Aker Arctic Technology Inc Newsletter March 2013

Arctic Passion News

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Ice challenge for green ships

The ice melting in polar seas is the clear sign of the ongoing climate change on the globe.
The changes in the Arctic areas are taking place in larger scale than elsewhere yet. For Arctic operators, like Aker Arctic, this means new challenges, but potentially also opportunities and increase in business.

But the climate change may not continue. This generation cannot leave a globe to next generations where our children would not be able to live. Therefore the Kioto Protocol was reached in 1997 and shipping needs to share the responsibility in achieving a stop for the climate change. Therefore IMO has decided to set stringent requirements to world shipping.

From January 1st this year new regulations to reduce the greenhouse emissions have made the Energy Efficiency Design Index EEDI mandatory for new ships to be built. From January 1st, 2015, in specific ECA areas - including Baltic Sea, English Channel and e.g. the North-American coastal waters will put limits to SOx emissions from ships.
And new restrictions are emerging.

The naval architects all over the world are now following their colleagues in the automotive industry where already significant improvements have been reached in fuel saving. The past has shown that there is room for a lot of new achievements in the maritime industries. But how will the ships be able operate in ice where typically more power is needed and regulations like Finnish-Swedish Ice Classes stipulate high minimum levels?

This 6th issue of Arctic Passion News is devoted to these contradictory challenges. As can be seen from the articles,
there is still a wide room for new innovations. With new innovative conceptual solutions energy savings up to 50 per cent are within our reach. Existing and newly built vessels can be additionally fitted with innovative devices improving the ice performance even though main engine power levels would be reduced.

Oil spill response capability is another responsibility for the maritime industries, especially for the oil and offshore industries. It could potentially become a "show-stopper" for the industry in Arctic environments. Here, too, a lot of room is still left for new innovations. And some of the solutions are offered by Aker Arctic as can bee read in this issue.

Greener seas are possible - and efficient sustainable winter shipping and Arctic operations are within the industries' reach!

Mikko Niini

Announcements

Juha Alasoini
Juha has been appointed Test Technician for the testing services department. He transfers from Aalto University, where he has been responsible for model ice and service of refrigerating units in the model test facility more than 30 years.

Tommi Heikkilä
Tommi joined AARC as Project Engineer in the ship design department last December. He graduated as Naval Architect from Aalto University in 2012 and his thesis considered bow wash system for ice going vessels.

Esa Ritari
Esa has been appointed Project Engineer (Outfitting) in the ship design department. He transfers from STX Finland Life Cycle Services.

Heikki Sipilä
Heikki has been appointed Senior Project Manager in the ship design department. He was previously General Manager of STX Finland Life Cycle Services.

Ville Valtonen
Ville has been appointed Project Engineer (Structures) in the ship design department. Ville conducted his Master's thesis investigating cross-deck structures for the Trimaran icebreaker concept and graduated from Aalto University in 2012.

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Front cover: S.A. Agulhas II is a South African icebreaking polar supply and research ship built in Finland last year. A Joint Industry Project on ice load measurements was arranged in the ice trials giving new and valuable data to AARC.
Read more on page 19.

Challenges in developing green ice capable ships

The environmental concern of global warming is beginning to reflect on sea transportations. Although transport of goods by sea freight is far more efficient than by any other means, the global trend is to reduce emissions on all transports. New rules such as the Energy Efficiency Design Index, the Polar Code and the EU Sulphur emissions directive will regulate shipbuilding in the future.

The Aker Arctic DAS® double-acting concept solves both emission and propulsion requirements. Our idea when we develop new vessel concepts is to find ways to do the same work with higher efficiency and smaller engines.

The IMO Energy Efficiency Design Index (EEDI) came into force 1st January this year. All new bulk carriers, tankers, gas carriers, container ships, general cargo ships, refrigerated cargo ships and combination carriers larger than 400 GT will receive an index stating how efficiently cargo is transported in relation to CO_2 emissions. The lower the propulsion power, the better is the index. The reasoning behind is that when a ship uses less power to advance, less fuel is used and emissions causing global warming are reduced.

EEDI does not cover all kinds of vessels yet. For instance offshore vessels and vessels using electric propulsion are not included in the rule. Also ice-class ships up to Finnish-Swedish ice class 1 A Super have a reduced scaling, simply because it is not possible to reduce power to the same extent for ice-going ships. As per today there is no exact guidance of EEDI interpretation for higher ice classes than 1 A Super.

