationary. The oblique mode has not been used for icebreaking, as it is not needed in her current task, and secondly the ice in the region is often much thicker than the *Baltika* was designed for. The oblique mode was, however, tested during ice-trials and showed that the relatively small icebreaker can create a wide channel in the ice by breaking ice obliquely, just as planned. The *Baltika* is also constantly ready for emergency rescue and oil spill response on site.

Aker Arctic's Development Manager, Alexey Shtrek, visited the *Baltika* in the Gulf of Ob in May to gather feedback about her operations and to inspect that the ice load monitoring system on board functions well.

"The feedback from the crew was that no other icebreaker can perform such ice management operations as the *Baltika*, even if they are more powerful," Shtrek says. "The icebreaker master told me that the vessel is easy in operation, however requires practice to steer."

"The unique asymmetrical hull form together with the three free-moving Steerprop propulsion units, two in the stern and one in the bow, are a winning concept."

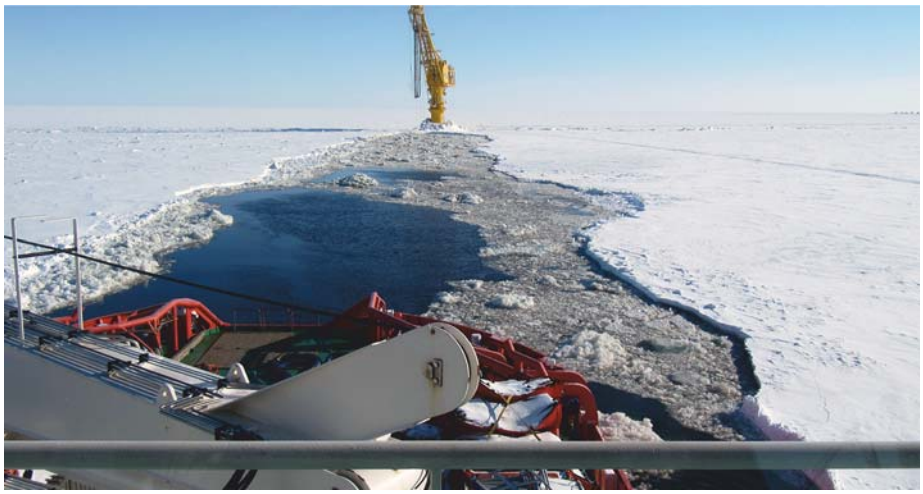
An ice load monitoring system has been measuring ice loads on the oblique side for two years. Data from the measurements will help developers learn more about the asymmetrical hull shape.

Successful transportation system

Five years ago, nobody thought it would be possible to explore this area with temperatures reaching -40 degrees Celsius in winter and with high-strength ice up to two metres thick. Three years ago, there was still nothing in this area during the long winter seasons. Today, there are 250-metre-long and 34-metre-wide 42,000 DWT shuttle tankers arriving every second day to the offshore loading terminal. In May, Gazprom Neft achieved a milestone when the total cumulative oil shipped from the Arctic Gates terminal exceeded five million tonnes.

"The transportation system we have created for this and other arctic projects seems to be working well," says Shtrek.

Aker Arctic developed the powerful Aker ARC 130 A icebreaker design to support tanker loading operations at the terminal. Two vessels, the *Aleksandr Sannikov* and the *Andrey Vilkitsky*, are currently under construction at Vyborg Shipyard and will be delivered this and next year.



The Baltika clears the loading area by pushing the ice away.

Technical specifications

Length	76.4 m
Beam	20.5 m
Draft	6.3 m

Diesel-electric power plant with three Wärtsilä 9L26 generating sets with a total output of 9 MW

Three 2.5 MW Steerprop SP60PULL azimuth thrusters, two in the stern, one in the bow

DP system by Navis Engineering

RMRS Icebreaker6

Built-in oil recovery system

They will have a similar propulsion concept to the *Baltika*, consisting of three azimuth propulsion units: two in the stern and one in the bow of the vessel.

Additionally, Aker Arctic was involved in the development of the 42,000 DWT shallow-draught icebreaking shuttle tankers that were built specifically to transport oil from the Gulf of Ob to Murmansk. The hull form was developed in cooperation with Samsung Heavy Industries and the development work also consisted of ice model testing at Aker Arctic's ice laboratory.

Oblique icebreaker concept

The innovative oblique icebreaker concept was the result of an innovation contest in the late 1990s. The idea was to design an icebreaker which could create a wide channel for oil tankers, without becoming too large and expensive. The exceptional concept received much attention, but construction of the first vessel only began in 2011 after the Russian Ministry of Transport decided to order one for assisting large vessels in icy harbours.

The asymmetrical hull form and the three propulsion units is a winning concept for excellent manoeuvrability.

Meet Alexey Shtrek

Alexey Shtrek joined Aker Arctic this year as Development Manager. He worked previously at the Central Marine Research and Design Institute in St Petersburg, Russia, and has been involved in joint icebreaker projects with Finland since 2002. Alexey was also part of the team of experts investigating innovative proposals in icebreaking technology including the oblique icebreaker concept. During 2011-2013, he actively participated in the feasibility study of the icebreaking LNG carrier for the “Yamal LNG” project. Alexey likes to spend his free time with his wife and two small children, skiing in winter and biking in summer.

Ice Load Monitoring System on Baltika

The oblique icebreaker *Baltika* has been equipped with a strain gauge sensor based measurement system to measure ice loads. The system has been up and running since 2014.

