Aker Arctic Technology Inc Newsletter

Arctic Passion News

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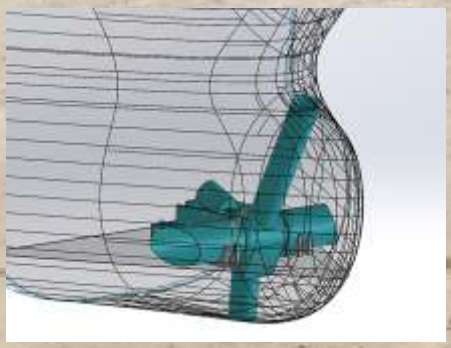


In this issue

Announcements

Veikko Immonen has been appointed Development Engineer in the Research and Testing department. Veikko will graduate this spring as a Mechanical Engineer from Aalto University School of Engineering, with a specialisation in mechatronics. The topic of his master's thesis was developing a new DP-capable ship model propulsion system.

Front cover:
Tommi Heikkilä from Aker Arctic joined the first Arctic Module Carrier on her sea trials in the South China Sea in January 2016. Read more about the successful trials on page 19.

Dear Reader,

During the past few years, the expectations and plans for developing the Arctic in terms of mineral and hydrocarbon production have been very high. The Arctic region and its development have received high-level attention both in business life as well as in public forums and national strategies. Expectations have been high as a huge source of business potential, although many companies already operating and doing business in arctic related works have been cautious in this “arctic rush”. This conservatism may today pay off, because evidently the low oil price has significantly changed the situation. Oil companies in particular have been forced to look for new strategies and have entered into significant cost savings in their operations. Even new investments into more low cost resources have been put on hold. Based on this, it is hardly likely that a new rush for oil resource development in the difficult conditions of the Arctic would take place any time in the near future.

The low activity in exploration and development of engineering for production facilities in the Arctic will naturally have an impact also in our area of development activities. One example is ice tank testing, which some years ago was dominated by platform developments. Today this activity is marginally low and almost all the testing is carried out for ships, although some offshore wind power energy projects bring new activity to the offshore segment.

Despite the fact that climate change will eventually result in less ice in sea areas that are today covered by ice, there will be a significant need for upgrading the world's icebreaker fleets, which are undoubtedly old. There are about 131 icebreakers or icebreaker type vessels today in operation, and their median age is 32 years. Icebreakers are long lasting ships, and many of them are used for up to 50 years even. Despite this we can conclude that in coming decades there will be a significant need to build new vessels to replace the old ones. We can already see this trend as building of new icebreakers is underway both in Russia and Finland, and also Canada and the US have started their plans for replacements. The Baltic Sea has been affected by warm winters with less ice, but icebreakers are still a necessity, and slowly the plans to replace the strong Atle/Urho class icebreakers (5 ships) are beginning in Sweden and Finland. Another interesting aspect in this is the modern development of low-powered energy-saving vessels, which will increase the work load of icebreakers, thus calling for sufficient capacity to ensure the practical and safe shipping services in wintertime.

IMO is implementing the Polar Code from 1st January 2017, which is a completely new regulation to cover the overall design and construction as well as environmental and operational aspects of polar shipping to ensure adequate safety standards. These regulations and requirements are already being taken into account and here we at Aker Arctic can utilise our long experience and knowhow to reach reasonable and practical solutions both technically and operationally. It has encouraged us to open new services, which are more targeted towards the operational use of the vessels. For example, our aim has been to create a training possibility with a realistic simulator and to provide a highly modern system for detecting ice-influenced loads on the ship hull. These products will result in safer and damage-free polar shipping, thus lowering the long-term cost for the shipowners.

You can read about these new services and many other topics in this issue of Passion News.

Reko-Antti Suojanen
Managing Director

Arctic Condensate Tanker for Yamal LNG

Aker Arctic has developed the concept design for an Arctic Condensate Tanker and has signed a design licensing agreement with Guangzhou Shipyard International (GSI). We have now proceeded to model testing and basic design. The vessel, which is intended for delivery in 2017 will be used to transport gas condensate from the Yamal LNG production site in the Russian Arctic to Europe and Asia.

There are not many tankers in the world with an Arc7 ice class.

Yamal LNG is a natural gas project with the majority shareholder Novatek, an independent Russian gas producer, and minority shareholders from France and China.

The vast gas reserves are located in the northern part of the Yamal peninsula in the Russian Arctic. Most of the year, the climate is cold and the waterways are frozen. The temperature may drop to -50°C. The liquefied natural gas (LNG) plant and the port of Sabetta are currently under construction on the coast of the Ob Bay.

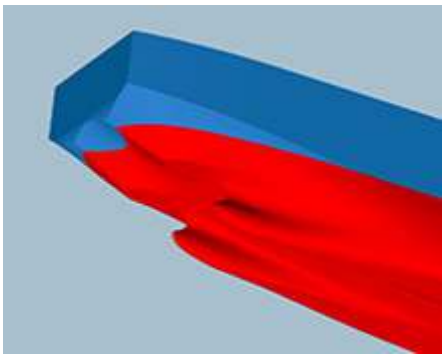
The gas condensate tanker, will be used for transporting gas condensate, the by-product which is fine oil separated from the natural gas before its liquefaction process. This product is a low-density mix of light oils and is a valuable raw material for the petrochemical industry or as fuel.

Aker Arctic and its predecessors have been working with the Ob Bay projects already since 1995, beginning with initial ice research and then undertaking two test voyages to Sabetta in 1995 and 1998, and later on with development work, research and planning for how to solve the transport needs from Sabetta. From 2010 onwards Aker Arctic was involved in the design development of the LNG-carriers for export of the natural gas, participated in the planning of Sabetta port as well as designed the icebreakers needed to ensure safe, reliable and efficient operations in the area.

Two years ago, Aker Arctic designed two Polar-class heavy cargo carriers, of which the first was completed in the beginning of 2016 and began transporting construction modules for the LNG plant from Europe and Asia.

Gas condensate tanker

Due to the harsh environment and long lasting severe winters in the Russian Arctic, the gas condensate tanker has to be specially designed in order to secure safe transportation of the gas condensate throughout the year. Additionally, the condensate production diminishes over time. Therefore, the tanker has been designed so that, in the future, it is capable of transporting other oil products as a product tanker.

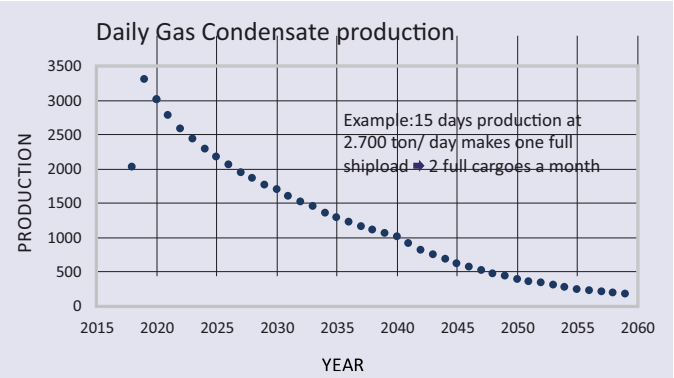


The hull form is new with a round-shaped twin skeg aft hull. Model tests have shown that such an aft hull form will work well in the harsh circumstances the vessel will be sailing in.