"The index is calculated from main engine power, which means it does not directly take into account the level of all emissions from a ship. Auxiliary engine power is taken as a function of the main engine power. Correction can be made for the calculated auxiliary engine power, when in a normal seagoing situation the actual power differs significantly from the calculated. This leaves a loophole for auxiliary systems used in icebreaking situation e.g. air bubbling systems. We come to a situation during icebreaking, where it can be more beneficial to use engines with low efficiency thus producing more Co_2 only to receive a good EEDI index. Every year the temptation to use these loopholes is increased, as the EEDI index is tightened," Sales and Marketing Manager Arto Uuskallio highlights.

The EU directive on sulphur emissions concerns certain areas so far; the coastal waters of North America, the Baltic Sea, the North Sea and the English Channel. From 2015 onwards, allowed level of sulphur emissions falls to 0.1%, which is a tenth of the current level. In order to meet the directive ships will have to either use fuel with less sulphur, which is more expensive and requires changes in engines, or install scrubbers to clean the emissions from sulphur. A third option is to use other fuels like liquefied natural gas or biofuels.

The mandatory Polar Code will regulate many issues related to ship design and operation in order to ensure safety when sailing in the Arctic and Antarctic waters. (Read more about the Polar Code on page 3.)

AARC's approach

"Our approach is that all new ships should be designed so that they are clean and energy efficient. A good example is our electrically driven Double Acting Ship®-concept, which is designed to operate without icebreaker assistance, can have bow form optimized for open water and uses even as low as 50 % of the power in ice operation compared to conventional ships. Our mission is to always find new ways to do things and new ways to do them more efficiently. We follow closely how rules and regulations develop and try to be one step ahead at all times, instead of trying to find loopholes in the regulations," Mr. Uuskallio explains.

In order to plan an efficient ice going ship that is also environmental friendly, there are four options we can help our customer with:

1. Develop ship hull forms, which are efficient both in ice and in open water operation using the tools we have, like CFD and model scale testing
2. Develop efficient vessel concepts, e.g. DAS®, Trimaran, Oblique icebreaker
3. Install auxiliary systems for improving performance in ice, e.g. vertical thruster in the bow
4. Consider different machinery concepts, e.g. gas fuel option and energy recovery systems

When developing new vessel concepts our idea is to find ways to do the same work more efficiently and with less power. Our double-acting concept, where a ship moves ahead in open water and astern in ice, had a breakthrough in the Arctic waters many years ago. The concept is also in use for oil transport in the Baltic Sea and the first dry cargo ship for the Baltic Sea was delivered last year. DAS®-ships are able to work more independently and cost-efficiently in ice and use significantly less fuel compared to conventional ships. The concept has now been further enhanced with the new multi-screw solution with a large centre propeller, whereby the overall propulsion efficiency is higher than in the "traditional" DAS® concept.

New concepts such as the Oblique icebreaker now under construction and the Trimaran icebreaker now under development are both relatively small vessels with lot of value. Both of them can for instance make an ice channel twice the width of a traditional icebreaker, but with the same propulsion power!

In certain ship types and operation modes ships can benefit from auxiliary systems designed to improve ice going capabilities. Examples of these systems are an air bubbling system or a vertical bow thruster. Both of these systems are used to reduce ice resistance and thus reduce the needed propulsion power.

Ship hulls can be developed further to optimise usage of propulsion power; at lower speed a different hull is better than at higher speed. We have also invested in Computational Fluid Dynamics programs in order to improve the open water characteristics and energy efficiency of ice going vessels due to the fact that most of modern icebreaking vessels operate a good part of the year in open water.

Then an option to consider is to make the ship gas fuelled in order to avoid SOx and to minimize Nox emissions. Compared to diesel fuel the CO_2 emissions are also reduced by 25 %. In recent years we have designed several gas fuelled ships. Also the new Coast Guard vessel for the Finnish government is dual fuelled. In order to increase the use of gas fuelled vessels, infrastructure and service points have to be developed, though.