An ice load monitoring system was installed on board the *Baltika* in 2014. As she was a completely new vessel design, Aker Arctic wanted to measure the ice load effects on the new oblique hull form.

“The ice load monitoring system installed on the *Baltika* included 22 gauges on the port side of the hull,” says Electrical, IT and Automation Team leader Antero Jäppinen. “The display onboard shows only the plain data from each sensor, instead of prediction and the more user friendly graphical user interface, which our current system has. The amount of data that is registered by the system is around 1TB per year.”

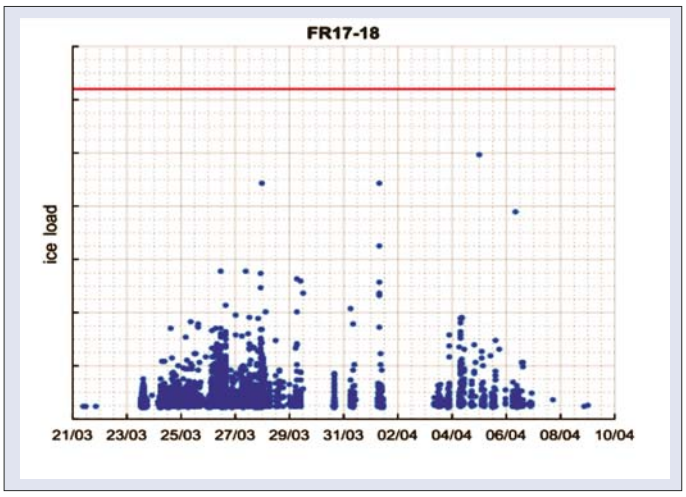
In the current version of the ice load monitoring system, there are sensors on several locations around a vessel's hull. The results are also immediately displayed on a monitor for a clear overview of the load, peak values and the predicted ice load in simplified form. This supports the captain in deciding how to proceed in an ice field and at what speed.

Two different types of sensors can be used, fibre-optic sensors or traditional strain gauge sensors. The advantage of fibre-optic sensors is that they are free of any electrical interference and can easily be installed on both dry and wet tanks. The main advantage of traditional sensors is the lower price range for the overall package.

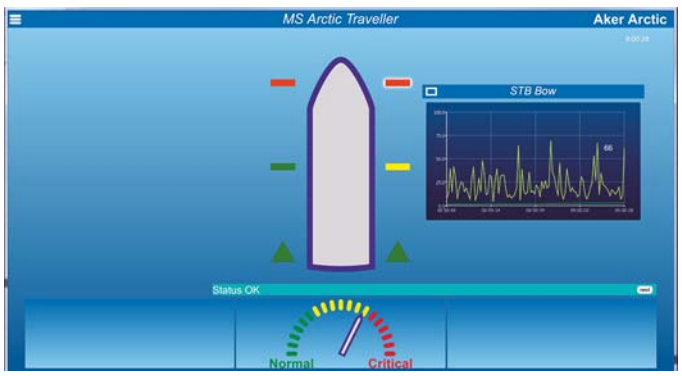
A new feature under development is to add propulsion monitoring to the system.

“Our plan is to offer an integrated monitoring and prediction system for ice loads on both the hull and the propulsion line in the future,” Jäppinen adds.

The ice load monitoring system is especially useful for vessels which do not constantly operate in areas with ice, as it helps the crew to operate more efficiently and safely in ice.



The ice load monitoring system has been operating for two years on icebreaker Baltika.



Brash ice channel project continues

There are currently no clear guidelines in the Finnish-Swedish ice class rules on how to prepare a brash ice channel for model tests. Aker Arctic and Aalto University therefore started a joint project last year, with the target of defining the channel properties and production methods.

The project began with gathering information from the main facilities worldwide, and defining the parameters for two different ice channels.

"The guidelines define the thickness and width of a rule channel, but we know that many other parameters affect the channels resistance as well," says Topi Leiviskä. "We have now conducted tests in our facilities with different variations in parental ice strength, porosity and cohesion."

"In order to demonstrate a situation where there is no cohesion in the ice, we ordered six m³ of 50 mm sized ice cubes, and poured them into the testing basin," adds Research Engineer, Riikka Matala. "Visually this worked well as you can see from the pictures below."

This situation was then compared to tests where the brash ice was prepared from traditional model ice, which represents another level of ice strength and cohesion.

These tests show that different ways of preparing the ice give different results in channel resistance, and more studies are required to find the right composition.