The “Aker ARC 212” design is planned to be 214 m long and 34 m wide. It can transport almost 60,000 m^3 gas condensate or oil cargoes in five cargo segregates. It has a moderate ice bow and is designed on the Double Acting Ship (DAS®) principle, sailing bow ahead in open water or light ice conditions and ▶

stern first in heavy ice. Its propulsion is based on diesel-electric machinery with two azimuth propulsion units. The hull form is a new type with a round-shaped twin skeg aft hull. Model tests have shown that such a hull form will work well in the harsh circumstances the vessel will be sailing in and will improve performance in open sea conditions as well. Due to year-round operations in the Arctic area, the hull is ice-strengthened to a high ice class Arc7 according to the Russian Maritime Register.

Gas condensate production diminishes over the years and therefore the vessel has been designed to carry also other cargoes in the future.



Two test voyages to Sabetta with the ice-strengthened tanker MT Uikku were carried out in 1995 and 1998.

With the large Arctic LNG-carriers leaving Sabetta port every second day year-round in the future, the gas condensate tankers can also utilise the broken ice channel the carriers create.

"There are not many tankers in the world with an ice class this high," says senior designer Mauri Lindholm, Aker Arctic Technology Inc. He adds that the reference vessels for this design are the two 70,000 tdw tankers for the Prirazlomnaya project, designed for Sovcomflot some ten years ago. The new gas condensate vessel, however, has a higher ice class and her cargo capacity is smaller.

"When we began the design task in early 2014, the plan was to construct one larger vessel. Nevertheless, during the process it was decided that two smaller vessels would be better for the future, in view of versatility and redundancy."

Main dimensions:

Length	214 m	Cargo and slop tanks	59,800 m^3
Breadth	34 m	Service speed	13.0 knots
Draught design	11.7 m	Propulsion units	2 × 11 MW
Draught ice	12.0 m	Main diesel generators	31.36 MW
Draught scantling	12.9 m	Ice class	Arc7 (RMRS)
Deadweight	43,400 t (with condensate cargo)	The tanker will have dual classification provided by Bureau Veritas (BV) and Russian Maritime Register of Shipping (RMRS).	
	49,700 t (with oil cargo)		

First LNG-carriers under construction

Aker Arctic's co-operation with Yamal LNG included the design development of the LNG-carriers for exports of the liquefied natural gas (LNG) to the market. The 170,000 m^3-sized vessels are currently being constructed at Daewoo Shipbuilding & Marine Engineering (DSME) in South Korea.

The first one of fifteen vessels was launched in January and is expected be ready in the end of 2016. The remaining fourteen vessels are scheduled for delivery over the next four years. Aker Arctic has been supporting DSME in the design work.

Once the LNG plant is in full production, a large LNG-carrier will leave Sabetta port every second day year-round and deliver LNG to Asian and European ports, where it will be stored for consumption or reloaded and shipped further with ordinary LNG carriers.

New contracting service for shipbuilding

A new contracting service, where Aker Arctic takes full responsibility for ordering and delivering special components and systems for ice-going vessels from selected partners, is now available for shipbuilders.

When planning vessels and special constructions for ice conditions, technical expertise is necessary to understand the technical requirements of the components and systems. At Aker Arctic, we have many employees with a shipyard background, and therefore with extensive know-how in building ships and specifying requirements to material suppliers.

"We have noticed that our customers value this technical know-how combined with the delivery and commissioning of the actual component. Therefore, we have started a few pilot projects to develop this service," Kari Laukia, head of ship design and engineering, explains.

"The idea is to use selected partners to manufacture the components. Then we take full responsibility for the design, delivery, installation and/or supervision and finally commissioning, with the final scope depending on the customer's needs. We guarantee that the component will work in the challenging ice conditions it is designed for," Laukia says.

These services are particularly intended to complement our own design projects with demanding material deliveries but are also available separately.

"The first pilot projects are underway. We are now developing this service, deepening our cooperation and fine tuning our working methods. Our plan is to incrementally add more products to the portfolio we can offer our clients," Laukia adds.

Propeller delivery service

Aker Arctic delivered the propellers for the arctic module carrier and supervised the installation.

We have a profound understanding of propulsion concepts. When we design vessels, we also have to make sure that the chosen propulsion system fulfils the performance requirements. Taking care of delivering the propellers and/or shaftline components for vessels we have designed is therefore a natural extension of our service.

We take responsibility of the entire delivery process and our partner suppliers manufacture the propeller; e.g. by combining our vessel design with the propeller delivery, our customers can benefit from assured quality as well as cost efficiency.

"Our pilot project last year was delivering the high ice class propellers to the arctic module carriers, and that went very well," Laukia says. Read more about the project on page 7. ▶

Bridge service for ice vessels

The command bridge of an ice going vessel requires some additional design aspects compared to an open water vessel. In our normal design work, the bridge design is at a concept or basic design level, which means that there are still interfaces the shipyard needs to subcontract or do on its own. By going deeper into details in the bridge design, we can provide cost savings for the shipyard.

We can also deliver the necessary equipment as we cooperate with many suppliers. The equipment and design package can include plans for classification and the shipyard for the navigation and communication system, signalling equipment, consoles, lighting, interior, HVAC, preliminary steel construction plans for wheelhouse and mast, bridge windows and wipers. The key idea is to include the bridge as an ongoing, unbroken process from early concept all the way to the finalised vessel. User feedback helps us to enhance future bridge design and supplies and is important throughout the entire process. Installation and supervision are also available as an option.

We can provide cost savings for the shipyard by taking detail design into account already during the concept phase and utilizing standard solutions when possible. We can also deliver the necessary equipment as we cooperate with many suppliers.

The simulator we have developed for simulation of ice operations and vessel behaviour in ice is a very useful tool in the detailed planning of the bridge. It can also be used to test a ship design in operational simulation, and even in ice conditions.

On-site support in construction

We always support shipyards that build the vessels we have designed to ensure correct construction solutions and to avoid mistakes. Now, we are taking this support one step further by providing a support person on-site during construction. This person will focus on ice and cold related matters, which need special attention to achieve the required quality, and ensure that the design details are kept during production phase.

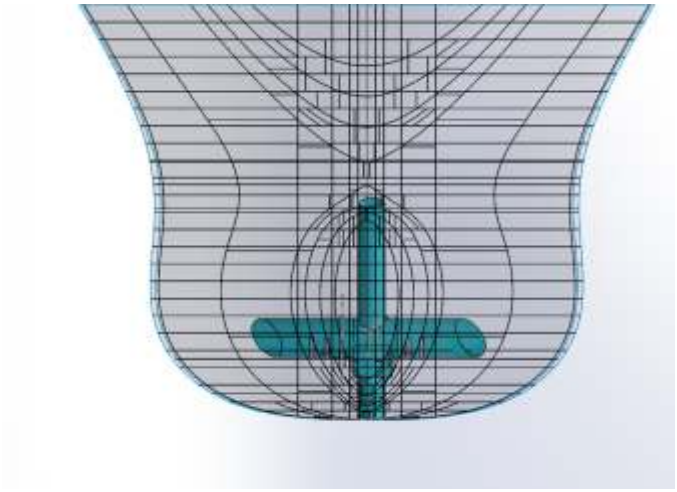
"The higher the ice class and the lower the design temperature, the more details there are that need to be done in a certain way. This service is especially important if a shipyard is building an ice vessel for the first time," Laukia emphasises.

The support service is, for instance, currently being provided to the Piriou Shipyard in France, which is building a new polar supply vessel (see page 9). We have agreed to provide on-site support during the construction period.

