Aker Arctic Technology Inc Newsletter March 2014

# Arctic Passion News

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## First Arctic LNG fleet

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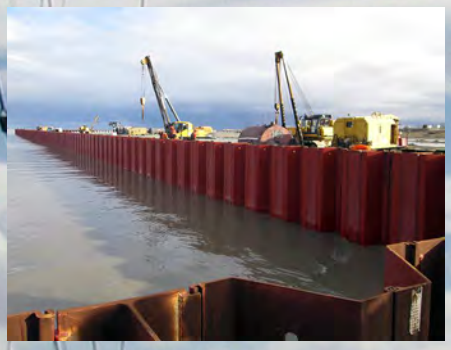

## Icebreakers for Sabetta harbour

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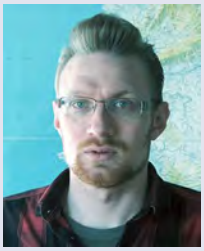
## Announcements

**Teemu Ikonen** *joined AARC as Structural Engineer in the ship design department. Teemu graduated from Aalto University in 2013. He majored in Techical Mechanics and developed an inverse method for ice-induced load determination in his Master's thesis.*

**Tuomas Romu** *has been appointed Project Engineer in the ship design department in September after graduating as Naval Architect from Aalto University School of Engineering. Previously, Tuomas has also been studying Arctic Technology in the University Centre in Svalbard."*



**Jukka-Pekka Sallinen** *has been appointed Research Engineer in the testing department. He graduated as Naval Architect from Aalto University in spring 2013 and his thesis considered brash ice resistance of Aframax class tankers.*

# Thanks !

Time flies – and very fast. It is now ten years from the moment I was invited by the Board of Aker Yards to start putting together a new company for independent business on Arctic marine technologies. Later in 2004 we had all the shareholders, Aker Yards, Wärtsilä, ABB and Aker Kvaerner in place and Aker Arctic Technology Inc was ready to start its operations.

Since the tiny 12 person staff we have now grown to a company with 46 persons and many ships created by us are sailing on the icy oceans, including several "double-acting" shuttle tankers, azimuthing propelled offshore support vessels as well as the world's first oblique icebreaker.

Aker Arctic is today working on all the seven seas and with Clients on all the continents and the surveys report on high client satisfaction.

It is now 50 years since I first time entered through a shipyard gate to start my career in the Finnish marine industry. The five decades have brought ups and downs, and many new technologies have been emerging and introduced since then, but we continue the Finnish success story. Today we live in a post-industrial era in Europe. We have returned to a former shipyard area, today as one of the leading global technology providers for the Arctic industries.

Through our internal "Arctic Horizons" competence program we have systematically mentored ourselves for the inevitable generation shift.

Now, after the 50 years at work, at the end of February 2014, it is my turn to step aside and give room to the eager and strong younger generation. Reko-Antti Suojanen has taken the responsibility with his generation's talents and skills for bringing Aker Arctic through next decennium's challenges towards new successes.

I would like to thank all the friends, partners, clients and competitors in all parts of the world and in many cultures for having provided me a rich, interesting and motivating work life in the Arctic marine and offshore business. I sincerely hope that we at Aker Arctic have been able to bring added value into Your operations.

Thank You!

*Mikko Niini*
Senior Management Adviser

*This summer and fall a total of 71 ships have transited the Northern Sea Route, North-East Passage.*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# Ole Johansson takes chairmanship and Reko-Antti Suojanen appointed Managing Director for Aker Arctic

## The Way Forward

The past year turned out to be significant for Aker Arctic. It was our 8th year of operation with a constant and stable situation in the market. The increased interest and public awareness of the Arctic development has been steadily growing. This resulted in some new openings at the market, as well as increased focus on the environmental issues.

The activities also increased in our home waters. A major step in our traditional icebreaker development was taken, when after many years, a new Baltic class icebreaker was designed for the Finnish Transport Agency. For us this work gave us a possibility to work closely with the local icebreaker operators. As a result there is now an extremely modern icebreaker under construction, being the first icebreaker in the world which can operate with LNG fuel. Aker Arctic's qualified and innovative personnel, together with the operational know-how of our partners and clients, have been crucial for this achievement.

The year 2013 ended with an ownership change as the Finnish Industry Investment Inc obtained a majority ownership of Aker Arctic. In my opinion, this will further improve our services and cooperation possibilities with our customers.

For the last years we have been experiencing changes in personnel due to generation shift. However, this has been well prepared over the years by letting next generation take a more and more active role in the work.

Personally, I have worked at Aker Arctic right from the beginning and enjoyed the arctic challenges. I am excited about the new position as Managing Director, to continue the success of Arctic development after the great work by Mr Mikko Niini.

From now on, we will continue active development of new solutions, and together with you, clients and partners, we will have an interesting and successful future ahead of us.

Reko-Antti Suojanen
Managing Director
Aker Arctic Technology Inc

After the acquisition of 66,4 % of the shares by Finnish Industry Investment Ltd (fully owned by the State of Finland) Aker Arctic Technology Inc's extra-ordinary shareholders' meeting appointed the new Board of Directors for the Company. On January 2014 the board members are Ole Johansson, Juha Koskela (ABB Oy), Antti Kummu (Finnish Industry Investment), Valborg Lundegaard (Aker Engineering & Technology A/S) and Juha Marjosola (Finnish Industry Investment). Ole Johansson was nominated Chairman and Juha Marjosola Vice-Chairman of the Board

Mr. Ole Johansson, BSc (Econ.) served as the President&CEO of Wärtsilä Corporation from 2000 to 2011. He is the Chairman of eQ Oyj and member of the Board of Svenska Handelsbanken AB.

Since Mr. Mikko Niini, reaching soon the age of 68, has made the decision to retire from the Managing Director position the Board of Directors appointed Mr. Reko-Antti Suojanen Managing Director. Mikko Niini´s employment with the company continues until the end of February 2014. “Mikko has done a great job for Aker Arctic, building the Company from its foundation in 2004

into a recognized provider and developer of maritime solutions for the ice covered and arctic waters. His ambition for maritime business and development is strong and valuable and we are looking forward to having him in an advisory position also in the future” said Ole Johansson. “Reko-Antti Suojanen has served as Research and Development Manager for Aker Arctic and has also been leading many major client projects. He has a broad experience in the business area and will together with his Management Team further continue to lead the operations of the Company in developing innovative and attractive solutions for the customers”.

# The State of Finland acquires majority of shares in Aker Arctic


The Finnish Government owned investment company, Finnish Industry Investment Ltd, has on December 17th, 2013 purchased a 66.4 per cent majority stake of the shares of Aker Arctic Technology Oy from STX Finland Oy.

Aker Arctic is one of the world's leading companies in Arctic marine logistics and offshore solutions as well Arctic vessels design. The Company's other shareholders ABB Oy Finland and Norway's Aker Engineering and Technology AS, part of the Aker Solutions group, are holding equal shares, now each 16.8 per cent.

The value of the deal was 9.3 million euros. The acquisition was carried out at market terms based on an external expert valuation. At the same time, the minority shareholders will increase their share in Aker Arctic on equal terms with the state acquisition.

“Arctic shipping is expected to increase substantially in the upcoming years and decades. As a world leader in solutions for development of Arctic engineering Aker Arctic has good prospects to gain a significant market share in the industry. This of course also has a positive impact on the Company´s long-term value. That is why I consider this deal highly successful from the state's point of view”, Minister of Economic Affairs, Mr. Jan Vapaavuori said.

In recent months the Ministry of Employment and the Economy has been studying actively the possibilities for securing the Company's know-how and further development in Finland. The transfer of the Company´s know-how, such as intellectual property rights, away from Finland, would have meant a serious setback for the entire Finnish Arctic marine industry's future development.

“The Government of Finland has a special interest in contributing to ensure a secure basis that offers possibilities for open stable ownership for Aker Arctic to develop and retain its knowhow. In addition to Aker Arctic's globally adapted commercial applications the Company's know-how and services can now also be utilized by the Finnish Defence Forces. The Company´s expertise and its utilization hold a key role in Finland's Arctic strategy, as well as in implementation of the Ministry's Marine Industry 2020 working group proposals”, Vapaavuori said.

Aker Arctic has accumulated the most important Finnish arctic marine know-how. The Company has designed a number of successful ship concepts for Arctic shipping, including the world's first oblique icebreaker concept, which is currently under construction at Arctech Helsinki Shipyard Oy. Aker Arctic has been involved in significant logistic solutions in the North-West Russia and is also in the design of both Canada´s and China's new polar icebreaker.

The development and utilization of a cutting-edge arctic know-how is important to Finland for several reasons, including arctic business development, as well as in terms of security of national supply issues. In the coming years Aker Arctic has a promising growth prospects e.g. in connection with opening of the Northeast Passage.