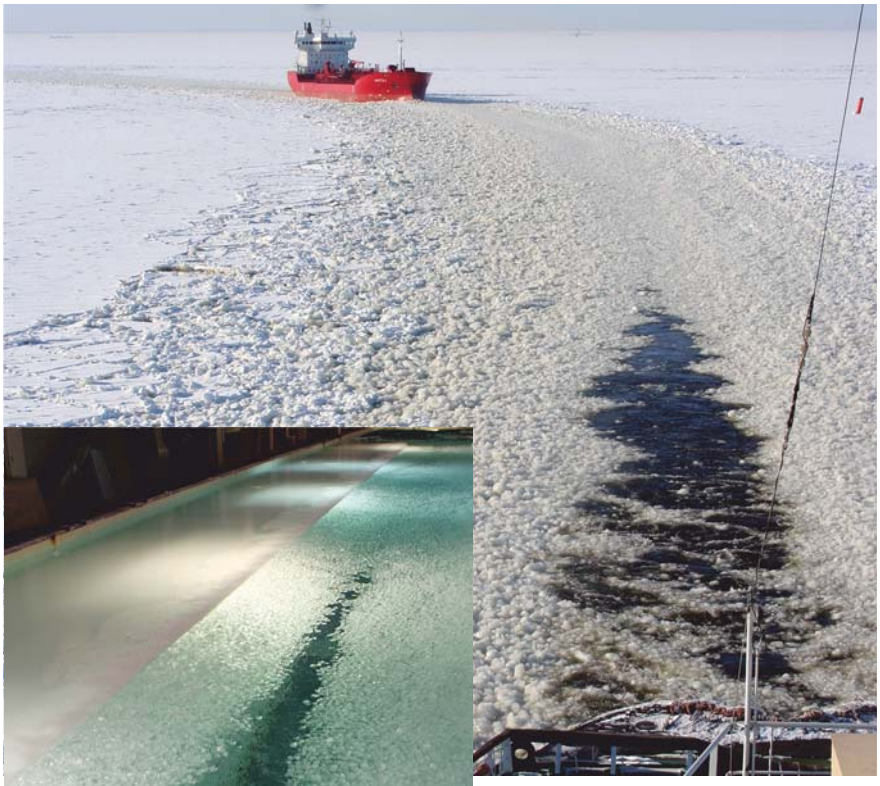
"Due to variations in test results, more full-scale channel test results are required to find the best solution," Matala says. "The best option would be to perform both model tests and full-scale tests with the same vessel in an ice channel with carefully measured parameters."

An additional finding was that a consecutive test in the same channel gave different results in channels, which were made from an FGX model ice (F=fine, G=grained, X=containing fresh water layers). Existing rules or guidelines do not regulate how many times a test can be performed and the model basins have varying practices in this respect. The results obtained so far are now being analysed and additional verification tests will be performed. The plan is to have the project ready by the end of 2017.

FGX model ice

Aker Arctic uses granular model ice, so called FGX –model ice (F=fine, G=grained, X=containing fresh water layers), which is produced using a spraying method. The NaCl-doped water is taken from the test basin, and sprayed using a carriage that moves back and forth above the basin. In spraying, the water droplets freeze and the model ice layers are formed from small, granular ice crystals. The spraying circuit is repeated as many times as needed to reach the required model ice thickness.

After spraying, the ice strength is adjusted with an adequate freezing period. The length of the freezing period needed depends on the model ice thickness and the target value of flexural strength.



Brash ice channels in real life.

Ice cubes represent a situation where there is no cohesion in the ice. Six m³ of ice cubes were used for this test.

The same test performed in model ice with more cohesion.

Basics about ice, Part 2:

Special features of vessels operating in ice

Ships operating in ice can be referred to as either “ice-going” or “icebreaking” depending on their mission and general characteristics. Ice-going ships are structurally strengthened for navigation in ice-covered waters, but often have to rely on icebreaker escorts in challenging ice conditions. Icebreaking vessels are designed to operate independently and, when necessary, break their own path through the ice field.

Both ice-going and icebreaking ships have certain design features that set them apart from vessels operating in open water: increased structural strength, higher propulsion power and a hull form fit for purpose.

The icebreaking hull form

The development of an ice-going or icebreaking hull form begins by outlining the operational conditions of the vessel concept. This includes: the location (where it will operate), the time (when it will go there) and the mission (what it does once it gets there). This will be used to establish the icebreaking capability of the built-for-purpose vessel, for example the maximum level ice thickness that can be broken in a continuous motion. As most vessels operate in ice for only part of the year, open water performance and seakeeping characteristics typically cannot be neglected; sometimes the hull form may be a compromise between open water and ice operation. However, some icebreakers feature a no-compromise extreme icebreaking bow that allows them to break very thick ice with relatively low propulsion power.

An icebreaking hull form is designed to minimize the additional resistance resulting from hull-ice interaction. A modern icebreaking bow, characterized by smooth rounded waterlines and small flare angles, breaks the ice in the most energy-efficient way: by bending it downwards. Stem and shoulder areas are designed to minimize crushing of the ice. After breaking, the ice floes are accelerated smoothly as they are displaced around or submerged under the moving vessel. Special attention needs to be paid to hull appendages when designing an icebreaking vessel: for example, a badly designed forefoot can significantly increase the ice resistance.

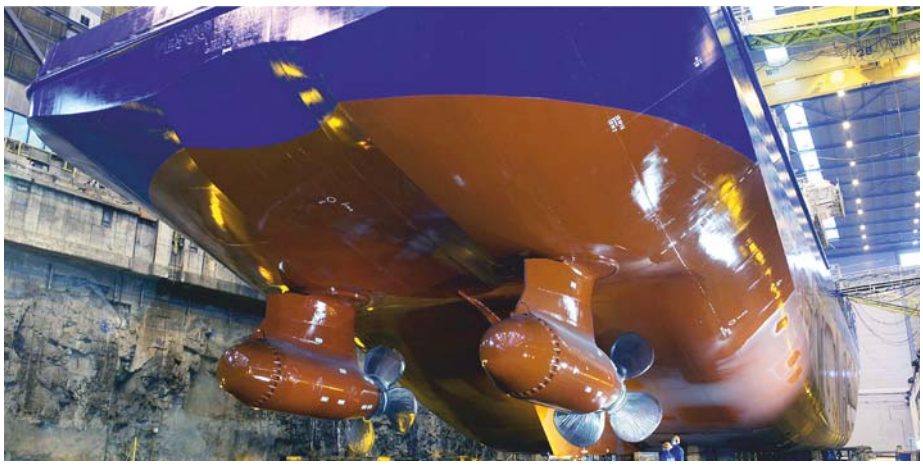
Icebreaking vessels typically feature sloping sides which serve two functions: they increase the manoeuvrability of the vessel in the ice, which is particularly important for escort icebreakers operating in close proximity to other ships, and they reduce the ice loads on the hull structures in compressive ice.