Bow Flushing System

Environmental demands keep growing all the time. Aker Arctic has developed a new auxiliary system, the Bow Flushing System (BFS), which decreases ice resistance in ice channels for certain hull forms, consequently lowering the propulsion power needed to maintain the vessel's original speed. This can be an advantage for instance for vessels of lower ice-class which are affected by the Energy Efficiency Design Index (EEDI).

Alternatively, when EEDI is not an issue, the vessel's speed can be increased while using the original propulsion power, thus enabling the possibility for increased earnings. In harbours it is used as a normal side thruster, but in channel ice it becomes a vertical thruster. Bow form and bulb design must be done taking into account the BFS system in order to achieve best efficiency.



Located in the bow of a vessel, Aker Arctic's new auxiliary system, the Bow Flushing System, decreases ice resistance for certain hull forms, lowering the propulsion power needed.

The simulator we have developed for simulating ice operations and vessel behaviour in ice is a very useful tool in the detailed planning of the bridge.

The Aker Arctic designed module carriers are equipped with propellers we have custom-designed for them.

Propeller delivery for Arctic Module Carriers

Aker Arctic took full responsibility of delivering the propellers for the two Polar-class heavy deck carriers constructed at Guangzhou Shipyard in China. The propeller delivery service was successful and fulfilled the customer's high quality and short delivery time requirements.

The first one of the two Aker Arctic designed Polar-class heavy deck carriers is already in use and busy transporting construction modules to the arctic LNG plant being built in Sabetta.

Special propellers

The customer trusted us with the delivery of the propellers. Our partner in Russia, Zvyozdochka, manufactured the propellers based on Aker Arctic's design. The installation was then done at Guangzhou shipyard under our supervision.

"We were fully responsible for the vessels' propellers," says Kari Laukia, head of ship design and engineering at Aker Arctic.

"These propellers are very special as they are suitable for extremely demanding use in heavy ice conditions. They were part of our design work, and therefore we could take responsibility that they would work as they should," Laukia adds.

The vessel's successful sea trials were conducted in January where all the requirements were met.

The benefit for the customer was to get high quality custom-designed propellers within the agreed delivery time in the extremely tight construction schedule.

"We have very good partners and suppliers that we have worked together with for many years and, in addition, a demanding customer. That is the best recipe for success," Laukia says.

High quality solution

"The design and delivery of these special high ice class propellers in a tight schedule showed the quality and how effectively we work. This service is something we offer in selected vessel projects where there is a clear benefit to our customer to use a combined service package. Our expertise in propulsion design combined with our vessel design guarantees our customers a high quality and cost-efficient solution."

The propellers are very special as they are suitable for extremely demanding use in heavy ice conditions.

Chinese research icebreaker soon ready for construction

China has four permanent research stations in Antarctica (The Great Wall, Kunlun, Zhongshan and Taishan) and one in the Arctic (Arctic Yellow River Station)

The highly advanced polar research icebreaker for China is now in its final design phase and will soon be ready for construction. Aker Arctic was awarded the concept and basic design in 2012.

The Polar Research Institute of China has selected the main equipment suppliers for its advanced research vessel. Aker Arctic is expecting to complete the basic design before autumn this year. Construction will begin later this year when the shipyard has been selected.

Once the vessel is ready, its main task is research operations in polar areas. Scientists will be able to move independently to and from Antarctica where China has three permanent research stations, as well as perform advanced scientific research on the ship, which is fitted with all the necessary equipment. The vessel is also able to operate in the Arctic.

Modern solutions

All the technical solutions chosen both for the vessel itself and for research purposes represent the most modern available. It is fitted with scientific equipment and instruments for marine geological and geophysical research, marine biological and ecological research as well as climate change monitoring, marine and seismic surveys. There is plenty of laboratory space reserved and the researchers can make use of a moon pool when operating in ice conditions.

The vessel will be able to break 1.5 m level ice with a 20 cm snow cover. This can be performed in both ahead and astern directions. It is fitted with diesel-electric machinery and two azimuthing thrusters. Two bow tunnel thrusters are provided for manoeuvring and position keeping. The power generation station consists of four main diesel generator sets. Propulsion power is 2 x 7.5 MW and there are two skegs protecting the propulsion machinery from multi-year ice blocks in the aft ship. The vessel can advance 12 knots with one engine, 15 knots with two engines, and all four engines can be used as needed in ice.

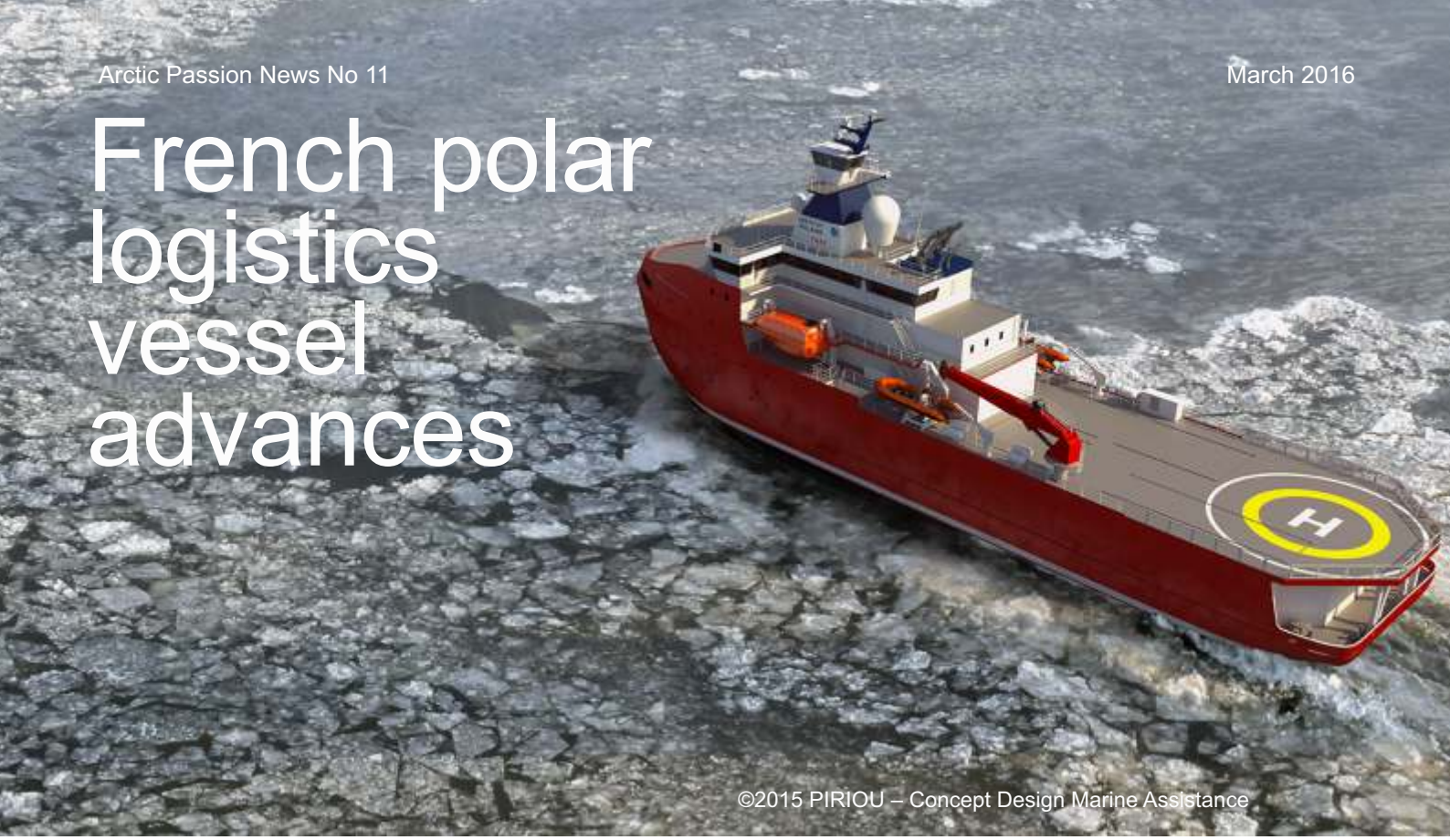
There is a cargo crane for efficient cargo handling, large cargo spaces in the bow and cargo fuel tanks. Also, a helicopter landing area and a hangar is provided. The vessel additionally fulfils the low noise requirement for research vessels.