“The Company's operations will also strengthen the Finnish marine industry cluster and its prospects in strong and competitive areas of special expertise. For the preservation of the Finnish arctic and marine industry related know-how is important that the Aker Arctic´s expertise, as well as its long and successful business relationships on the international market will remain within the range of Finnish research and development”, Minister Vapaavuori said.

“The arrangement is very welcome for us as it gives the message of stability and strong Government backing for our efforts in developing the Company and our technologies further” said Mr. Mikko Niini, Managing Director of Aker Arctic when the deal was closed.

“We are working with customers in America, Europe, Russia and Asia, which represent oil majors, mining industries, ship owners, shipyards, equipment manufacturers and classification societies. The new shareholding also signals our neutral position to all markets and clients, which certainly will improve our ability to catch new customers”, Mikko Niini added.

# World's first LNG fuelled Next generation icebreaker for Finland


**The Finnish Transport Agency signed a contract with Aker Arctic for the design of the new icebreaker for the Finnish Government last April. Design work and model tests have been going on all summer and autumn.**

Aker Arctic has designed the new icebreaker for the Finnish government in cooperation with ILS Oy. Tasks included were the technical documents needed to arrange the tender for its construction in compliance, taking responsibility over the performance of the vessel, and assisting the Transport Agency in negotiations with shipyards.

## Delivery by 2016

The Government in February decided to procure the new icebreaker at a price of 123 million euro for delivery by winter 2016. The icebreaking capacity of the new icebreaker in all parameters will comply with the URHO-class icebreaker. Due to its diesel electric machinery, it will be able to move continuously through 1.6 m thick level ice, to break a 25 meter wide channel in 1.2 m thick ice at speed of 6 knots, as well as to reach 9..11 knots of average assistance speed in the Baltic Sea. The draught of the vessel with full fuel tanks will be maximum 8 m, which enables operations on all major sea-lanes. The service speed of the vessel in open water should be minimum 16 knots.

## Oil spill response

In addition, the new icebreaker will be equipped for oil spill response operations and will perform emergency towing missions 95% of the time in the open water and ice conditions prevailing in the Baltic Sea.

*The agreement was signed by Ms. Tiina Tuurnala of Finnish Transport Agency and Mr. Mikko Niini of AARC. In the background from left Mr Jarkko Toivola, head of winter navigation, Mr. Jyrki Lehtonen, Managing Director of ILS Oy and Mr. Kari Laukia, Design Manager of Aker Arctic.*

The vessel will be able to collect spill oil at significant wave height up to at least 2 meters, and 95% of the time in the wind conditions prevailing in the Baltic Sea. The recovered oil tanks and heating capacities for recovered oil will be sufficient for 1500 m³ of collected volumes. The vessel will be designed for 50 years of service life, and the icebreaker will have accommodation in total for 24 persons, with reserve for additional crew in case of oil spill response operations.

The ordered design materials were completed so as to make it possible to complete the tender for construction of the icebreaker by end of 2013.

"The Finnish foreign trade is fully dependent on efficient winter navigation. Our oldest icebreaker *Voima* is already sixty years old, and it is important that after a fifteen-year long gap we are able to renew our icebreaker fleet. Due to the new technology, our goal is to improve the new level of icebreaker services and to ensure the competitiveness of our exports," says Antti Vehviläinen, Director General, Finnish Transport Agency.

**The new Finnish icebreaker is being designed according to latest technology and will improve icebreaking services to ensure the competitiveness of Finnish exports.**

"It is amazing that the future flagship of our icebreaking fleet can be designed by the most experienced engineering companies of the country, Aker Arctic and ILS, which guarantees a high quality result of the project," says Jarkko Toivola, Winter Navigation Unit Manager at the Finnish Transport Agency.

"This new design of the Finnish icebreaker will give us a significant reference for the growing international Arctic markets and as a result we can show that the Finnish icebreaking technology continues having top design work in the world. During the past summer we have assured in advance the performance capacity of the new icebreaker by ice model tests," said Mikko Niini.

"It is important for this kind of national project that all competencies and experience can work towards a joint goal. Our emerging cooperation with Aker Arctic is inevitable to preserve the status of Finnish know-how in a growing international competition," says Jyrki Lehtonen, Managing Director of ILS Oy.

# Oblique icebreaker proceeding


*Hull Assembly took place at Arctech Helsinki Shipyard and BALTIKA was launched on December 12th 2013.*

*The cooperation between Yantar Shipyard and Arctech Helsinki Shipyard is in line with President Putin's shipbuilding strategy to increase use of Russian shipyards in construction of vessels.*

## Aker Arctic designed Oblique icebreaker under construction for the Russian Ministry of Transport is proceeding. Hull is now being assembled at Arctech Helsinki Shipyard and the first ship in this Aker ARC 100 design will be delivered in Spring 2014.

"Yantar JSC in Kaliningrad has manufactured the hull parts, which were last spring transported to Finland and assembly done here," says Chief Designer Mika Hovilainen.

"In August the propulsion equipment arrived from Steerprop and was installed. The schedule is tight to get everything ready for trials in February 2014 so the yard's full capacity is now working on the ship and it advances fast."

"Our work for the vessel is almost done. When the ship is ready and delivered our responsibility is to demonstrate that it fulfils our promises. We are responsible for the ice trials, which will take place in spring 2014 in the Baltic Sea."

The ship operator will be Gosmorspassluzhba (Russian Marine Emergency Rescue Service), responsible for oil spill combat and rescue operations in Russian waters. The vessel has been named BALTIKA.

### Instrumentation for full-scale measurements

Aker Arctic is now planning for a new major project in order to gather information from the Oblique icebreaker for future use.

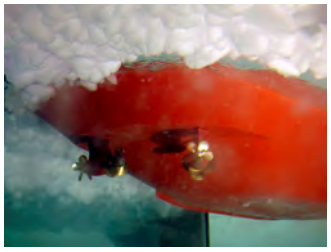
"We plan to instrument the vessel so that full-scale measurements can be made over several years. As this vessel is a new concept, which differs from anything previously built, it is important to verify theoretical calculations and compare how theories apply in reality," Mr Hovilainen explains.

In May this year, Aker Arctic launched a new arctic concept of the Oblique icebreaker, which has received widespread attention in media and among professionals in the shipbuilding, design and offshore industry (see next page).

"Full-scale measurements from the Oblique icebreaker will form the basis when we design the Heavy-duty Oblique icebreaker for arctic use more in detail," Mr Hovilainen says.

# Aker Arctic brings heavy duty oil spill combat icebreaker to market


*The Arctic Oblique icebreaker was presented at the Offshore Technology Conference in Houston in May 2013 and received widespread attention in media.*



*Along with the vessel concept development also new propulsion options are developed, among them contra-rotating propulsion with Steerprop Ltd.*

With construction underway on the first ever Oblique Icebreaker, Aker Arctic Technology has unveiled a new version of the unique vessel type that will bring ice management and pollution control in thick first year ice to a new level.

The first ARC 100 is due delivery to the Russian Ministry of Transport in early 2014. The resulting newbuilding is a breakthrough in asymmetric three-thruster conceptual design, which will bring new capability in terminal operations; ice management and oil spill response in freezing seas. The 76 m long vessel, with her oblique ice-breaking action is a game changer in year-round oil spill response. Additionally, a single Oblique Icebreaker cuts channels through ice for cargo ships to follow as wide as two equivalent conventional icebreakers moving ahead side by side.

## More power

Aker Arctic has followed up with a “Heavy Duty” ARC 100 HD version of the design – a 98 m long and 26m across the beam vessel. The vessel will draw on 24,000 kW of engine power and 19,500 kW of propulsion power to offer 190 tonnes of bollard pull in open water. This is 2.5 times the pull offered by the ARC 100.

Planned to be classed by the Russian Maritime Register of Shipping as an Icebreaker 7, the design is based on extensive model tests at Aker Arctic, Helsinki. Tests demonstrated that the ARC 100 HD would be able to break through 1.5 m thick ices when moving ahead and astern at 5 knots (2 knots through 2 m thick ice). In the oblique mode, it will be able to cut a 50 m wide channel through 1.5 m thick ices. In broken ice, its vertical side will push ice pieces and its inclined side will break ice floats.

## New ice management functions

As well as increased size, power and manoeuvrability, the ARC 100 HD adds new ice management and oil spill response functionality. Its dynamic positioning capability will mean it can 'spin on the spot' to widen channels. It will also be able to assist during ice field direction changes – effectively cutting ice alongside the cargo vessel exposed to unfavourable ice flows.