Most modern icebreakers are capable of operating in both ahead and astern directions in the same ice conditions, meaning that the stern hull form is designed following largely the same principles as the bow. In addition, the stern must be designed to work efficiently with the selected propulsion system. Double Acting Ships (DAS™) combine an ice-going bow with an icebreaking stern, resulting in a vessel that is capable of operating independently in ice in the astern direction while remaining economical in open water and light ice conditions where it sails bow-first.

Propulsion system design

While ice-going ships typically feature conventional mechanical shaft lines and rudders like their open water counterparts, icebreaking vessels have more variety in propulsion systems: up to four shaft lines or azimuthing propulsion units, or a hybrid propulsion with combinations of both. Many icebreakers have propellers also in the bow of the vessel. This is a result of following the same principles as with the hull form: the design is tailored according to project-specific operational parameters and limitations. Regardless of the project, the goal is to achieve the desired icebreaking capability with the smallest installed power, resulting in a vessel that is less expensive and more economical to operate. While icebreakers have high propulsion power compared to other ships, it should be kept reasonable.

Typical icebreaking bow form



Icebreaking aftship hull form –”double acting ship”

Sloping sides increase manoeuvrability in ice

Centreline skeg improves course stability

While a diesel-electric powertrain is generally favoured due to the good low-speed torque characteristics of electric motors and fixed pitch propellers due to their simplicity and robustness, a number of icebreakers have been equipped with controllable pitch propellers mechanically coupled to the main engines. In case of the latter, oversized flywheels are sometimes used to protect the main engines from sudden torque peaks resulting from propeller-ice interaction. The flywheel also prevents the propeller from stopping while the vessel is moving, a situation where most propeller damage occurs. Open propellers are usually preferred in icebreaking applications as nozzles may suffer from clogging in heavy ice conditions.

Regardless of the selected solution, the design principles regarding strength are the same: the propulsion system components must be strong enough to withstand the propellers coming in direct contact with the ice. Icebreakers typically use built-up propellers with detachable blades. The design follows the so-called strength pyramid where a propeller blade should fail before damage to other components occurs. Most icebreakers carry spare blades and have provisions for changing them at sea, but repairing other propulsion components would usually require drydocking.

Ice strengthening

Both icebreaking and ice-going vessels require additional structural strengthening to be able to operate safely in ice-covered waters. If the ice loads on the hull are excessive, the results can range from small dents in the shell plating to buckled frames and, in the worst case, loss of watertight integrity and sinking of the vessel.

Both ice-going and icebreaking vessels typically have a transverse framing system which distributes the ice loads more effectively than longitudinal framing. High strength steel is typically used at least in the ice belt area to reduce weight; using mild steel could result in a shell plating thickness of up to 50 mm. The basis for ice strengthening is a so-called ice pressure plan where the hull of the vessel is divided into separate regions and a design ice pressure is assigned to each part:

“In addition to classification society rules, we use our in-house calculation methods and experience in determining the extent of each region and the design ice pressure. The hull strengthening is based on the selected ice class and the overall operational icebreaking capability of the vessel,” Project Engineer, Tuomas Romu explains. “In particular, highly manoeuvrable icebreakers may require additional hull strengthening in parts of the hull.”

Icebreaking Supply Vessels ”Arcticaborg” and ”Antarcticaborg”.

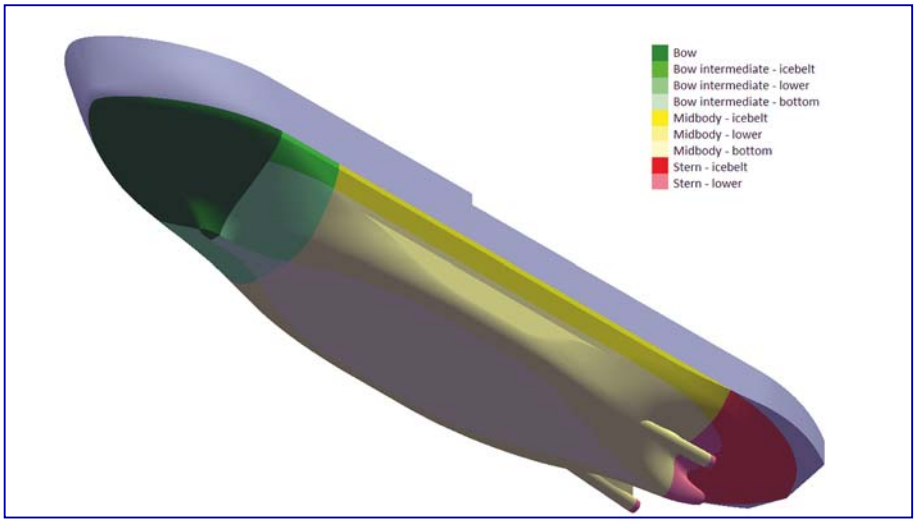
Nuclear Icebreakers ”Taymyr” and ”Vaygach”.

Series of five Arctic Container Vessels.