"This research vessel has cutting-edge solutions and is easy to operate in both open water and demanding ice areas, where it can operate independently. It is expected to be ready in 2018," says Kari Laukia, head of ship design and engineering at Aker Arctic.

Technical details:

Length over all	122.5 m
Length on design water level	117 m
Breadth max	22.3 m
Draught at design waterline	7.85 m
Draught max	8.3 m
Depth to main deck	11.8 m

French polar logistics vessel advances



The French polar logistics vessel is both a transport vessel and a patrol vessel.

Construction of the polar logistics vessel for France will begin this spring. Aker Arctic is supporting the shipyard also in the ship construction phase in the special requirements of an ice-strengthened vessel.

The design work and model testing have been completed for the new French polar logistics vessel, which will replace the existing vessels, L'Albatros and L'Astrolabe, and construction work is about to begin.

The steel hull will be constructed at CRIST in Poland starting this spring and then transported in autumn 2016 to the shipyard in Concarneau, France where it will be outfitted and finalised. The vessel is planned to be ready in summer 2017 so that it can sail to Antarctica when summer arrives to the southern hemisphere.

The first trip will be to France's research station Dumont d'Urville in Adélie Land and then the ship will continue to the Indian Ocean. The vessel will be based on Reunion Island and operate as a patrol vessel in the Indian Ocean. The French Navy will provide the crew for the new vessel, as the ship has patrol duties in addition to logistics tasks.

Support in construction

Aker Arctic is providing the shipyard with building time support spanning over the entire construction time in short periods at a time.

"Our engineers will stay on-site and supervise the work and give technical support during one or two weeks whenever there is a new phase in the construction," project manager Heikki Sipilä explains.

The Aker Arctic support focuses particularly on the vessel's construction and equipment so that winterisation, i.e. performance in freezing conditions, meets the set requirements.

"This is one of our services, which we can offer to customers building ice-going vessels. By combining our design and technical expertise with construction support, the customer can rest assured that all winterisation aspects are taken care of," Sipilä emphasises.

For the shipyard in France, this is an interesting project as they will be able to build an ice-strengthened ship with many special features. The demanding Antarctic conditions require, for instance, thicker materials of special quality than what is the case in ordinary vessel projects. This allows the shipyard to gain new experience and increases the possibility to participate in similar projects in the future.

Multi-purpose vessel

The owner of the ship provided the vessel concept. Aker Arctic then continued and finalised the design so that the ship would fulfil necessary performance in ice.

"Our design work consisted of our normal expertise such as developing the hull form and model testing it in both open water and ice in order to verify requirements," Sipilä outlines. "We also performed sea-keeping tests to make sure that the vessel can manage in the rough sea conditions of the southern Atlantic. Additionally, we planned the machinery and winterisation aspects."

The multitude of activities possible with this ship makes it very special. It can transport researchers to and from Antarctica. Furthermore, it has plenty of cabin and cargo space, a helicopter landing area and it can carry a helicopter in the cargo space. The rear is equipped with an A-frame that can be used to lower research tools into the sea. The icebreaking capability is 80 cm level ice.

"It is a logistics support vessel and a patrol vessel simultaneously," Sipilä says.

Main dimensions

Length	72 m
Beam	16 m
Draught	5.2 m
Deadweight	1,300 tonnes
Open water speed	14 knots
Propulsion power	6.4 MW
Ice class	BV Icebreaker 5

Full-scale trials for R/V Sikuliaq

Last winter, AKAC performed full-scale trials of the research vessel Sikuliaq in the Bering Sea to conduct ice operational training of the officers and to identify the ice operational performance and limits of the vessel. Juha Varis, an experienced Finnish icebreaker captain, assisted with the hands-on training.

The Sikuliaq has a suite of on-board sensors and equipment to allow it to perform a number of science missions in ice.

Sikuliaq is a research vessel based in Alaska. It is owned by the National Science Foundation and is operated by the School of Fisheries and Ocean Science at the University of Alaska Fairbanks. Its intended area of operation is year-round in the Bering Sea, and seasonal operations in the Beaufort and Chukchi Seas. It is designed to break 76 cm (2½ ft) thick first year winter ice continuously at 2 knots.

Prior to the full-scale trials, AKAC developed an Ice Operations Manual for the vessel, which included developing guidelines for conducting science operations in ice including towing operations and deployment science equipment over the side in ice. The operational experience and performance data obtained from the trials was used to revise the manual.

Part of design group

"We were also part of the design group for the vessel long before it was built," says Mike Neville, head of AKAC's St. John's office in Canada.
"It was AKAC's responsibility to develop the design for the purposes of enhancing its operational capabilities in ice. During the design process, the Sikuliaq was model tested several times, including in 2002 at Kvaerner Masa-Yards Arctic Technology Centre (prior Aker Arctic facility) and also in 2009 by Aker Arctic's new test facility."

Another part of AKAC's role was also to introduce new arctic marine technologies and methods to achieve an independent capability to conduct various science missions in ice. The vessel uses advanced azimuth thruster technologies, which increase its ability to operate independently in ice, and applies azimuth thruster wake to expand its science capabilities in the presence of ice.

Main dimensions

Length Overall	79.7 m
Maximum Beam	15.8 m
Draft	5.8 m
Displacement	4,066 tons
Propulsive Power	2 × 2,238 kW Wärtsila Icepod thrusters

Meet Mike Neville

Mike Neville is a Naval Architect with AKAC (Aker Arctic Canada). Having worked with AKAC during his undergraduate degree in 2006 and 2007, Mike started working fulltime with AKAC in 2010 as head of the St. John's NL office. Since receiving his Bachelor's Degree in Ocean and Naval Architectural Engineering at Memorial University in Canada, he has worked exclusively on arctic marine and ice offshore related projects, including technical feasibility and concept design studies, ice model tests, full scale trials and ice management operations.

In his free time, Mike likes to spend time outdoors camping, fishing and hunting. He also enjoys travelling.

Most advanced port icebreaker in the world

The port icebreaker Aker ARC 124 will assist large LNG carriers in approaching and berthing in Sabetta.

With two pairs of thrusters, the icebreaker will be moving extremely well in the harbour basin in Sabetta.

The port icebreaker Aker ARC 124, ordered to support LNG-carriers' operability in Sabetta harbour in the Russian Arctic, will have state-of-the-art technical solutions.

Basic design is now in process for the port icebreaker Aker ARC 124. Both ice and open water model testing has been completed, confirming the vessel's performance. Design work will be completed in June and construction is planned to begin this summer at Vyborg Shipyard PJSC in Russia.

Cutting-edge technology

The technical decisions made for this vessel are new, modern and cutting-edge.
"What is special in this icebreaker is firstly the propulsion solution," says project manager Mika Hovilainen. The vessel has four thrusters, two in the bow and two in the stern.
"Manoeuvrability has been taken to a new level with two pairs of thrusters. The icebreaker will be very capable in the harbour basin in Sabetta when it is assisting large ships in berthing. Additionally, the propellers will be efficient in flushing the ice away when cleaning the quayside from ice," Hovilainen adds.