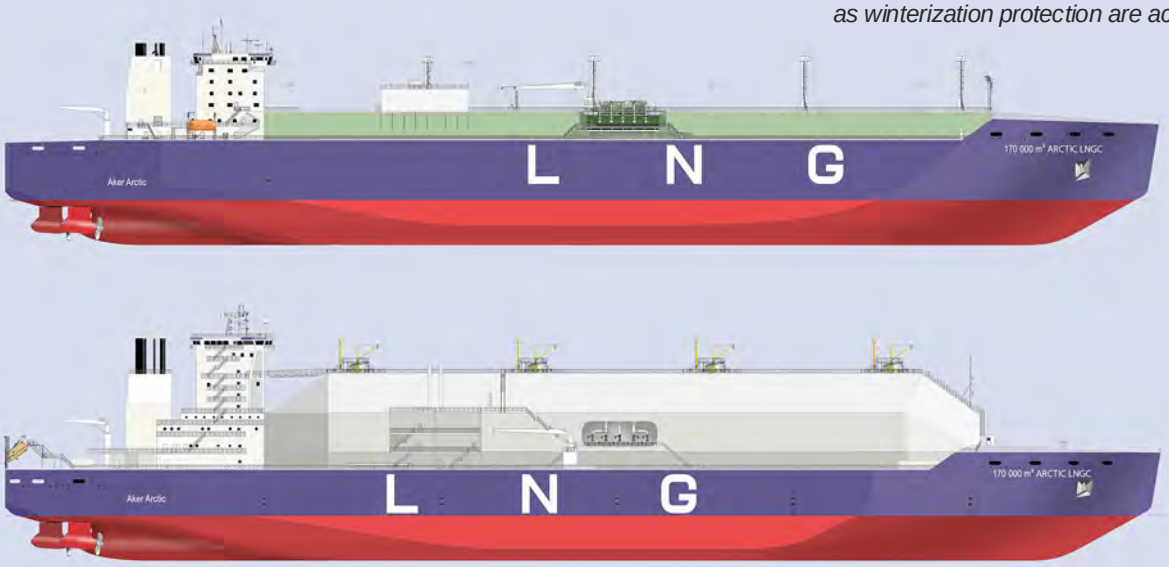
Aker Arctic has incorporated specific oil recovery measures. As with the ARC100 design, instead of the vulnerable rubber arm sometimes seen in oil spill response operations, the ARC 100 HD's vertical hull side itself will act as a sweep arm up to 60 m across in heavy waves. The vessel will also feature a skimmer system, including a side door, effective in-built brush skimmers/collector tanks for oil separation, recovered oil transfer pumps, and a discharge pump.

“This project is a significant milestone for icebreaker expertise, as it shows the way design and construction efforts are keeping pace with continuing demand for harder to recover energy sources," said Mikko Niini in the press conference.

“With the awarding of drilling permits in the Arctic subject to increasing scrutiny, this is another example of Aker Arctic Technology's commitment to meeting the challenges set by nature.”

# Developing the First Arctic LNG fleet

*The ship concept development included two different tank options: GTT-membrane tank system or MOSS spherical tank system. The latter was based on Aker Arctic's patented Integrated Hull Structure (IHS), where lower steel structure weight, improved strength and endurance as well as winterization protection are achieved.*




Russia's largest independent gas producer OAO Novatek and French energy major Total S.A. are in partnership developing an LNG plant project on the eastern coast of Yamal Peninsula in the village of Sabetta. China National Petroleum Corporation, CNPC, has additionally joined the project as well as a confirmed of supply of minimum 3 Million tons of gas per annum.
The Arctic location presents challenges for exports of the liquefied natural gas and Aker Arctic has been actively involved in researching and creating solutions for JSC Yamal LNG since 2010.

Yamal LNG cooperation includes planning and design development of an LNG-carrier for exports of LNG to the market, developing and designing the Sabetta harbour as well as designing the icebreakers to ensure efficient all year operations. Cooperation with Yamal LNG began three years ago when CB&I Lummus was conducting a Pre-FEED study on the production unit and Aker Arctic conducted studies on the LNG transport solution and carrier itself.

Aker Arctic had a vision of an Arctic LNG carrier already many years before, and had from 2003 onwards systematically been developing an LNG Carrier solution for the Arctic market. The conclusion after researching several options was that the best one would be a large LNG carrier, 150.000-200.000 m³, which could manage independently in ice, without icebreaker assistance. This technically and economically possible option, with several technological challenges, was presented at various conferences.

## Marine transportation FEED

"In 2011 we were selected by Yamal LNG to join for their FEED (Front End Engineering Design) on how to solve the transport needs from Sabetta and started to develop the vessel concept. We used the earlier developed vessel concept as base. Different propulsion possibilities were evaluated, as well as variations in icebreaking capability, manoeuvring capability and size of the ship. Technical surveys were made together with the client and CNIIMF (Russian Central Marine Research and Design Institute). Also the main equipment producers Wärtsilä, ABB, Steerprop Ltd. and Rolls Royce Marine were involved," Reko-Antti Suojanen tells.

"Additionally, the most economical and viable transport routes were investigated. As a result, the best option turned out to be transporting LNG to Europe during wintertime over Kara Sea and to Asia in summertime using the Northern Sea Route."

"The ship concept we developed included two different tank options: GTT-membrane tank system or MOSS spherical tank system. The latter was based on our patented Integrated Hull Structure (IHS), where lower steel structure weight, improved strength and endurance as well as winterization protection are achieved more efficiently compared to traditional Moss design," Mr Suojanen continues. "This concept is already utilised by Mitsubishi Heavy Industries (MHI) and Hyundai Heavy Industries (HHI) in their recent LNG carrier contracts."

## Safe operations in harbour

An important part of the project has been studies the harbour and how to efficiently manage operations in a safe manner at the harbour all year round. This work has been part of Aker Arctic's services to the client while LenMorNIIProjekt was carrying out the detailed harbour design. Aker Arctic has already for a longer period been creating a strategic partnership and jointly worked with Eranti Engineering, a well known specialist company for Arctic coastal engineering.

Sabetta is not only located in the Arctic with harsh winter conditions but has also shallow waters and will need to be dredged in order to achieve the necessary water depth for the large carriers. In the future when traffic is increasing in the harbour and the Ob Bay, brash ice amounts could reach up to 8 meters, according to computer simulation and calculations, which poses a real challenge for the tankers.

*Extensive model tests in ice have been conducted to ensure safe, reliable and efficient operations in the harsh conditions when transporting LNG from Yamal.*


"In Finland we face the same problem at our harbours in winter and have therefore developed an Ice Control System to manage the situation. By leading warm water to the piers, uncontrolled thickening of ice can be avoided and vessels can easily arrive and attach at the piers. A detailed layout plan for Sabetta harbour and an Ice Control System plan have been established to ensure safe terminal and loading operations," Mr Suojanen assures.

## Vessel's technical development

Key issues in the design of the vessel were size, propulsion system and optimum combination of ice performance and hydrodynamic characteristics.

Different sizes between 150.000 and 200.000 m³ were tested. Model tests showed that all sizes were suitable for icebreaking and good speed with reasonable power was achieved. Due to the shallow water situation in Sabetta harbour and narrowness of fairways in the Ob Bay, manoeuvrability of the largest vessel could become a challenge and therefore a reduced ship size of 177.000 m³ was finally chosen.

A Double-Acting ship concept proved in ice model tests to be most efficient and allowed also for independent operations in the shallow waters. Ice class Arc7 according to Russian Maritime Register of Shipping was determined.

Propulsion options under the consideration were either a two, three or four pod system. Hybrid combinations with shaftlines and azimuth thrusters were also analysed. After thorough research a three Azimuth pod system was chosen with 15 MW each as this gave best manoeuvrability in ice.

The machinery is a dual fuelled diesel electric engine capable of using both LNG and oil fuel (HFO, MDO). Operating on gas fuel in ice is challenging because engine load in ice can vary quickly. This feature was researched and tested with running engines jointly with Wärtsilä in their test bench in Spain, resulting in development of a Smart Integrated Load Control System, which ensures engine performance even in heavy icebreaking situations while using LNG.

Arctic ships spend a substantial amount of time in open water conditions. With a bulbous bow, the power need can be around ten per cent lower compared to bow without bulb. The ships with Double-Acting principle can either have bulb or ice bow and good ice going performance can always be achieved by sailing stern first. Also a special bulb design can be built for reasonably good ice breaking capability allowing operation in most typical ice conditions. On the other hand a bulbous bow may pose some risks in ice conditions and current RMRS rules do not allow the use of it for vessels above ARC4 ice class. Recent development has proved that it is possible to safely use a bulbous bow in harsh ice conditions and rules are also increasingly becoming positive to the use of it. Nevertheless, due to the high safe operations requirements of Yamal LNG to ensure efficient, regular and reliable operations in all ice conditions, an ice bow type hull form was finally chosen for the LNG-carrier.

aker Arctic designers then continued the open water testing in order to achieve also good open water characteristics. CFD and open water model tests were conducted both in still water and waves. The result is a bow design with relatively good open water characteristics.