”Mangystau 1-5". Series of five Shallow Draught Icebreaking Tugs.

Arctic Shuttle Tankers ”Mikhail Ulyanov” and ”Kirill Lavrov”.

Arctic Module Carriers ”Audax” and ”Pugnax”.



The selection of ice class, which determines the general level of ice strengthening for ice-going and icebreaking vessels, is not straightforward. If it is too low, there is a risk of ice damage due to inadequate strength and local administrations may impose traffic restrictions during the worst part of the winter. If it is too high, excessive steel weight will increase the construction cost and operational expenses, and reduce the amount of fuel and cargo that can be carried onboard.

French polar logistic vessel delivered

L'Astrolabe, the new Polar Logistic vessel for France, left metropolitan France towards her home port at Reunion island in the south of the Indian Ocean to carry on Antarctica missions according to the original plans, and schedule.

Aker Arctic was awarded the basic design contract for the French polar logistic vessel in June 2015. By January 2016, the design work and model testing was completed. The steel hull was constructed in Poland and then towed to Concarneau in France, where the vessel was outfitted and finalised for the past 7 months at Piriou Shipyard.

Inclining tests were performed in May 2017, when the vessel was nearly ready. The lightweight and centre of gravity of the ship were determined in the successful tests.

In June 2017, open water tests were successfully completed, where performances such as speed, endurance, noise and vibrations, turning and manoeuvrability of the vessel were tested.

Positive feedback

Project Manager, Anders Mård, and Managing Director, Reko-Antti Suojanen were present during the name giving ceremony in Concarneau on 12th of July when the vessel was named the *L'Astrolabe*. Speeches from the Minister of Overseas, Annick Girardin, and CEO of Piriou, Pascal Piriou, were held before the name giving ceremony.

“We received very positive feedback about Aker Arctic's efforts on the project from all the parties involved,” says Mård.

The *L'Astrolabe* was delivered in September 2017. Soon afterwards, she will be deployed for her first supply mission to Reunion Island in the Indian Ocean, where she will operate as a patrol vessel during the southern hemisphere's winter. From Reunion, she will sail to Hobart in Tasmania for her first cargo loading and then continue to the French research station, Dumont D'Urville, in Antarctica. During the southern hemisphere's summer months she will complete four resupply trips between Hobart and Antarctica.

TAAF - the French Southern and Antarctic Lands, IPEV - the French polar Institute and the French Navy will jointly own and operate the new logistic vessel. She will replace two existing ships, the L'Albatros and the former L'Astrolabe.

Technical solutions

The fairly compact sized polar logistic vessel, based on a concept design issued by the French engineering company Marine Assistance, is fitted with two shaft lines. Its four main engines are Wärtsilä 8L20 engines with a total propulsion power of 6.4 MW. Two sets of engines are connected to one reduction gear on both sides of the ship. The reduction gears can be connected to power take out (PTO) generators (with 500 kW power each), used mainly for operating of bow thrusters. The electricity required by the ship is supplied by two auxiliary generator sets.
All main engines and auxiliary engines fulfil the IMO's Tier III regulations, with reduced NOx emissions as a result.

The two shaft lines are equipped with controllable-pitch propellers (CPP), which have the advantage of being able to navigate the ship at different speeds without changing the rotation direction of the engine. With this setup, the ship also has a faster response, which comes in handy in icy waters.

The vessel is capable of carrying various goods onboard, such as containers, heavy construction work equipment, pallets and liquid drums in the cargo hold or on the aft exposed deck above the cargo hold. The ship has a deadweight of about 1,600 tonnes and can also fit two helicopters.

Model testing

Ice model tests in the Aker Arctic test basin verified that the design fulfils all requirements. The vessel can break 80 cm of level ice at a speed of 2 knots. It is capable of navigating in areas with second year ice and can also sail through a stretch of coastal ice with a concentration of 10/10 up to 1 m thick. Furthermore, it can penetrate through ice ridges in ramming mode.

Aker Arctic also performed the seakeeping model tests in order to ensure that the vessel can manage in the rough sea conditions of the southern Atlantic.

“We additionally performed resistance and propulsion model tests in order to obtain more precise information about the performance of the vessel,” Mård explains.

Construction support

In addition to basic design and testing, Aker Arctic provided technical support to the shipyard during the entire construction period. Aker Arctic's specialists visited the shipyard for a few days at regular intervals to ensure that aspects necessary for an ice-going ship were taken into account in the construction work.

Mård says it has been a very positive shipbuilding project and mentions especially the tight schedule that was maintained from the start of the project.

“As with most Aker Arctic projects, this is a special vessel which is custom designed for its intended use. It's a one of a kind vessel and to keep to schedule without delays is an excellent achievement for a shipyard building a high ice class vessel for the first time.”

Piriou Shipyard states that collaboration with Aker Arctic was found to be very constructive. "It was a very interesting experience for Piriou to share Aker Arctic's experience and skills in designing and building ice and arctic vessels. Aker Arctic and Piriou teams have worked together in order to find the best technical solutions to achieve the vessel's performances and to meet the tight schedule for her delivery. Despite differences in cultural and shipbuilding practices, the two parties have worked together with positive dialogue in order to succeed in this challenging project."

Meet Anders Mård

Anders began his career at Aker Arctic in early 2011 when he was still studying at Aalto University. He worked at the ice model testing facility preparing ice, arranging tests and outfitting the ship models. In 2012, he transferred to the ship design department as project assistant for the Chinese research vessel. A year later Anders finished his master's thesis titled, “Experimental study of the icebreaking Trimaran” and graduated as a naval architect.