The icebreaker will also be competent in the worst possible situation, when the brash ice level grows to several meters thick. Brash ice is created every time a vessel breaks ice. The pieces mix with cold water and freeze again. As there will be frequent traffic in the Sabetta harbour, an increasing amount of brash ice will be created, making navigation extremely difficult.

"The second special feature of this ship is the new direct current electrical system developed by ABB," Hovilainen says. The system, Onboard DC Grid, consists of rectifiers that convert the alternating current from the diesel-driven main generators to direct current. This is then fed to two DC drive line-ups that convert it back to alternating current for propulsion units and other onboard consumers. In Aker ARC 124, each DC drive line-up provides power for one propulsion unit in the bow and one in the stern and full load for auxiliary consumers.

The Onboard DC Grid offers several advantages over the conventional AC systems that have been used in diesel-electric icebreakers since the 1980s. Firstly, the system allows the main diesel generators to run at variable speed rather than fixed speed, reducing fuel consumption and emissions when the power plant runs at partial load. Secondly, the system allows running the harbour generator parallel to the main engines without limitations. Finally, the equipment is somewhat smaller and lighter than the conventional frequency converter setup, an advantage to the designer.

New engine type

Aker ARC 124 will be the first vessel in the world to feature Wärtsilä's new 31 series main engines, recently acknowledged as the world's most efficient four-stroke engine type. The main power plant will consist of three 8-cylinder Wärtsilä 8V31 main engines. The installation will also include Wärtsilä's online engine monitoring, thereby enabling the operating condition of the engines to be closely followed remotely.

"The new engine type has improved fuel economy, especially on lower speeds. This is achieved because the optimal speed range is wider than other engines," Hovilainen says.

An additional characteristic of the newly introduced engine is that it will feature a new approach to maintenance. The first major service required by the Wärtsilä 31 comes only after 8,000 running hours (compared to 2,000 running hours for engines of a similar class). This improvement reduces maintenance costs as well as increases the vessel's uptime availability. Its modular design also allows parts to be removed and replaced, thus simplifying service.

"Our propulsion solution brings energy efficiency, lower power needs and savings in operational costs as a result," Hovilainen emphasises.
"The electrical and engine solutions also aim to lower operational costs and decrease emissions, thus resulting in both a powerful and more environmentally friendly port icebreaker."

More possibilities in model testing

With the latest improvements to our model testing facility, more complex testing options are now available both for our customers and our own research and development team.

Over the past two years, we have been developing a system for testing Dynamic Positioning (DP) in ice. In order to be able to do all the tests desired, some of the equipment in our model testing facility needed upgrading. All the necessary improvements are now completed, which has opened up new possibilities in model testing.

"The biggest mechanical change is that the propulsion motor for azimuth thrusters is now under water as it is in the real world," says development engineer Veikko Immonen, who is responsible for the technical development. This reduces the number of moving parts and enables a cleaner torque measurement from the motor, allowing for more accurate real-time power control.

"Another big change is that we now have fully controllable tunnel thrusters. Until now we've had no need of them in our testing, but for DP testing, they are essential – given that the real vessel has them, of course."

"On the technical side, we have opted for state-of-the-art vector control for the brushless permanent magnet electric motors. Additionally, the azimuth movements are now computer controlled by using a closed-loop stepper motor system," Immonen explains.

New internals for azimuth thrusters

Modular principle

Each propulsion unit contains an independent microcomputer. They are all connected to a common CAN bus with the master controller module. All commands and measurement values are transmitted through the bus, which makes connecting multiple thrusters easy to do. This is good for DP vessels, as they can have many – for example drillships with six azimuth thrusters are already in operation.

"Previously, we had a limitation on how many thrusters we could put on a model. These limitations are now history, I suspect we'll physically run out of space on a model before the control system's limits are reached. If you can build it, we can test it," Immonen assures.

A DP system needs good quality GPS and gyrocompass signals to operate. Since the required accuracy is measured in millimetres in model testing, using an actual GPS is not an option.

"We had to fake a GPS signal using data from our infrared camera positioning system. We also fake a gyrocompass using that same data. The actual DP software is exactly the same that runs on real vessels."

A view of the DP control station.

A DP controlled model fending off ice floes coming its way

DP tests in ice

A DP system helps a ship to automatically keep its position. External forces such as wind, current and waves are counteracted with the thrusters and propellers. The problem arises when ice is present, because the forces involved are an order of magnitude higher, sudden and difficult to predict.

"The equipment in our model testing basin will be used to find the situations where DP does not perform well in ice. Our aim is then to find new algorithms or improve existing ones to enable the DP system to respond to ice forces in such a way that DP operation in ice is reliable," Immonen outlines.

Sometimes a vessel does not need full DP certification, but the thruster configuration is such that it is difficult to control the vessel manually. The vessel can then have an autopilot system that is technically similar to a DP system but without some of the strict requirements of DP. With our new equipment, we can test autopilot systems as well.

"All the improvements made for DP open the way for other advanced tests. This also enables new possibilities for multi-model testing," Immonen adds.

Meet Veikko Immonen

Veikko Immonen is tasked with technical development projects for the model testing facility. He is also involved in developing the ice simulator and the ice load monitoring system. Veikko has worked as Development Engineer at Aker Arctic since July 2014. His master's thesis for Aalto University concerned upgrading the model propulsion system for DP operation.

Veikko likes long bike rides and does not mind pedalling in cold weather or through snow. In summer, he likes to spend time on a certain island in the Saimaa Lake district.

Ice management prediction tool updated

Over the last few years, AKAC has been developing an ice management prediction tool to a commercial level, called AKAC Ice Management Suite (AIMS). The latest version of AIMS has been enhanced to include a wide range of ice conditions from low concentration to heavy ice pack, and is applicable for a variety of vessel types including ice classed supply vessels and icebreakers.

The first version of AIMS was developed for a commercial client in 2013. The initial version was considered suitable for ice management predictions of ice-breakers for operations in heavy pack ice.

However, it appears that the industry's initial steps into the arctic offshore will focus on dealing with season extension operations in sub-arctic regions, where open water is common and pack ice may only occur occasionally, and typically in lower concentrations. For such conditions, vessels with an ice class but otherwise an open water hull shape are preferred over icebreakers as they are less expensive, are in greater supply, and have better seakeeping characteristics.

An example of such a region is the Grand Banks, located southeast of Newfoundland in Canada, where sea ice is not experienced on an annual basis, and when it does, the ice is not winter ice strength but rather deteriorated. Therefore, typical standby and supply vessels used on the Grand Banks have a relatively low ice class but otherwise an open water hull shape optimised for efficient operations in heavy seas.

Low concentration ice conditions

Recent interests motivated AKAC to update AIMS to allow for ice management predictions in lower concentration conditions, and to consider ice management performance with low ice class vessels. Thanks to a recent Joint Industry Project (JIP) completed earlier this year, the most recent version of AIMS incorporates the physical management of low concentration ice conditions using low ice class supply vessels.

In the JIP, a key focus area where AIMS was updated was the ice management logic used for managing severe ice features in relatively low ice concentrations. For example, the use of pre-ice management, which is an effective tactic used in practice to physically manage potentially hazardous ice features such as large floes prior to the arrival to the operational site, was incorporated to the logic.