## Terminal construction underway

Construction of Sabetta harbour began in 2012 and is planned to be ready in 2016.

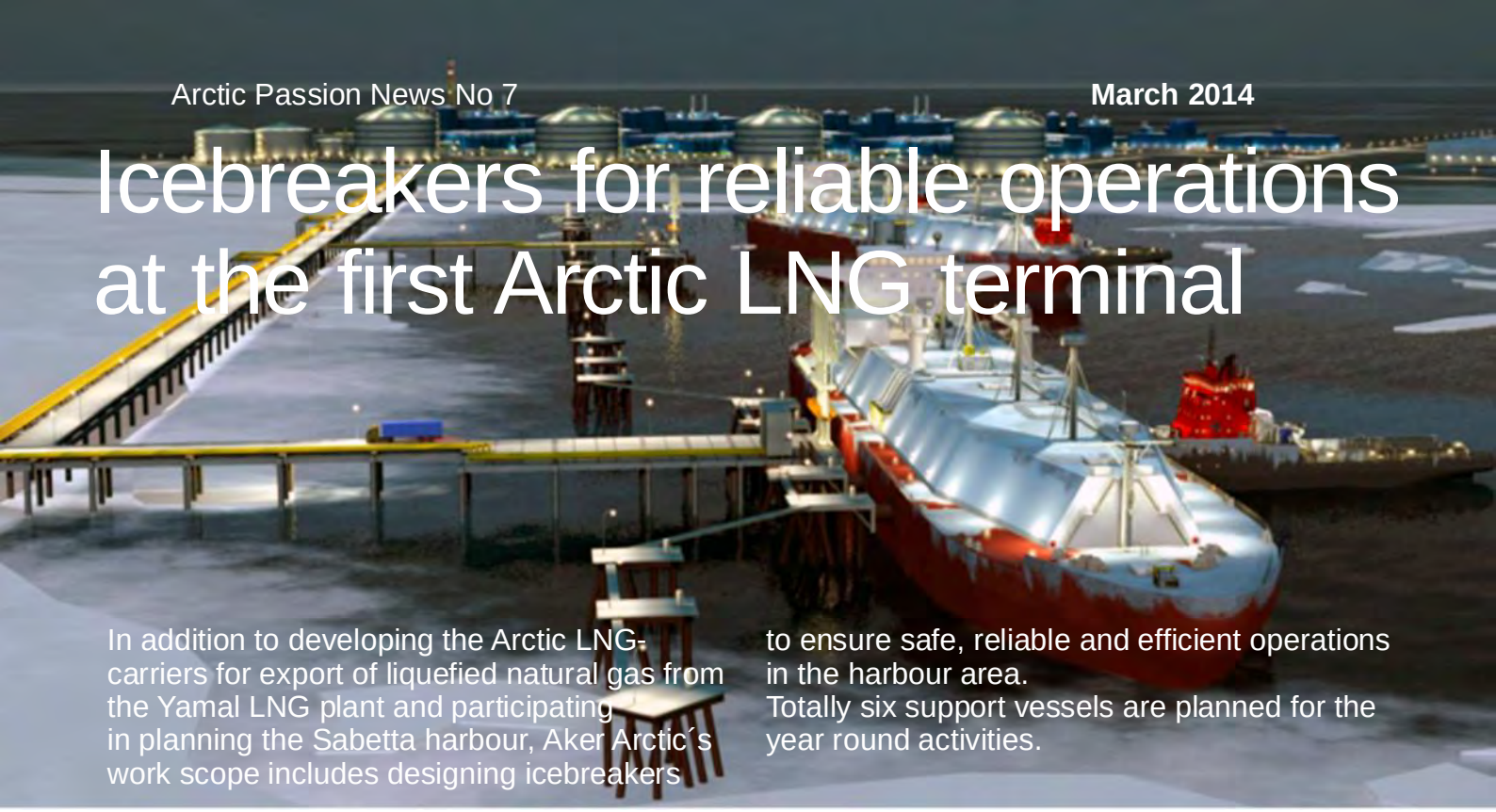
Technip/JSC were awarded the contract to build the LNG production plant with the first train to be ready by 2016. Quite a number of various types of ships, including dredgers, were operating last summer and fall on the Northern Sea Route bringing equipment and material supplies to the port. Preparations are now under way and the plant construction will be made on a modular principle and transported to Yamal.

"In addition to this, our work has included designing icebreakers to ensure safe, reliable and efficient operations in the harbour area. Totally four different icebreaker types are needed for the year round activity," Mr Suojanen adds.
(Read more on next pages)

## DSME of South Korea to build the world's first Arctic LNG carriers

Technical specifications for the LNG-carriers were ready last year and Aker Arctic supported Yamal LNG in preparing the tender documentation, which was sent to major qualified shipbuilding yards. After revision of offers, Daewoo Shipbuilding & Marine Engineering was selected for construction of the vessels and a preliminary slot reservation agreement for building up to 16 Arctic LNG carriers was signed in July 2013. First vessel is expected for ice trials in Sabetta area during 2016 while the remaining units would be arriving into service between 2017 and 2018.
"Aker Arctic's policy is to follow its projects throughout the construction and trials in order to keep "hands-on" also in the practical shipbuilding work, as the feedback of this is utmost important for accumulating experience and improved design services for future projects. This has been experienced already with Sumitomo in Japan for the MASTERA Aframax series as well as the 70.000 tdw VASILY DINKOV-type Varandei shuttle tankers built in co-operation with Samsung Heavy Industries. In a similar way Aker Arctic and DSME will work in close co-operation in the execution of the Yamal LNG carriers," says Suojanen.
"For the Prirazlomnoye MIKHAIL ULYANOV-type 70.000 tdw Arctic shuttles we were responsible for the complete basic design while working with Admiralty Shipyards of Russia."

# Icebreakers for reliable operations at the first Arctic LNG terminal



In addition to developing the Arctic LNG-carriers for export of liquefied natural gas from the Yamal LNG plant and participating in planning the Sabetta harbour, Aker Arctic´s work scope includes designing icebreakers to ensure safe, reliable and efficient operations in the harbour area.
Totally six support vessels are planned for the year round activities.

Aker Arctic conducted an extensive feasibility study together with JSC Yamal LNG on how reliable harbour operations would be best achieved. Aker Arctic first established the different assistance operations needed in the demanding circumstances and then specified the types of vessels required to ensure the cargo traffic. Totally four different support vessel types were considered necessary for the year round operations: Line icebreaker for securing operations at Ob Bay and in the dredged sea access channel at northern part of Ob Bay, harbour icebreaker for maintaining harbour area and the dredged harbour access channel in operational conditions and icebreaking harbour tugboat for ice management and assistance in harbour together with harbour icebreaker. For summer operations three light ice class port tugs are needed for securing safe and reliable operations in prevailing weather conditions.

## New features

Consideration was given to dual-fuel engines using mainly liquefied natural gas but they can also use fuel oil. The line icebreaker can additionally use heavy diesel oil as a third fuel type, as the plan is to use it on the Northern Sea Route in summer time where more fuel capacity is required.

"All the icebreakers designed are based on experienced solutions and proven technologies, but still some new, novel features are incorporated," says Chief Designer Mika Hovilainen. "Each one has novelties and special features, the most important one being the exceptional icebreaking capability, with azimuthing thrusters which is a big leap forward in Arctic vessel development."
“The line icebreaker will be the most efficient icebreaker with diesel machinery ever built. Its performance is as good as a nuclear icebreaker, even better in some operations. It may, however, be that the investors decide to rely on services provided by existing icebreakers, descriptions of which are found on following pages."

"The harbour icebreaker is a totally new concept especially developed for heavy harbour ice circumstances with extensive thick brash ice. Some features are similar to the Oblique icebreaker and the new icebreaker for the Finnish government but in this one operability in thick brash ice and harbour ice management capability have been taken one step further. The hull form and propulsion system are something exceptional. There are four azimuth thrusters, two in the bow and two in the astern," Mr Hovilainen continues.

The vessels are optimized for thick brash ice, which develops in cold circumstances when water gets mixed in between layers of ice and then freezes. The thickness of this ice can grow up to 4 metres which requires a special kind of vessel able to assist large tankers, support them turn in the harbour and attach to the pier. Also the icebreaking tug will assist tankers in the harbour during the winter periods. In summer during open water season (3-4 months) three port tugs of lower ice class will assist and protect tankers in the harbour.

“No previous operations to this extent have taken place in as harsh circumstances as they are in Yamal. Therefore the icebreaking escort tug has to be clearly stronger than anything built before. Also the LNG-feature is unique," Mr Hovilainen emphasizes. "The tugs for summer use are closer to open water harbour tugs."