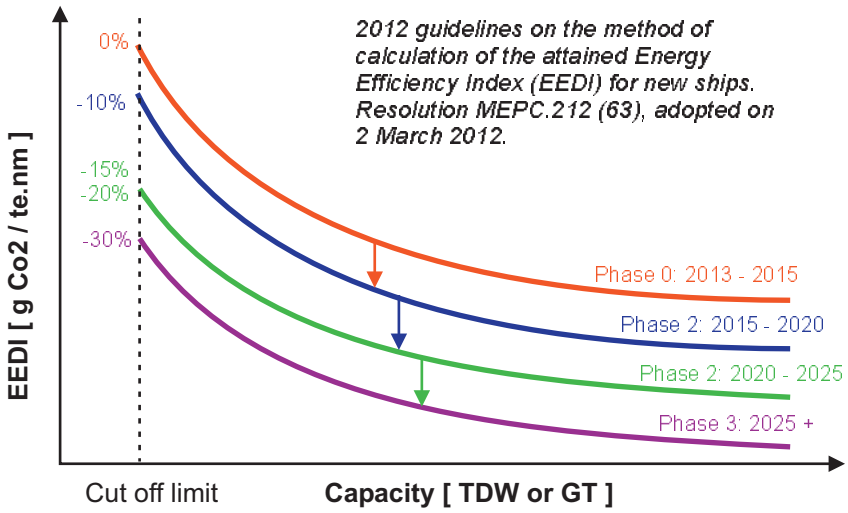
LNG-fuelled ships have cleaner emissions. We have developed several gas fuelled ships in recent times. The first LNG fuelled vessel with the new Aker Arctic multi-screw DAS® propulsion is currently under construction at STX Rauma yard for the Finnish Border Guard.

Ships can be equipped with assisting methods to improve ice going capabilities, such as air bubbling systems or a vertical thruster.

Future trends

Next development trend in environmental protection could be rules on underwater noise. There are already class notations on maximum noise emission levels for different types of vessels. Improved technique allows tighter regulations at the same time when tightening rules enhance technical development in a certain direction.

"During winter 2011 we conducted noise measurements about existing noise levels at sea in order to gather basic information about the situation today. It is essential to know the starting point before deciding on any target level," Mr. Uuskallio says. "It is important for us in Finland to follow rule development for vessels that operate in ice.



2012 guidelines on the method of calculation of the attained Energy Efficiency Index (EEDI) for new ships. Resolution MEPC.212 (63), adopted on 2 March 2012.

If there are too few vessels available on the market to transport goods to and from Finland, transportation costs will rise and we might be out of goods in the shops.

The Finnish-Swedish ice class rule regulates the minimum propulsion power for ships that get assistance in entering the Finnish ports while EEDI index drives ships towards low propulsion power. EEDI will also result in slower ships, which in turn leads to bigger vessels or to an increased need of vessels to carry out the same transport amounts as before."

It is a delicate balance and that is why AARC is not only actively monitoring global trends and changes in regulations jointly with the Finnish maritime cluster and authorities, but also lobbying and acting in the background of political decision making for the benefit of our customers. The Polar Code now being developed at IMO has to be evaluated and streamlined with other design rules and environmental regulations taking also into account a holistic view of the specialities related to shipping in ice-covered waters.

IMO's Polar Code advances

In order to improve safety in the Polar areas, IMO decided in 2010 to start a Correspondence Group to develop a compulsory regulation named the Polar Code. Arto Uuskallio from Aker Arctic is following the process to prepare for the shipbuilding requirements it will bring in the future.

The Polar Code is intended to improve personal and environmental safety in the Polar areas.

The current target is to have the Polar Code ready by 2014, says Koji Sekimizu, IMO Secretary General, who recently visited AARC and discussed among others the Polar Code.

Ships operating in the Arctic and Antarctic environments are exposed to a number of unique risks. Canada was first in developing the "Guideline for Ships Operating in Polar Waters", an international code of safety with the aim to provide that all ship operations in polar waters meet internationally acceptable standards. The International Association of Classification Societies (IACS) developed a set of unified requirements which address essential aspects of construction for ships of Polar Class. The Polar areas are not restricted by national laws and are therefore free to traverse. Traffic in the Polar areas has been increasing and after some accidents, especially in the southern oceans, a need to introduce international compulsory safety requirements beyond the existing requirements of the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL) arouse. The IMO Polar Code is the answer with the intention to improve personal and environmental safety in the Polar areas.

A complicated process

The work on the IMO Polar Code began in February 2010 and is coordinated by Norwegian Ms Turid Stemre. IMO has several subcommittees, which usually gather for its main assembly once a year. The Polar Code belongs to the subcommittee DE (Design and Equipment). During the annual meeting week, the Polar Code Working Group prepares material for decision making to the final DE meeting. The DE meeting then decides if a Correspondence Group is needed to review open issues for the following DE meeting.