Since then he has worked as project engineer in different research icebreaker projects and as discipline manager for the research discipline for the Chinese research vessel. For the French polar logistic vessel, Anders first worked as project engineer and later as project manager.

In his spare time Anders spends time with his family and friends. He also enjoys playing disc golf and the guitar. ■

Ice Transit Simulation Model under development

Aker Arctic is currently in the process of developing a new simulation model to improve its capability to perform feasibility studies involving ice transits.

The objective of the new model is to efficiently provide accurate information on vessel transits in ice infested waters. For destination shipping, the model will be capable of providing statistics such as transit times, distances, and fuel usage, along with representative routes for transiting through ice, which can be further used to determine the optimal number of vessels to maintain shipping schedules.

At the core of the model is a route-finding algorithm, allowing for the efficient calculation of an optimal route through the ice in varying environmental conditions, while allowing for the avoidance of unsafe ice features, sensitive ecological zones, shallow waters, and other 'no-go' zones. The route can be optimized based on a variety of measures including the shortest distance, the fastest transit

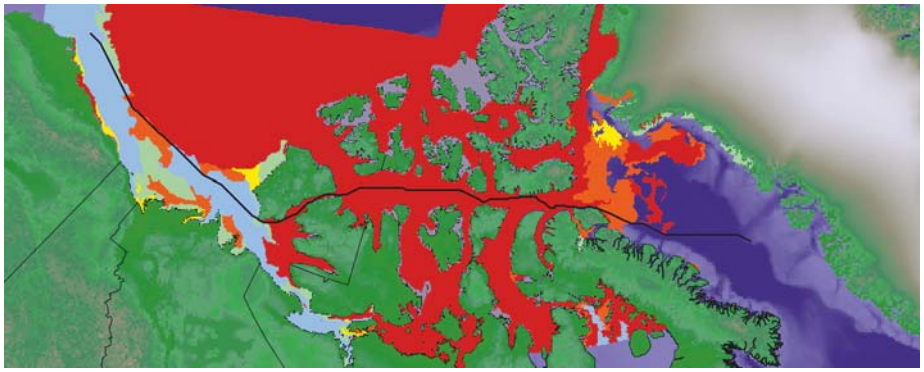


Figure 1. Sample Routing through the North-West Passage during October

In addition to destination shipping, the model is capable of determining ship operational regions based on specified criteria such as ice class, icebreaking capability, and/or draft limitations. One such application of the model is to allow Aker Arctic to assist in the development of Polar Water Operations Manuals by developing guidelines for allowable operating regions based upon the Polar Code's Maximum expected time of rescue criteria. Based on the location of potential rescue assets, the model will be capable of generating maps showing the expected time for the rescue assets to arrive.

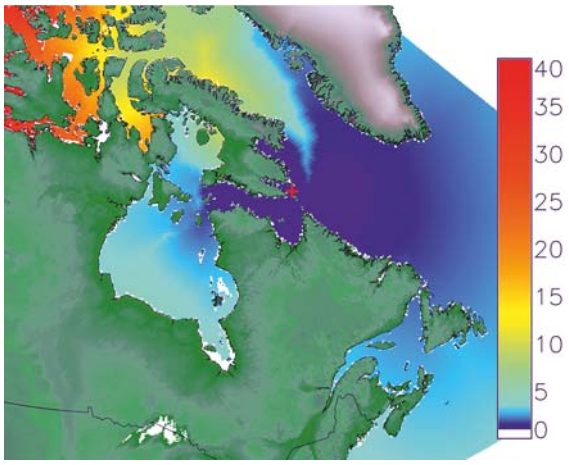


Figure 2. Sample transit time (in days) for a vessel originating from Iqaluit, Canada during May.

times, or optimal fuel usage. Project specific criteria can be developed as required to meet client needs.

The model has been developed using a modular approach, which will allow Aker Arctic to interface with a wide variety of data sources, including ice data, weather data, bathymetry, etc. The model can be easily extended to include new data sources through the introduction of plug-and-play modules.

The new transit model will reduce the overhead time in extracting ice and environmental conditions, allowing Aker Arctic to produce results for a wider variety of scenarios in less time. Hence, clients will be able to receive more comprehensive results earlier in their planning process.

The model will draw upon Aker Arctic's extensive background in model testing and full-scale trials to provide reliable estimations of performance in ice, combined with modular support for interfacing with a wide array of data input sources.

12th Arctic Passion Seminar in Helsinki

Aker Arctic's annual customer seminar gathered nearly one hundred Arctic specialists and other professionals from the shipping, shipbuilding and other related industries from around the world.

Finland took over the two-year chairmanship of the Arctic Council from the United States in May 2017. Aleksi Härkönen, the Ambassador for Arctic Affairs from the Ministry for Foreign Affairs of Finland, opened the day and talked about Finland's goals for this period.

CEO Reko-Antti Suojanen reminded the audience of the significant milestones for this year: beginning the IMO Polar Code, Yamal LNG's first arctic LNG project and the first LNG icebreaker *Polaris* entering into service.