## Environmental benefits of LNG

Environmental friendliness has been a top priority in designing the operations and the vessels. "The benefits of using LNG-fuel would be many, especially from the environmental point of view. There are no sulphur oxide nor particle emissions, 75% less nitrogen oxide emissions and 30% less $CO_2$ emissions than conventional fuel."

There are technical challenges with LNG-fuel, which makes it more complicated to use. Once the natural gas is liquefied, it has to be stored in -162°C, which is a challenging and expensive system. It also requires double the tank space compared to traditional fuel, which in small tugboats always is a challenge.

"LNG tank capacities would, however, give only one week operation time at average winter conditions. Extended operation can be achieved by operating on fuel oil. The vessels are also designed according to the zero-dumping principle. All solid and liquid wastes will be stored on board and discharged to shore," Mr Hovilainen says.

*Sabetta gas field on the shores of Ob Bay. Photo M. Niini during the ARCDEV project with experimental loading of tanker UIKKU.*




## Line icebreaker Aker ARC 123

Line icebreaker intended for supporting LNG carriers approaching the Sabetta port on the Yamal peninsula.

**Primary tasks**
- Escorting LNG carriers at Ob Bay in the river channels
- Ice management in the Ob Bay area to support the LNG carriers
- Pilot transfer to the LNG carriers.

**Secondary tasks**
- Operations on the Northern Sea Route during the summer period

**Special design features**
Ice strengthening enables independent operation in the Arctic seas in coastal routes during winter/spring navigation in ice up to 3 m thick and summer/autumn navigation without restrictions.
Hull form has been developed taking into account that the vessel needs to create a wide enough channel enabling to support the LNG carriers, but still optimized to reduce produced emissions to air by minimizing required propulsion power. Hull form is developed for low ice resistance caused by icebreaking. Basis of propulsion system selection has been maximizing the propulsion efficiency. Diesel-electric power plant consists of six engines for good flexibility in optimizing the engine loadings in various operational profiles. Propulsion is arranged with three azimuthing units located astern.

**Main dimensions**

| | |
|---|---|
| Length | 135 m |
| Breadth | 35,4 m |
| Draught | 9,0 m |
| Deadweight | 5.000 tonnes |
| Open water speed | 19 knots |
| Bollard pull | 420 tonnes |
| Propulsion power | 39 MW |

The vessel is designed with good ice-going properties both ahead and astern. She is able to proceed at 5 knots speed on 2,1 m thick first year level ice and 8 knots at 4 m thick brash ice with consolidated layer on top.

## Port icebreaker Aker ARC 124

Port Icebreaker (PIB) intended for supporting LNG carriers' operability in approach channel to harbour and in the terminal of Sabetta.

**Primary tasks**
- Escorting LNG carriers through approach channel into the port
- Icebreaking in port
- Assistance in harbour manoeuvres of the tankers
- Ice management in the approach channel and harbour basin.

Secondary tasks
- Oil spill response
- Standby duty during cargo operations of LNGC
- Fire fighting
- Transportation of deck cargo
- Harbour tug operations

**Special design features**
The Vessel is designed for winter operation in the Ob Bay area. Her ice strengthening enables independent operation in thick first year ice year-round.
Hull form and propulsion arrangement give maximized operability in level ice and especially in pre-broken very thick brash ice in limited water depth conditions which prevail in approach channel and in harbour basin. The vessel is fitted diesel electric machinery with four azimuth propulsion units. Two of the thrusters are pushing type located to stern of the vessel maximizing ice management by ice flushing effect of propeller wake. Two pulling type thrusters are located in bow of the vessel minimizing ice resistance by efficient flushing of hull and maximizing operability in brash ice and rubble fields. Hull form and thruster arrangement give excellent manoeuvrability in ice and enable managing ice by pushing it away by the vessel's vertical sides.

| **Main Dimensions** | |
|---|---|
| Length | 84,3 m |
| Breadth | 21,3 m |
| Draught | 6,5 m |
| Deadweight | 510 tonnes |
| Open water speed | 15 knots |
| Bollard pull | 105 tonnes |
| Propulsion power | 10 MW |

The vessel is designed with ice-going properties both ahead and astern. She is able to proceed at 2 knots speed in 1,5 m thick level ice and 4 knots speed at 5 m thick brash ice conditions in limited water depth which prevails in harbour area.

## Icebreaking port tug Aker ARC 125

Icebreaking Port Tug (IBPT) intended for supporting LNG carriers' operability in approach channel in open water and in light ice conditions and year-round in the port of Sabetta.

**Primary tasks:**
-Escorting LNG carriers through approach channel to port
-Icebreaking in port
-Assistance in harbour manoeuvres of the tankers
-Ice management in the approach channel and harbour basin

**Secondary tasks:**
-Oil spill response
-Standby duty during cargo operations of LNGC
-Fire fighting to external fire
-Transportation of deck cargo
-Harbour tug operations
-Escort tug operations

**Special design features**
The Vessel is designed for year-round operation in the Sabetta harbour area. Her ice strengthening enables independent operation in pre-broken thick first year ice year-round. Hull form is designed for operation in thick brash ice conditionsin Sabetta harbour still maintaining adequate operability as an escort and harbour tug. Propulsion arrangement maximizes bollard pull without sacrificing performance in ice. The vessel is fitted with dual fuel diesel electric machinery and with two contra-rotating azimuth thrusters located to stern of the vessel. Large keel constructed forefoot is arranged to bow part of the hull to increase manoeuvring force to escorted vessel in escort tug operation.

| **Main dimensions** | |
|---|---|
| Length | 45,2 m |
| Breadth | 15 m |
| Draught | 6,0 m |
| Deadweight | 270 tonnes |
| Open water speed | 13 knots |
| Bollard pull | 70 tonnes |
| Propulsion power | 6,6 MW |

The tug is able to proceed at 2 knots speed in 1,0 m level ice and 2 knots speed in 4 m thick brash ice with consolidated layer on top in limited water depth which prevails in Sabetta harbour.

## Ice class Port Tug Aker ARC 129

Ice Class Port Tug (PT) intended for supporting LNG carriers' operability in approach channel in open water and in light ice conditions in the port of Sabetta.

**Primary tasks:**
- Escorting LNG carriers through approach channel to port
- Harbour tug operations
- Escort tug operations
- Assistance in harbour manoeuvres of the tankers
- Ice management in the approach channel and harbour basin

**Secondary roles:**
-Oil spill response
-Standby duty during cargo operations of LNG carriers
-Fire fighting to external fire
-Transportation of deck cargo

**Special design features**
The Vessel is designed for operation in the Sabetta harbour area. Her ice strengthening enables independent operation in pre-broken moderate first year ice.
Hull form is designed for good operability as an escort and harbour tug still maintaining adequate operation in brash ice conditions in Sabetta harbour. Propulsion arrangement maximizes bollard pull. The vessel is fitted with diesel electric machinery and with two azimuth thrusters with ducted propeller. Thrusters are located to stern of the vessel. Large keel constructed forefoot is arranged to bow part of the hull to increase manoeuvring force to escorted vessel in escort tug operation.

| **Main dimensions** | |
|---|---|
| Length | 44,0 m |
| Breadth | 15 m |
| Draught | 6,0 m |
| Deadweight | 250 tonnes |
| Open water speed | 13 knots |
| Bollard pull | 70 tonnes |
| Propulsion power | 4 MW |

She is able to proceed at 2 knots speed in 0,6 m level ice.

Aker Arctic has developed a new arctic offshore construction vessel intended for construction and servicing arctic oil fields. Similar open water vessels are available but this is the first one for real arctic use. She brings substantial saving potential with her capabilities in harsh conditions.

# New arctic offshore construction vessel

**The Aker ARC 114 is an icebreaking multi-role vessel, specifically designed to provide assistance to offshore field installations in both ice covered and open water developments.**

## Ice management

The hull form adopts an efficient bow design for icebreaking, with a level icebreaking capability of 1.6 m in the bow-ahead mode at the installed propulsion power of 18MW. The Aker ARC 114's stern incorporates Aker Arctic's Double-Acting Ship technology and is optimised for icebreaking stern first, and ice ridge clearing / ice management tasks. The vessel is capable of achieving 2 knots in 1.9 m level ice operating in this mode. The optimisation of the stern for icebreaking means that bow can consequently be more adapted to extended operations in open water.

The stern configuration and provision of azimuthing thrusters enables effective ice management of smaller floes and ridges by using the directional propeller wash from the thrusters to break-up the ice. In addition the icebreaking bow allows for very effective ice management of large ice floes, either by pushing or breaking, functions that are required when operating in tandem with a larger primary icebreaker.

"The vessel can be used in thick one-year ice but it is also developed with freezing open water areas in mind. The worst condition is actually heavy open water seas at freezing point when every splash of water freezes to ice making outdoor operations impossible," says Chief Designer Mika Hovilainen.
A high capacity winch for iceberg towing is stored below deck as a winterization feature.