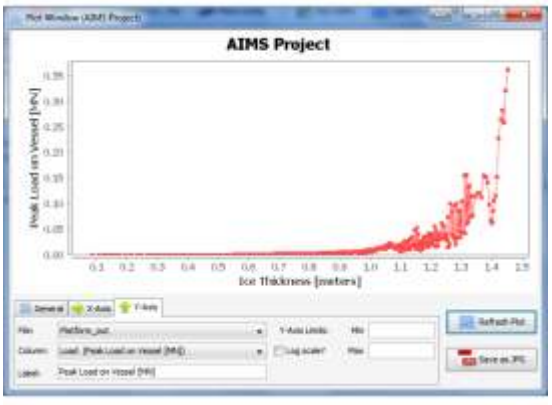
Ice class is not enough

A common misunderstanding is that selecting a vessel of a particular ice class guarantees a vessels performance. However, ice class rules provide little assurance regarding the ability for a vessel to perform ice management. In fact, the structural limitations of a vessel operating in ice is the only distinction between the ability of different ice class vessels to perform ice management. Therefore, selecting a vessel for ice management duties based on ice class alone does not automatically yield an optimum ice management vessel.

As part of the updated AIMS work, AKAC implemented a vessel performance algorithm based on both the attainable performance and the safe operating speed in a given environment. This includes incorporating models to predict the performance of ice class vessels with different hull forms, including bulbous bows and vertical stems, and a safe speed model to limit the speed of the ice management vessels. This upgrade to AIMS will improve its applicability for ice management fleet selection studies, to ensure that the vessels selected have sufficient capability from both a performance and structural safety perspective.

AIMS is both commercially available for license as well can be applied on a project-by-project basis to assist clients in selecting the right assets for their projects.

AIMS is a software package for calculating the station keeping performance of floating ship shaped platforms with the influence of ice management. It has now been enhanced to include a wide range of ice conditions from low concentration to heavy ice pack, and is applicable for a variety of vessel types including ice classed supply vessels and icebreakers.



AIMS has a graphical interface designed to be operated on a Windows PC. The interface is easy to use by someone with an understanding of ice management concepts.

Text by Mike Neville, head of St. John's office in Canada.

AKAC (Aker Arctic Canada) is the Canadian arm of Aker Arctic's activities. AKAC specialises in tailored solutions for offshore operations in ice conditions and complements Aker Arctic's icebreaker and offshore design expertise. Aker Arctic Canada has operations in Victoria and St. John's.

Ice load monitoring and prediction helps in decision making

The oblique icebreaker Baltika has been equipped with sensors, which measure ice loads.

Aker Arctic has developed an ice load monitoring system to assist the navigator to monitor ice loads against the vessel. A new feature is a prediction tool, which will forecast if there is risk for ice damage and are the ice loads increasing or decreasing. This will be very useful in real-time decision-making.

The ice load monitoring system measures ice loads against a vessel. The results are displayed immediately on a monitor for a clear overview of the magnitude of the load, peak values and most importantly, what is the outlook for the ice load and how large is the risk of ice damage in current conditions. Based on this information, the vessel's captain can make the decision to continue, change heading, slow down or even stop entirely so that the vessel is not damaged from the ice.

Sensors gather information

"We use different sensors which are attached to the vessel's hull," explains Antero Jäppinen, electrical systems specialist at Aker Arctic Technology and responsible for developing the ice load monitoring system.
"When ice loads are encountered, the sensors register the pressure and send the information to the monitoring system. Part of our job is to find the optimal location for the sensors so that the measurements are accurate."

Based on the information gathered by the system, we can offer the owner a season analysis where we analyse the ice load pressure and vessel data over the entire season. This is especially useful if the ship has been damaged and the owner wants to know how it has happened and learn to avoid damages in the future.

On-line monitoring

Another new feature will be online monitoring. This means that, depending on a vessel's communication system, we can monitor system condition and send warnings if necessary. Previously, the measurement data has only been available later when somebody actually has collected the hard drive from the ship.

"The possibility to forecast ice loads is really important," Jäppinen emphasises. "When you drive into an ice field and the vessel is designed to manage a certain load, it is a crucial information to know how the ice load will develop. Is it likely that it will increase, can the vessel continue, should speed be lowered or course changed, or should the vessel stay still and wait? Based on the prediction, the captain can make informed decisions."

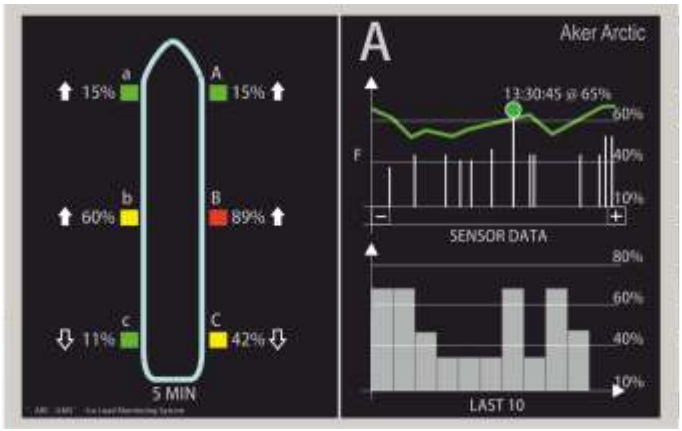
"The ice load monitoring system is currently available. We have already used it to measure ice loads on vessels such as the oblique icebreaker *Baltika.*

Measurements and analyses are part of our expertise. What we are now improving are the algorithms for the load prediction and the user interface. Our aim is that the improved system is ready for actual use in early autumn."

Aker Arctic Technology Inc and Light Structures AS have signed a cooperation agreement when working exclusively with fibre-optic sensors. Light Structures has a long experience in fibre-optic sensor and measurement technology. Our package can be offered as part of Light Structure's scope and vice versa.

The benefits of the ice load monitoring system:

- season analysis of measured data
- allows use of various sensor technologies
- ice loads forecasting function
- online monitoring and warning



The ice load monitoring system is a very useful tool for predicting ice loads on a vessel. It will help the captain to make informed decisions.

Meet Antero Jäppinen

Antero Jäppinen joined Aker Arctic last year as specialist in electrical systems at the Engineering department. He was previously at Edec Oy, where he worked 10 years as project manager in electrical design projects. Antero also has a solid background in shipbuilding from working twelve years at Helsinki Shipyard, Kvaerner Masa Yards.

In his free-time, Antero is involved in a wide range of activities. Apart from spending time with his wife and two children, being a radio amateur and a technical delegate for the Finnish Red Cross international delegate reserve, he likes to repair old machines and equipment, work in the garden and forestry.

Polar Code begins in 2017

The International Maritime Organization's new Polar Code comes into force in 2017. The Polar Code contains new certificates, technical requirements and procedures, which have to be complied before entering the Polar waters.

The new compulsory requirements take into account the vessel's structural integrity in ice, technical operability in cold environment and include also requirements for training of the crew and for ship's operation manuals. They will apply for new ships keel laid after 1 January 2017 and for existing ships at their first intermediate or renewal survey after 1 January 2018.

New terminology

Polar **S**hip **C**ertificate (PSC) defines where and when a ship can operate. It is a document approved by the flag authority and issued after survey.

The contents of the certificate include the category of the ship (A, B or C), the ice class including possible operating drafts and **P**olar **S**ervice **T**emperature (PST). A chapter for operational limitations is included referencing maximum ice conditions, minimum temperature and maximum latitude for safe operation.