Professor Gary Marquis, Dean of the Aalto University School of Engineering, talked about the Aalto Ice Tank, which is being significantly improved, as well as the cooperation with Aker Arctic. During the Arctic Passion Seminar, Aker Arctic and Aalto University signed a co-operation agreement on the joint use of ice tanks for model testing and research purposes. The combination of two ice laboratories – Aker Arctic's 75 m long and 8 m wide basin and Aalto University's unique 40-by-40 m square tank – has resulted in improved capabilities particularly for manoeuvring and other operative icebreaking model tests. The co-operation also brings new opportunities for research in ice technology.

Tero Vauraste, CEO of Arctia Ltd, the company responsible for icebreaking in the Baltic Sea, presented the first experiences of the LNG icebreaker *Polaris* in the Northern Baltic, where she has been assisting vessels from January onwards. He said the vessel has proved to meet all operational expectations and the selected hull and propulsion concept provide significant operational benefits compared to older vessels. He added that the *Polaris* has proved, that the design supports more effective and quicker assistance to meet the rising demands for icebreaker capabilities and the new challenges from the assisted vessels such as new EEDI designs. Mikhail Grigoryev, Director for GECON, gave an update on the economic development of the Russian Arctic Zone, including the forecasted freight traffic and the foreseen tasks ahead for shipbuilding.

Polar expedition cruises are becoming increasingly popular but are associated with safety risks if the cruise vessels are not designed for cold and ice. Director Nicolas Dubreuil and Captain Etienne Garcia from Compagnie du Ponant gave an interesting presentation of their polar expedition cruises and how they assess the risks involved to keep passengers safe.

Aker Arctic has been assisting Daewoo Shipbuilding and Marine Engineering Company with the development of an LNG carrier for Yamal LNG. Sung-Pyo Kim, Deputy Director, DSME and Ilkka Saisto, Team Leader, Aker Arctic Technology Inc., presented the development project.

Then followed an ice tank demonstration. This year, we demonstrated the ability of a modern icebreaking vessel to penetrate pressure ridges both in the ahead direction using conventional ramming and backing methods, or astern utilizing the flushing effect of the azimuth propulsion units. The ice ridges in the model test basin were produced by a method that mimics the natural process of ridge formation, resulting in a realistic triangular cross-section.

In the afternoon, a joint presentation of case studies on ice propeller development was held by Kari Laukia, from Aker Arctic, Ari Viinikkala, from TEVO Oy and Alexander Ilyintsev, from JSC Zvyozdochka.

Aker Arctic Canada has developed a new ice strengthened lifeboat, which Evan Martin discussed. You can read about this project in the 1/2017 issue of Arctic Passion News.

The design and construction of the first ever arctic condensate carrier was presented by Li Tao, Managing Director at Guangzhou Shipyard International. The gas condensate tanker will be used to transport gas condensate, which is a by-product separated from natural gas before its liquefaction process.

In 2014, Aker Arctic designed two PC3 class module carriers, in close cooperation with ZPMC Red Box Energy Services, for the delivery of construction modules to the LNG plant in Sabetta. The two vessels, named the *Audax* and the *Pugnax*, were delivered in early 2016 and Dirk Verhoeven, COO of ZPMC Red Box Energy Services, described the first operational experiences.

Mikhail Belkin, Assistant to Director General, Rosatomflot, explained how their company plans to support arctic shipping in the future and what atomic icebreakers are in process. The demand for their services has and will further increase.

The day was concluded by Tomas Årnell, Head of the Icebreaking Department at the Swedish Maritime Administration. The topic of his presentation was icebreaking in Sweden and the Northern Baltic and plans for the future.

We would like to thank all the guest speakers and participants of this year's successful and interesting Arctic Passion Seminar! The seminar presentations can be found on http://akerarctic.fi/en/arctic-passion/arctic-passion-seminars.

Special vessels for the Finnish Navy

The Logistics Command of the Finnish Defence Forces has signed a design contract for a multipurpose vessel with Rauma Marine Constructions (RMC) in Finland. A total of four corvette type vessels will be built and once they are ready they will replace seven vessels currently in use. The design contract follows a letter of intent signed last year indicating RMC as the shipbuilding partner for the Squadron 2020 project.

Design picture of four Finnish Navy vessels side-by-side.

Aker Arctic has developed the vessel hull and propulsion concept in cooperation with the Finnish Navy over a number of years. Finland needs vessels, which can be used at all times and in all weather conditions, as all Finnish ports can potentially freeze over, meaning that winter sea faring must be taken into account in all design aspects.

"We have developed the hull form so that it is optimised for both open water and ice, without being an icebreaker," says Kari Laukia, head of ship design and engineering for Aker Arctic Technology. "The propulsion design, including strength calculations, as well as hull model testing and full-scale propeller strength testing were also part of our work. In propeller design, we have developed new design criteria, which combine ice-going capabilities and low noise levels."

According to current plans, construction will begin at RMC in 2019 and the new vessels will be delivered between 2021 and 2024.

Test trial in ice at Aker Arctic.

Starkice de-icing system in operation

Starkice new de-icing system combines technology from Aker Arctic and Pistesarjat and Labcotech.

The first intelligent de-icing system for commercial vessels has worked faultlessly throughout the past winter season 2016-2017 on the *MS Pasila*, owned by ESL Oy. The vessel's main areas of operations are the northern Baltic Sea with its demanding weather circumstances, as well as Russian harbours.

"Experiences from the *MS Pasila* have assisted us in creating and developing new features for commercial vessels," says Starkice Oy's CEO, Ilkka Rantanen.

Additionally, the delivery of winterisation equipment to Asian shipyards has been successfully completed.

"The future looks very interesting and new implementation areas for the PolarPad-elements (a heating solution for marine and offshore use) and control systems have emerged from new markets," Rantanen adds.