## ROV operations

"In order to develop arctic offshore operations, multirole service vessels are needed for subsea production, inspection and servicing also during the winter period. Aker ARC 114 can perform many maintenance and inspection duties also through ice," Mr Hovilainen adds.

She can be used for subsea work in ice through three moon pools fitted with Aker Arctic developed ice protection barrier. The remote operating vehicles can be lowered also in ice and their umbilical protected from ice. Moon pools are fitted with remote operated bottom hatches to minimize ice formation during transit and provided with top hatch for safety operations and ROV handling. The design allows for the possibility of heated water in moon pools, which also include effective wave dumping chambers to improve operability in heavy waves.

The Aker ARC 114 has been especially designed around an integrated module handling tower-concept for handling of 60 tonne offshore modules and deployment of subsea equipment. Stabilizing tanks are located for reduction in rolling and to allow the vessel to operate as a very stable platform for heavy lift and module handling operations.

## Winterization aspects

The ARC 114 design includes many features for winterization and operation of the ship in low temperatures. One item to observe is the requirement to fulfil the DNV Winterized Arctic notation. The requirement drives in many ways the layout of the Vessel as this notation also requires the notation RPS ( Redundant Propulsion and Separate): RPS requires taking into account failures caused by fire and flooding, making the

*The Aker ARC 114 is an icebreaking multi-role vessel, specifically designed to provide assistance to offshore field installations in both ice covered and open water developments. This is the first offshore construction vessel designed for real arctic use.*

Vessel's layout and equipment arrangement between a DP2 and DP3 Vessel.
Flexibility in accommodation is provided considering the various missions and roles of the ship. The vessel can accommodate 88 persons.
For added flexibility and to increase the operational abilities of the vessel further, the Aker ARC 114 is prepared for supporting diving operations.

## Environmental technology

"The vessel is designed with latest environmental technology in mind using the principles of DNV's Clean Design notation. Use of power in ice is minimized, it uses Double-Acting technology for saving energy, machinery is equipped
with latest cleaning methods for emissions and has the possibility to use low sulphur fuel. It fulfils all today's environmental requirements and standards," Mr Hovilainen emphasizes.

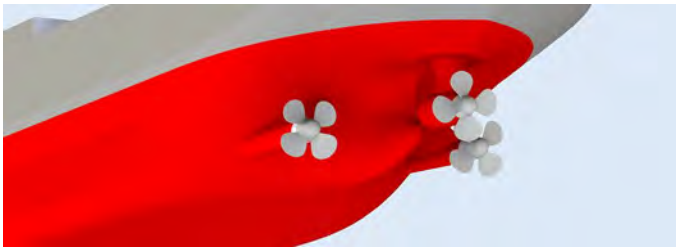
In addition to the main propulsion units the vessel is equipped with two tunnel thrusters and one retractable azimuthing thruster forward to enable excellent station keeping characteristics for stationary operations, meeting the requirements of a DP2 class system.

"We are now planning to further develop the vessel for arctic well intervention activities. It will be presented in the near future," Mr Hovilainen promises.

For this goal a co-operation agreement with Navis on DP in ice was recently concluded.

# Canadian Polar icebreaker reaches final design phase III

Final design of the polar icebreaker for the Canadian Coast Guard is closing to the end and the detailed design phase has started. A hybrid propulsion solution was chosen after extensive testing and studies.



*After various studies by AARC, a hybrid propulsion concept with two wing shaftlines and pod in the middle was chosen for CCGS icebreaker John G. Diefenbaker.*

Aker Arctic is part of a team led by STX Canada Marine designing a multi-mission polar icebreaker for the Canadian Coast Guard. Phase I and Phase II of the ship is completed and the final design Phase III nears also completion, where all details of the vessel are specified and the basic technical decisions are transformed into working solutions soon. This phase will be ready soon and the finalized design package is then available to Seaspan Shipyard in Vancouver for production design work.

## Hybrid propulsion solution

"The design of the propulsion system is one of our responsibilities and we are now designing the final model," says Project and Design Manager Kari Laukia. "Different options were thoroughly evaluated and tested in model scale and finally the Canadian Coast Guard chose a hybrid concept with two wing shafts and a centre pod instead of three shafts. The biggest advantage of this solution is manoeuvrability of the ship in ice, as it improves substantially by using an efficient propeller thrust in all 360 azimuthing angles. Operation even in astern mode is now possible with this (double-acting ship)."This will be the first pod turning 360 degrees ever designed for PC 2 class. Total propulsion power is 34 MW, the centre pod accounting for 12 MW and the side shafts 11 MW each. The stainless steel propeller diameter is 5,6 m in the centre and 5,9 m in the side. The diesel-electric propulsion consists of propellers with propulsion motors, frequency converters, diesel generators and transformers. The propulsion motors and frequency converters are designed so that motors have enough over torque capabilities available in extreme ice conditions.

## Regular meetings

"The project has advanced well and is according to schedule. Cooperation work among the different partners (STX Canada Marine, Imtech Marine/Techsol Marine, SNC-Lavalin, Aker Arctic) has been excellent with weekly telephone conferences. Additionally regular technical review meetings have been held with the client in Canada. The Canadian Coast Guard has taken a very active role in the project as they wanted to understand the practical implications of design decisions made," Mr Laukia tells.

"Seaspan Shipyard in Vancouver, which will be the constructing shipyard, is also involved in this final design stage so that they can give their input on planned constructions, as this is practically the final stage to impact on production design. By getting familiar with the ship already now, it is much easier for them to continue."

*AARC developed patented multi-screw DAS™ propulsion is also chosen to Rosmorport's subarctic icebreaker LK25 which is currently under construction by Baltic Shipyard in Russia.*

## New regulations to steer ice class vessel designs

# Update on IMO decision making

World shipping has in recent years started to give its contribution for the fight against the climate change and reduction of greenhouse gases. In addition The Baltic Sea and the American waters have already been declared as sensitive areas and emission reduction measures will enter into force.

The IMO Energy Efficiency Design Index (EEDI) came into force in 2013 January, but it did not include guidance on interpretation for higher ice classes than 1 A Super. . Additionally the Finnish-Swedish ice class rule and EEDI CO2 emission levels work are somewhat contradictionary in propulsion power requirements This proved a challenge especially for cargo ships designed to move independently in for instance the Arctic. To overcome this problem Finland and Sweden made a proposal to IMO's Design and Engineering subcommittee on how high ice class and power requirement could be combined with the EEDI requirements:

1. The first possibility would be to further develop ice class correction coefficients to cover also high ice class ships designed for independent operation;
2. The second possibility would be to introduce a two-level power system: unlimited power for ice-breaking operations and certain restricted power for open water operations; and
3. The third possibility would be to apply regulation 21.5 in chapter 4 of MARPOL Annex VI. This regulation reads: "For each ship to which this regulation applies, the installed propulsion power shall not be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions as defined in the guidelines to be developed by the Organization".

## Icebreaking ships exempted

At the IMO the proposal was taken into consideration among many others EEDI related proposals. At the MEPC meeting in May 2013 a number decisions and additions to EEDI were made. Previously exempted ships such as ro-ro cargo ships, cruise passenger ships having non-conventional propulsion, LNG-carriers and dual-fuel engines were now included in EEDI. Surprisingly it was, however decided that cargo ships having an ice-breaking capability of 1.0 m or more are exempted from EEDI.

"Cargo ship having ice-breaking capability" in relation to chapter 4 means a cargo ship which is designed to break level ice independently with a speed of at least 2 knot when the level ice thickness is 1.0 m or more having ice bending strength at least 500 kPa.

## Decision raises many questions

"The purpose of EEDI, which is to promote energy efficient ships and thereby reduce CO2 emissions, will not be fulfilled by this decision," says Sales and Marketing Manager Arto Uuskallio, who is following up on IMO's rule development. "If you can prove that your ship breaks at least 1 metre ice, then you don't need to choose the most energy efficient solution for an ice-going vessel as you are exempted from EEDI."

"This raises many questions. How is the icebreaking capability verified? By calculations, model tests or full-scale tests? What would be the ice class needed from the vessel, as the current criteria only emphasizes vessel speed?

A process needs to be established similar to open water vessels with calculations, hydrodynamics tests, pre-permission to construct and finally full-scale tests and verifications," Mr Uuskallio emphasizes.

"Our stand-point is to always design an energy efficient vessel to the environmental conditions the vessel will be used in."

Mr Uuskallio mentions another open issue.

"What will happen if the vessel in final verifications does not qualify for EEDI? Will there be a penalty or does the vessel have to be scrapped?"

A likely consequence might arise that owners willing to operate in icy waters in the future define 1,0 meter ice performance as a specification target.