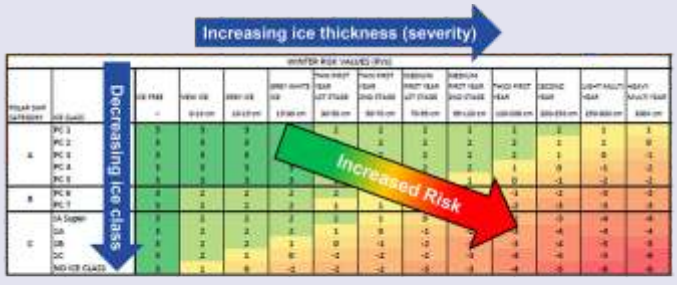
The operational limitations will be connected to the POLARIS system (**P**olar **O**peration **L**imit **A**ssessment **R**isk **I**ndexing **S**ystem), which is a tool for the master to evaluate the risk in operation based on the prevailing ice conditions. It links the ice class and the actual ice conditions. The basis for the ice conditions evaluation is the WMO (**W**orld **M**eteorological **O**rganisation) "Egg Code". The POLARIS system is still under development at IMO but is expected to be ready this year.

An important part of the Polar Code is the PWOM (**P**olar **W**ater **O**peration **M**anual), which provides the owner, operator, master and crew with information regarding the ship's operational capabilities and limitations in order to support the operations in the Polar waters (see next page).

We can help

Each of these documents requires expert knowledge of ship designs and their operation in harsh environment. Aker Arctic has the required experience and know-how to assist ship owners and operators to comply with the various requirements of the Polar Code. These services include ship design, crew training and documentation services.

POLARIS links risk level to decision making



Risk values depend on ice type and ice class. Source IMO.

RIO_{limit}	Ice classes PC1-PC7	Ice classes below PC 7 and ships not assigned an ice class
RIO ≥ 0	Normal operation	Normal operation
-10 ≤ RIO < 0	Elevated operational risk	Operation subject to special consideration
RIO < -10	Operation subject to special consideration	Operation subject to special consideration

Evaluation criteria for independent operations. Source IMO.

The World Meteorological Organisation (WMO) has developed standards for sea ice charting and observations. The standard format of "egg code" will be used for ice reporting worldwide. It provides information on ice concentration, type of ice and ice floe size. Available ice data from the Canadian Ice Service, the US National Ice Center, the Arctic and Antarctic Research Institute and the Danish Meteorological Institute will be used.

Through a basic calculation procedure from the ice chart and the assessment of a vessel's risk values, the **R**isk **I**ndex **O**utcome (RIO) will tell whether or not to proceed in the actual situation. The **R**isk **V**alues (RV) are a function of ship ice class, season of operation and state of the operation (independent operation or icebreaker escort). A positive RIO indicates acceptable risk (proceed) whereas a negative RIO indicates unacceptable risk (reassess situation).

Polar Water Operations Manual in process

One of the demands in the Code for Ships Operating in Polar Waters (Polar Code) is that all vessels are required to have a Polar Water Operations Manual (PWOM) on board the vessel. We are now developing the manual so that we can offer this service to our customers.

The vessel specific Polar Water Operations Manual (PWOM), required from January 1st, 2017, provides the owner, operator, master and crew with information regarding the ship's operational capabilities and limitations in order to support the operations in the Polar waters.

"We are now developing the manual based on the model table of contents," says Maximilian Vocke, project manager at Aker Arctic.
"The manual will vary according to the type of vessel, what ice class the vessel has and where the vessel is operating, as it needs to be adapted to the area of operation."

Part of design package

"Our core know-how is arctic vessels. We know thoroughly how to operate them, we know the ice circumstances in different areas and can predict how it is most useful to operate a vessel in ice, in addition to winterisation needs," Vocke explains.

"Based on our know-how, we can go through a ship and see how it works, and then evaluate the limitations of that vessel. We can also suggest upgrades in order for it to work better."

Aker Arctic is therefore in an excellent position to offer the PWOM service to customers. In new vessel design projects, the manual is already part of our basic design package. For vessels constructed before 1 January 2017, the requirements have to be met by the first intermediate or renewal survey, whichever occurs first, after 1 January 2018. A vessel is required to have a PWOM in order to receive the Polar Ship Certificate.

"We will be able to compile the manual also for existing vessels and help ship owners with approval," Vocke assures. "The basic manual will be ready during this year and then adapted to meet the requirements for each specific vessel."

Model of Polar Water Operation Manual

1. Operational capabilities and limitations

Chapter 1 - Operation in ice

Chapter 2 - Operation in low temperatures

Chapter 3 - Communication and navigation capabilities in high latitudes

Chapter 4 - Voyage duration

2. Ship operations

Chapter 1 - Strategic planning

Chapter 2 - Arrangements for receiving forecasts on environmental conditions

Chapter 3 - Verification of hydrographic, meteorological and navigational information

Chapter 4 - Operation of special equipment

Chapter 5 - Procedures to maintain equipment functionality

3. Risk management

Chapter 1 - Risk mitigation in limiting environmental condition

Chapter 2 - Emergency response

Chapter 3 - Coordination with emergency response services

Chapter 4 - Procedures for maintaining life support and ship integrity in the event of prolonged entrapment by ice

4. Joint operations

Chapter 1 - Escorted operations

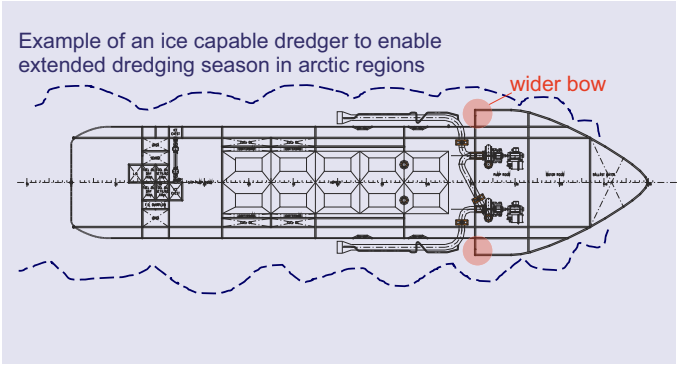
Chapter 2 - Convoy operations

Meet Maximilian Vocke

Maximilian Vocke has been working in shipbuilding for twenty years, first at the Helsinki Shipyard and then at Aker Arctic. He has mainly been involved in the design work of offshore vessels and icebreakers as project engineer and project manager. One of his designs is the offshore supply vessel and standby icebreaker *FESCO Sakhalin,* nowadays *SCF Sakhalin*.

Apart from work, Maximilian enjoys swimming and downhill skiing with his family.

Arctic dredger under development



Last September, Hydromec Group (Russia) and Aker Arctic signed a Memorandum of Understanding to begin the development of an ice strengthened dredger that could work in the Russian Arctic. There are no arctic dredgers available on the market.

Aker Arctic and Hydromec (Russia) are jointly developing an ice strengthened and winterised dredger that could be used for maintenance work in the Arctic.

Zavod Hydromekhanizatsii (Hydromec) is Russia's leader in production and designing of dredgers. In this cooperation project, they are providing their expertise in dredgers and Aker Arctic is providing the expertise in ice technology and ice-going vessels.

An extensive amount of construction work is currently taking place in the Russian Arctic in order to build harbours and infrastructure needed for oil and gas production and transportation to the markets. The dredging equipment for capital dredging has normally been transported from various locations to the Arctic and can operate only in open-water season during summer months.

“However, harbours, rivers, sea lanes and trading routes need continuous maintenance to stay open and remain deep enough for vessels to move in,” says Ilkka Rantanen, head of offshore services at Aker Arctic.