Starkice Oy specialises in keeping critical areas ice-free and functioning properly in freezing conditions. www.starkice.com

Cooperation agreement with Aalto University

During the Arctic Passion Seminar in March 2017, Aker Arctic and Aalto University signed a co-operation agreement on the joint use of ice tanks for model testing and research purposes. The combination of two ice laboratories – Aker Arctic's 75 m long and 8 m wide basin and Aalto University's unique 40-by-40 m square tank – will result in improved capabilities particularly for manoeuvring and other operative icebreaking model tests. The co-operation also provides new opportunities for research in ice technology and provides the best capabilities for the ice model tests.

Discovery Canada at Aker Arctic

Discovery Canada visited Aker Arctic in June 2017 to film an ice model test of an icebreaking tanker.

Novyport tanker in ice trials

The first vessels of the series of six 42,000 DWT shallow-draught icebreaking shuttle tankers for Gazprom Neft are working transporting oil from the Arctic Gates terminal to Murmansk. The lead vessel, the *Shturman Albanov*, was tested in ice trials in April/May, last winter and fulfilled all design criteria. She also received the Polar Ship Certificate to certify that she complies with the requirements of the Polar Code, implemented from 1st January 2017 in the Polar areas.

Aker Arctic was involved in the development of these shuttle tankers. The hull form was developed in cooperation with Samsung Heavy Industries and the development work also included ice model testing at Aker Arctic's ice laboratory.

The series of six tankers has been engineered for year-round duty in the harsh Arctic environment and employs the double-acting principle and propulsion arrangements. The new shuttle tankers can independently break ice up to 1.8m thick by sailing stern-first, and up to 1.4m thick by proceeding bow first. In relation to their tonnage, the shuttle tankers are wide beam (34m), and have a comparatively shallow draught. The loaded draught has been limited to 9.5m due to the shallow waters in the Gulf of Ob, which is covered with ice from October to July. The ships are fitted with a special bow loading station for receiving oil at the offshore terminal.

Polar icebreaker for the United States Coast Guard

The United States Coast Guard launched an acquisition programme last year to replace two old heavy icebreakers with new polar icebreakers. Currently a U.S. Coast Guard Industry Study is taking place, with the aim to investigate different vessel options and make a design feasibility evaluation with today's modern icebreaker solutions.

The heavy icebreaker will be used for an annual resupply mission to Antarctica, where the icebreaker will open a channel through the Ross Sea ice pack and escort tankers and freighters to the world's southern-most harbour at McMurdo Station. The new polar icebreaker will also be used to support science missions in the Arctic and remain on constant stand-by for demanding search-and-rescue and marine environment protection operations.

There are five different consortia working on the proposals for the U.S. Coast Guard until February 2018. The shipbuilding proposals will be prepared during 2018 and the decision on where to construct the new vessels will be made in 2019. The first vessel should be delivered at the latest in 2023.

"The new polar icebreaker will need to manage long transits in open water, heavy seas and tropical heat, before breaking thick multi-year ice in freezing temperatures," says Mika Hovilainen, Aker Arctic.

U.S. Coast Guard photo by Petty Officer Patrick Kelley

Aker Arctic experts provided extensive conceptual development and design support for the medium icebreaker USCGC Healy, delivered in 1999. Healy is the United States' newest and most technologically advanced polar icebreaker.

Rowing race in the white summer nights

Aker Arctic's rowing club participated for the 29th year in a row in the Sulkava rowing event, held every July in Lake Saimaa in Finland. This year the rowing event celebrated 50 years of races as well as Finland's 100 years of independence.

Our rowing team after having successfully completed this year's race, from bottom left: Riikka Matala, Su Len Quach, Saara Matala, Jillian Adams, Jana Vamberova, Artur Nerman and Lauri Vesala. Top left: Tapani Pekkarinen, Sami Saarinen, Mikko Elo, Hannu Lipponen, Esko Voutilainen, Pekka Salmi, Kari Selonen and Göran Wilkman.

Sulkavan suursoudut is Finland's largest rowing event, held every July in Sulkava, Eastern Finland. The participants can race in teams, with long, old-fashioned, wooden boats, which people used for going to church in the old days. There are also other categories for single and couple-rowers, as well as kayaks and canoes.

"When my colleagues participated in the first race, they had no experience in rowing. They only wanted to have some fun in the summer," says Pekka Salmi, who retired from Aker Arctic in 2010 but still participates in the rowing team.

The top years of the event saw some twelve thousand participants, which has today fallen to about half. Also, the Aker Arctic team has varied over the years, and this year we had four newcomers in the team, racing for the first time.

"Nevertheless, we did well, 60 kilometres in 5 hours and 41 minutes," says Graphic Designer, Kari Selonen.

Salmi adds that the weather was lovely although there was a hard wind, as usual, on the longest stretch. "Traditionally, we join the night-race, which starts in the afternoon and ends around nine or ten pm."

Although the Sulkava rowing event is a race, the main point in participating is to enjoy the tranquillity and beauty of the Finnish nature, the landscapes surrounding the lake, the forests and the islands. July is also the best time of the year to experience the white summer nights when the sun is up most of the night.

Meet us here!

We will participate in the following events:

NEVA, St. Petersburg
19 - 22 September 2017

Arctic Shipping Forum North America, Montreal
30 October - 1 November 2017

Marintec China 2017, Shanghai
5 - 8 December 2017

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