## Polar Code on schedule

Work on the mandatory Polar Code has advanced during the recent meetings. SOLAS related finalized draft text has been submitted to Marine Safety Committee (MSC) for approval in the next meeting in May (MSC93) and final adoption is scheduled to be in MSC 94 in November 2014. MARPOL related topics will be handled in the next Marine Environmental Protection Committee (MEPC 66) meeting in the end of March / early April. Even if a lot has been achieved there is still many things to be agreed on the practical application and the adaptation of the Polar Code.

## Aker Arctic can prove ice capability

"We follow closely how EEDI and Polar Code proceed. If the decision to exempt ice class ships from EEDI stays as such, we will help ship owners with proper designs and in proving the ice capability," Mr Uuskallio assures.

This can be done with our usual tools:
- using our ice performance tools
- ice model tests in our model testing facilities
- full-scale tests

“We also try to assist in the rule development and we will adapt our designs to match the applicable future rules.”

# Expert in icebreakers

*Matti (Masa) Arpiainen together with model of "Kapitan Evdokimov" , the first of the series of seven river icebreakers for Siberian shallow waterways. He was involved in the designing of the vessel, construction work and also went on full scale trials aswell.*

## Project Engineer Matti Arpiainen has been working nearly 40 years with icebreaker design and especially design of icebreakers for Soviet Union and Russia.

Matti Arpiainen has always been interested in technique and model construction. When it was time to choose career, he read about ship design and shipbuilding and immediately became interested and applied to Helsinki University of Technology to study Naval Architecture. Towards the end of his studies, he began to work at Wärtsilä Helsinki Shipyard building models of engine rooms. He stayed at the Shipyard after graduation in 1976 and transferred in 1991 to Masa-Yards Arctic Research Centre, which later became Kvaerner Masa-Yards Arctic Research Centre and finally Aker Arctic Technology Inc in January 2005.

"I have worked my entire life with icebreaker design and been part of numerous icebreaker projects during my career. Many of them have been projects for Soviet Union and in later years Russia, so you could say I have become an expert in those," Mr Arpiainen says.

### Kapitan Sorokin class

"The first icebreaker project I was involved with was *Kapitan Sorokin* class in 1977, which was the first shallow-draught polar icebreaker, the 'shallow' draught being 8.5 metres! It was a vessel of conventional form with the main diesel generators lifted up one deck in order to reduce stability. Engine rooms were wide, which caused the problem that the double sides became narrow. The two first vessels of the class were equipped with air-cooled propeller motors but in the later built versions water-cooling was used. For one of the series' vessels, *Kapitan Nikolayev*, the bow was converted to conical bow in 1990. Icebreaking with this bow was excellent but in heavy seas it did not behave that well."

### Kapitan Izmaylov class

Following project was the port/river icebreaker *Kapitan Izmaylov* class, of which three were built. It was the first icebreaker with power station machinery and AC main generators. Its draught was 4.2 m and it was built to be able to travel below bridges. For low air draught the masts could be folded and the funnel split in two.

### Kapitan Chechkin class

*Kapitan Chechkin* class, also in 1977, was a river icebreaker with draught 3.25 m. It was the first diesel-electric icebreaker for Siberian rivers. It had a traditional icebreaker hull form, three shafts, propeller motors from AEG in Germany, and three rudders in order to improve steering. "I made a model for the client to show them how the propeller could be removed if necessary," Mr Arpiainen describes.

### Irizar and Mudyug class

"After moving to the project department the first icebreaker project was *Almirante Irizar* of Argentina, delivered 1978.
I revisited *Almirante Irizar* in 2007 after a heavy fire to plan for repairs and

Next Soviet icebreaker was *Mudyug* class in 1982, a subarctic icebreaker provided with CP propellers directly coupled through reduction gears.
"The plan was to save weight, cost and fuel".

### Kapitan Evdokimov class

In these years it was important to extend the navigation season on the big rivers by a couple of months. "*Kapitan Evdokimov* class in 1983 was the first ship project I was involved in from the beginning until the full-scale tests. I was project engineer for this river icebreaker and we conducted many ice model tests and developed an excellent new hull form with cylindrical bow and buttock flow stern, which was very capable for icebreaking. It had four stern propellers and draught was only 2.5 m. Superstructures were of aluminium to get weight down, which was new for icebreakers. In official ice tests, she broke 1.02 m ice, which was 22 cm more than agreed."
The drawback was that she did not turn well in ice and in some situations ice gathered below the ship and slowed it down. Otherwise *Evdokimov* was a very successful ship, and the eight vessels of this class are still appreciated due to their excellent performance.

### Taymyr class

Polar icebreaker *Taymyr* was a long project, which lasted ten years. It is a shallow-draught nuclear powered polar icebreaker, steam turbine-electric, and the first polar icebreaker with frequency controlled alternating current propeller motors. The hull form looks traditional but has excellent icebreaking capabilities, over 2.5 m, but draught is 8.07 m only. Ice tests for Taymyr were done in 1990 simultaneously with *Kapitan Nikolayev* fitted with the new conical bow.
"A competition was arranged between *Taymyr* and *Nikolayev* in Yenisei to see which one was the fastest and strongest. The vessels started on the same line and sped up but it was very clear that *Taymyr* was stronger."

### Fesco Sakhalin

A project known as NB 486 was sold with the offshore icebreaking task combined with seismic gear for the Arctic summer in 1990, but was never built due to the collapse of the USSR. Following vessel project for Russia was not until 2005 with design and model testing of *Fesco Sakhalin*, an offshore supply and standby icebreaker. This was the first large icebreaker with Azimuth propulsion. It has a large open deck for cargo transport, cargo handling systems, and indoor space for 150 persons.

Recent icebreaker projects Mr Arpiainen has been involved in are the design work of the Canadian Polar icebreaker and the Chinese Research icebreaker. AARC has also been part of the design team for Russian icebreaker LK-25.

"The Azipod propulsion developed by AARC, Strömberg and Finnish Maritime Administration revolutionized the concept of icebreakers. The efficiency, manoeuvrability and durability achieved in ice are extraordinary. By making use of the Azimuth propulsion we have developed the Double-Acting concept, the Oblique icebreaker concept and recently the icebreaking Trimaran-concept. New innovations lead to other innovations. It is interesting to follow how they all will develop," Mr Arpiainen says.

Now I plan to retire from icebreaker design and possibly restart model building projects from my youth. My miniature railway project is still waiting for me. I also enjoy reading, drawing and rowing and I am looking forward to having more time for voluntary work with children and teenagers although I will surely miss my work and my colleagues!"

*This year was Masa's 19th race in the yearly Sulkava rowing event. He is one of the founders of AARC's rowing team.*

**Izmaylov Class**
**Harbour icebreaker, 3 vessels**

| | |
|---|---|
| Length max. | 56.5 m |
| Breadth max. | 16.0 m |
| Draught | 4.2 m |
| Diesel output | 3 000 kw (4 100 hp) |
| Shaft output | 2 500 kw (3 400 hp) |
| Displacement | 2 045 t |
| Speed in open water | 13 knots |
| Number of propellers | 2, both aft |

**Chechkin Class**
**River icebreaker, 6 vessels**

| | |
|---|---|
| Length max. | 77.6 m |
| Breadth max. | 16.3 m |
| Draught | 3.25 m |
| Diesel output | 4.65 MW (6 330 hp) |
| Shaft output | 3.2 MW (4 490 hp) |
| Displacement | 2 240 t |
| Speed in open water | 14 knots, 7.2 m/s |
| Number of propellers | 3, all aft |

**Almirante Irizar**
**Antarctic icebreaker**

| | |
|---|---|
| Length max. | 119.3 m |
| Breadth max. | 25.0 m |
| Draught | 9.5 m |
| Diesel output | 14.3 MW (19 500 hp) |
| Shaft output | 11.9 MW (16 200 hp) |
| Displacement | 14 900 t |
| Speed in open water | 16.5 knots |
| Number of propellers | 2 |

**Mudyug class**
**Subarctic icebreaker, 3 vessels**

| | |
|---|---|
| Length max. | 88.8 m |
| Breadth max. | 21.2 m |
| Draught | 6.0 m |
| Diesel output | 14.3 MW (19 500 hp) |
| Shaft output | 9.1/7.0 MW (12 400 / 10 000 hp) |
| Displacement | 5 560 t |
| Speed in open water | 16.5 knots |
| Number of propellers | 2 |

**Evdokimov class**
**River icebreaker, 8 vessels**

| | |
|---|---|
| Length max. | 75.5 m |
| Breadth max. | 16.6 m |
| Draught | 2.5 m |
| Shaft output | 3.8 MW (5 170 hp) |
| Speed in open water | 13.5 knots, 25 km/h |
| Number of propellers | 4, all aft |

**Sorokin Class**
**Polar icebreaker, 4 vessels**

| | |
|---|---|
| Length max. | 132.4 m |
| Breadth max. | 26.5 m |
| Draught | 8.5 m |
| Diesel output | 18.3 MW (24 800 hp) |
| Shaft output | 16.2 MW (22 000 hp) |
| Displacement | 14 900 t |
| Speed in open water | 19 knots |
| Number of propellers | 3, all aft |

**Taymyr class**
**Nuclear polar icebreaker, 2 vessels**

| | |
|---|---|
| Length | 150 m |
| Breadth | 28 m |
| Draught | 8.0 m |
| Steam turbines | 2 |
| Shaft output | 32.5 MW (44 200 hp) |
| Speed in open water | 18.5 knots |
| Number of propellers | 3 |

**Fesco Sakhalin**
**Icebreaking offshore supply and standby vessel, 3 vessels**

| | |
|---|---|
| Length OA | 99,9 m |
| Breadth max | 21,2 m |
| Draught | 7,5 m |
| Diesel output | 17,4 MW (23 660 hp) |
| Azimuth prop. units | 2 x 6 500 kW |
| Speed in open water | 16,7 kts |
| Number of propellers | 2 Azipods |

# 8th Arctic Passion Seminar

The popular Arctic Passion Seminar was held in March 2013 with close to one hundred participants from the shipbuilding, ship design and offshore industry.