"Therefore, we have noticed while working on other projects that there is a need of maintenance vessels which could stay year-round in the area. When maintenance dredging begins, a different type of equipment is needed for those activities. An extension of the working season will also have a great advantage on efficiency."

"None of the dredgers in use today are well ice strengthened or equipped for harsh winters," Rantanen adds.

Basic concepts for the ice strengthened and winterised dredger have already been outlined, and Rantanen believes actual design work could begin during this year.

Ice Simulator improved for training

Aker Arctic and Novia University of Applied Sciences have begun a 15-month project, where the ice simulator's features will be further improved in co-operation with Image Soft Oy and Simulco Oy.

The Aker Arctic Ice Simulator has been praised for its visual choices and realistic vessel behaviour. Now it will be further enhanced for training purposes.

The Aker Arctic Ice Simulator is designed for operational simulation purposes and for education. With the ice simulator, ship officers can be introduced to operate in various ice conditions with different vessel types. Modularity of the simulator enables adding new operational areas to meet the more specified requirements of the client.

The aim of this project is to add new features and improve existing modelling to achieve an even more realistic feeling of operating a vessel. During the project, icebreaker captains will validate the simulator. In addition, more tools will be added for teaching purposes. The teacher will have easy access to operations handling and student review.

“After completion of the joint development project, the Aker Arctic Ice Simulator will be fully capable to use for training ship officers to manage in ice conditions,” says newly appointed project manager Jukka-Pekka Sallinen.

Bronze propeller in full-scale tests

We have been developing a new ice bronze propeller concept jointly with TEVO Oy and the Technical Research Center of Finland VTT Oy. The last step in the project is a full-scale test in heavy ice conditions.

The full-scale test will take place in the Bay of Bothnia in March 2016. The bronze propeller will be installed on the Finnish Navy's multipurpose vessel, *Louhi*. It will be tested in heavy first-year level ice as well as in ice ridges.

Bronze is not as strong a material as stainless steel but has other advantages such as corrosion resistance. It is easy to manufacture and to maintain. Bronze is widely used in marine propellers in open water.

"It also has a very competitive price and could therefore be useful for commercial ships if it succeeds in the trials," says Kari Laukia, Aker Arctic.

Furthermore, environmental aspects are becoming increasingly important. This propeller is designed to combine low noise characteristics with high strength.

Read more about how the test went in next issue of Passion News.

The bronze propeller will be installed on the multipurpose vessel Louhi and tested in first-year ice.

Arctic module carrier in successful sea trials

The module carrier is the first of her kind.

The sea trials were held outside the coast of Macao in the South China Sea.

The temperature was warm and the sea was calm, which was good for the trials. Bollard pull test in process.

Tommi Heikkilä from Aker Arctic joined the first arctic module carrier on her sea trials that took place in the South China Sea outside Macao.

The vessel departed for the trials from Guangzhou, China on the 28th December 2015. All the basic tests were performed, such as speed tests, manoeuvring tests, navigation systems tests, and bollard pull. The vessel, propulsion and machinery worked as designed.

Heikkilä was part of the design team with a special focus on the machinery and propulsion system.

"It was essential for me to join the tests in order to examine the final vessel and follow how our solutions work in practice," Heikkilä explains.

"It was good to see that the vessel functions as it is intended to and that the project has been successful."

The construction of the arctic module carrier has been completed in a very tight schedule and has been a great achievement from the parties involved. The vessel was delivered in the end of January 2016 and she is now chartered for the demanding arctic construction services.

Tommi Heikkilä was part of the design team planning the arctic module carrier.

Aker Arctic designed ships displayed at Neva 2015

We presented our new Arctic Aframax concept and results from Baltika's successful ice trials at Neva 2015 in St. Petersburg. Not less than eight of our vessel designs were displayed on five other stands. The vessel models on show were Baltika, ARC 124, ARC 130, ARC 130 A, Kirill Lavrov, the LNG tanker for the Yamal LNG project and Mangystau.

Marintec China 2015

In December, we participated in Marintec China in Shanghai where we presented the polar class module carrier. The first vessel, Audax, is one of the largest icebreaking vessels in the world, 206.4 m long and 43 m wide, with an independent ice-going capability of 1.5 m of level ice. The second vessel, Pugnax, is under finalisation at the GSI yard. Aker Arctic Technology Inc was responsible for conceptual and basic design of these vessels.

Arctic Shipping Forum North America

Aker Arctic participated in Arctic Shipping Forum North America last November. Mike Neville explained key challenges for DP in ice, and Reko-Antti Suojanen discussed in a panel about new and innovative designs for ice class vessels.

New Finnish icebreaker named Polaris

On 3rd of January, shortly after winter arrived to Southern Finland, the new Finnish icebreaker Polaris was floated out from Arctech Helsinki Shipyard's covered dry dock and moved to the outfitting quay. Polaris is the first icebreaker in the world to use Liquefied Natural Gas (LNG) as fuel.

It is also the most powerful icebreaker ever to fly the Finnish flag. Polaris is based on the Aker ARC 130 concept developed by Aker Arctic in co-operation with ILS Oy and the Finnish Transport Agency.


Courtesy of Arctech Helsinki Shipyard

A medieval feast in Tallinn

Tallinn, the capital of Estonia, is a short boat ride from Helsinki on the southern shore of the Gulf of Finland. It is famous for its beautiful medieval old part of town with markets and cosy restaurants. The Aker Arctic team decided to visit Tallinn before Christmas to enjoy the festive spirit together.

The museum display includes the WW2-era submarine Lembit (pictured) and the icebreaker Suur Tõll, both of which have played an important role in the Estonian, Finnish and Soviet history.


MSV Botnica has twelve Caterpillar main engines, one of them was being overhauled during our visit.


Dinner at restaurant Olde Hansa.

The morning of our trip turned out stormy, so the ferry ride to Tallinn was a bit on the rough side. Most of the passengers struggled with evolving seasickness, but everybody cheered up upon arrival in Tallinn.

We had lunch on *MSV Botnica*, which is a multipurpose icebreaker built in Finland in 1998. The Port of Tallinn acquired the icebreaker from Arctia in 2012. *MSV Botnica* assists ships and convoys in arriving and departing the ports of Muuga, Kunda and Sillamäe, as well as the ports in Tallinn Bay, Kopli Bay and Paldiski Bay during the icebreaking season. Representatives of the Port of Tallinn and TS Shipping OÜ took us on a guided tour of the icebreaker.

Conquering the South Pole

The Estonian Maritime Museum had an exhibition about conquering the South Pole. As this seemed to be a suitable subject for us, we decided to visit the museum's modern exhibition hall, which is built at the Seaplane Harbour with its architecturally unique Seaplane Hangars. The museum also features the submarine Lembit, a seaplane, and Suur Tõll, the largest preserved pre-war icebreaker in the world.

“The highlight of the trip was a medieval feast at the restaurant Olde Hansa," says management assistant Jana Vamberova. "It began with a gathering at Freedom Square. The herald of the house received us together with musicians at the Town Gate and we then walked in procession, accompanied by drums and bagpipes, to the restaurant. We were guided along narrow medieval staircases to the dining hall, where we were treated to a fantastic feast."

Meet us here!

We will participate in the following events:

Neftegaz, Moscow
18 - 21 April 2016

SMM Hamburg
6 - 9 Sept 2016

Arctic Shipping Forum, Helsinki
19 - 22 April 2016

ATC 2016, St. Johns
24 - 26 October 2016

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