*Aker Solutions held a demonstration model test showing the Arctic drill ship design, created jointly with Aker Arctic.*

*Finland's Minister of Transport and Communications, Ms Merja Kyllönen, talked about the Finnish Arctic strategy being developed.*

*Mr. Igor Tonkovidov, VP of Sovcomflot descibed Arctic offshore as a growth area of the company.*

*Mr Tom Paddon, Baffinland, updated on the Baffin Island Mining project.*


*Mr Andrey Kalinin, OAO Yamal LNG, described Novatek's Arctic strategies.*

*Mr Qin Weijia, Deputy General Director, China Antarctic and Arctic Administration, presented the Chinese Polar research icebreaker.*

*Mr Strambrand, VP of Rosmorport described the new icebreaker plans in Russia. Aker Arctic Sales Assistant Mrs Tsvetskova to the right.*

Ms Merja Kyllönen, Finland's Minister of Transport and Communications, opened the day by giving an update on the Finnish Arctic Strategy and the National Maritime Strategy being developed.

Dr Mihail Grigoriev from Gecon, Moscow, then talked about development and uncertainty prospects in the transport system of crude oil in the Baltic Sea.

He was followed by Mr Igor Tonkovidov from JSC SCF Group, Moscow, who presented Sovcomflot's plans for the Arctic, and Mr Tom Paddon from Baffinland Iron Mines Corporation, Toronto, who gave an update on Baffin Island Mining project.

Novatek's strategies on Arctic opportunities and Transports were described by Mr Andrey Kalinin, OAO Yamal LNG, Russia. (Read also about Yamal LNG's cooperation on page 8).

Emission reductions and Energy Efficiency regulations pose challenges for icebreaking vessels. Mr Arto Uuskallio from AARC analysed the effects of these, after which Aker Solutions held a demonstration model test showing their solution for Arctic floaters.
Aker Arctic's on-going Polar icebreaker projects; the Polar icebreaker for the Canadian Coast Guard, the Chinese Polar Research icebreaker and the Russian LK-25 Polar icebreaker were all described in detail.
Mr Mika Hovilainen, AARC, then told about the new heavy-duty Oblique icebreaker which has been planned for Arctic use. (See more on page 5).

Finally Mr Jarkko Toivola, Head of Winter Navigation at the Finnish Transport Agency, talked about the future challenges of Baltic icebreaking.

All presentations can be found on website www.akerarctic.fi/news

# President of Finland Mr Sauli Niinistö visits Aker Arctic and discusses Arctic developments

Two thirds of the world population above the 60th parallel consist of Finns. Finland is one of the founding members of the Arctic Council and the Government has recently issued an Arctic strategy.


President of Finland, Mr. Sauli Niinistö has been very interested in the Arctic developments and in preparation of his speech and discussions last autumn at the "Arctic – Territory of Dialogue" international forum in Salekhard in the Yamal-Nenets Autonomous Area in Siberia he visited Aker Arctic and learnt about the actual projects and the Company's achievements, especially with the Russian clients.

In the picture to the above left the President discusses the challenges of preparing model ice.

To the right in the picture Mr. Pekka Pokela of Gaia, who in this occasion made a presentation to the President about the "Team Arctic Finland" project; a plan for intensified co-operation between the companies having Arctic offerings and efforts for preparing more comprehensive bids in tenders organized by the major investors.

In the picture to the right President Niinistö learns more about the oblique icebreaker concept through the model of the oil combat icebreaker IB BALTIKA, see also article on page 6.

# Crown Prince Haakon of Norway at Aker Arctic

Aker Arctic works for clients from all over the world, America, Asia and Europe. Norway is opening the Northern Barents Sea with new licenses for oil and gas exploration. Norwegian companies like Aker Solutions and Statoil are actively involved in meeting the new challenges and have linked Aker Arctic in several studies and R&D works.

This was the background for the HE Crown Prince Haakon of Norway to visit Aker Arctic during his official visit to Finland last October. He was hosted by Mr. Reko-Antti Suojanen, now Managing Director of Aker Arctic, who was guiding the prince around the ice laboratory.


# The Minister for Internal Affairs and Communications of Japan visits Aker Arctic

The ministerial meeting of the Arctic Council last May in Kiruna in their declaration welcomed China, India, Italy, Japan, Republic of Korea and Singapore as new Observer States. These nations have activated their efforts in Arctic issues and last autumn Aker Arctic hosted a visit by the Minister for Internal Affairs and Communications of Japan, Mr. Yoshitaka Shindo, former State Minister of Economy, Trade and Industry in the previous Fukuda Cabinet.

Aker Arctic has over the years been co-operating with several Japanese companies, including shipyards of Sumitomo (builders of the DAS™ tankers Tempera and Mastera), Mitsubishi, Kawasaki, Sasebo, Japan Marine United as well as with shipping companies Mitsui OSK Lines.

The Kiruna meeting announced the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic, the second legally binding agreement negotiated under the auspices of the Arctic Council.

The Council also recognized the central role of business in the sustainable development of the Arctic. During Canada's Chairmanship from 2013 to 2015 the Arctic states and indigenous permanent participant organizations are facilitating the creation of a circumpolar business forum - the Arctic Economic Council.


In the pictures Minister Yoshitaka Shindo of Japan together with HE Ambassador Mr Kenji Shinoda of Japan in Helsinki hosted by Mr Reko-Antti Suojanen, Managing Director of Aker Arctic today.

# Santa Clause from Finland visits Marinetec China in Shanghai

The days before Christmas are always very busy for Santa Clause of Lapland, Finland.

This did, however, not hinder him to visit Shanghai, China during the Marintec China exhibition in December. Aker Arctic has an ongoing contract from the Chinese Arctic and Antarctic Administration to conduct the Basic Design for the first Polar Icebreaking Research Vessel newbuilding, which was displayed at the stand.

# Commander of the Russian Navy, Admiral Viktor V. Chirkov visits Aker Arctic


Aker Arctic is working for various navies interested in ice capable vessel designs. Recent interest in AARC's capabilities was shown by the Russian Navy, whose Commander, Admiral Viktor V. Chirkov visited the facility.

Several icebreakers designed by Aker Arctic staff are in service in Russian waters. See also the article on pages 16 to 17.

# Visiting Arctic:
## Coking coal transportation project for Beringtranscoal

Part of Aker Arctic's business is to conduct ice expeditions and thereby explore or verify the ice conditions prevailing in locations where the clients are planning to study investment opportunities.

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In spring 2013 Ms. Annu Oikkonen and Mr. Sami Saarinen visited in Chukotka, Russia, Bering Sea shore to investigate ice conditions in potential ship terminal locations. The area is remote and logistically challenging, but consist significant coking coal reserves. Thus marine transportation is considered inevitable to exploit these reserves. Building of marine export terminal to the studied area is considered one of the most potential alternatives to export coal to southern markets.

Ice measurements were performed during the visit. These measurements gave important information on the suitability of the proposed terminal locations. The results are utilized to select best location and further develop terminal layout and orientation to the proposed locations so that ice associated challenges at the terminal are minimized.

## *Meet us here!*

**We will participate in the following events:**

**ATC** Houston
10.-12. February 2014

**Russia Offshore** Moscow
17.-20.February 2014

**Arctic Passion Seminar** Helsinki
6. March 2014

**Arctic Shipping Forum** Helsinki
8.-10. April 2014

**OTC** Houston 5.-8. May 2014

**World Petroleum Congress**
Moscow 25.-28.June 2014

**SMM** Hamburg
4.-7. September 2014

**Arctic Shipping North America**
St. Johns 1.-3. October 2014