"IMO follows a political process and all participating countries have a vote. If a proposition is not agreed on, the Correspondence Group has to revise it again until the next Design and Equipment committee's meeting, which might be only after one year. This slows down the process," Mr. Uuskallio says.

A moving target

In the beginning it was agreed that the Polar Code would be divided in three parts; the Actual Polar Code, Instructions for use and Motivation behind the Code. In practice the work done so far is for the first part. The Code includes chapters on ship stability, emergency and evacuation, fire safety, navigation, environment to mention a few. It concerns commercial ships with the exception of fishing vessels. Discussed is also whether to include pleasure boats. The plan is to divide ships into categories according to ice capabilities and grant permission to sail in the Polar areas during different times of the year. All ships would be required to have a Polar Waters Operation Manual (PWOM) with details on operations, crew requirements etc.

Mr. Arto Uuskallio emphasizes that the Polar Code is at the moment a working process, and there are multiple topics on the table with many of them still pending on the final selection. This makes the Polar Code a moving target and it is difficult to predict the final outcome.

"Many issues such as training, who will be allowed to grant the permissions and who will have the right to supervise the Polar Code are all under discussion and will have to be decided in the future.

Finnish goals

The main goals for Finland are to ensure that there are enough ice strengthened ships with sufficient propulsion power in the Baltic Sea in the future and to ensure that Finnish ice strengthened ships can operate elsewhere in the world. It means that the Finnish-Swedish ice class rule needs to be recognised in the Polar Code.

Companies like Aker Arctic cannot participate directly in the process, but we can follow what is happening and try to influence on the preparative work. It gives us a chance to be prepared for changes many years before they come into force. We work closely with the Finnish Transport Safety Institute Trafi who is participating in the Correspondence Group's work and the DE-meetings.They can also invite us to join in the Working Group and DE meetings, which I have done twice. The final Polar Code will be a list of requirements which have to be fulfilled. We can help our customers to prepare for this as well as advice them on how to fulfil the requirements," Mr. Uuskallio assures.

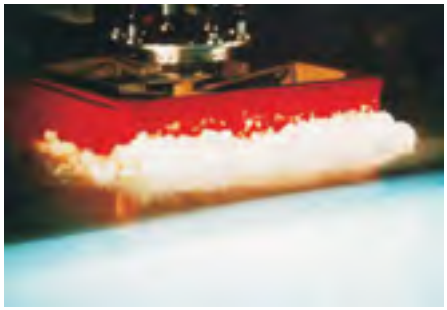
Content of the Code

The Code adresses:

- Certification
- Design
- Equipment and systems
- Operation
- Environmental protection
- To some extent manning and training

Ready for offshore challenges

Aker Arctic's offshore and coastal engineering team has sharpened its organisation and offers broader service packages as a response to customers' needs. The wide range of earlier projects gives customers a reliable base when proceeding with emerging new arctic plans.



Examples of model tests: Floating structures and Gravity Based Structure (Prirazlomnoye)

Aker Arctic has gathered its offshore and coastal engineering experts in a team in order to offer customers better service in arctic offshore projects. Service packages have been defined so that customers are offered a broader entirety. Also collaborating offshore engineering expertise has been mapped out and cooperation networks with both Finnish and foreign experts have been established.
Project Manager Sami Saarinen is responsible for coordinating the team. "We have organised ourselves to respond better to our customers' Arctic offshore needs. All offshore-projects are complex and need to be tailored according to customer requirements. We have the pieces in place from which we collect the suitable combination for each project according to demands."

Structural design is a key issue

One of the key challenges in arctic offshore and coastal engineering is designing the structures (e.g. drillships, FPUs, SEMIs, windmills, harbour piers etc.) so that they match the harsh ice conditions and meet the client requirements. Aker Arctic's core expertise is defining and minimizing the ice loads as well as associated hull structural design (geometry and ice strengthening) accordingly. Definition of possible propulsion systems and their capacity on ship-shape solutions as well as winterization belongs to AARC's services, but all processes inside the hull are primarily designed by other experts.
"Station keeping capacity, ice loads, ice management and operative window all go hand in hand. Therefore, ice management is often considered as a part of the overall Arctic Offshore Concept. Increased efforts in ice management result in an increased operative window and reverse. Usually our customers are interested in knowing about different possibilities and what would be the optimal ice management effort," Mr. Saarinen explains.

"When hull structural design is determined according to anticipated ice loads, possible propulsion system defined, winterization aspects taken into account and required ice management efforts defined for a specific case, then our ship designers can start designing the required ice management vessels and the customer gets the entire package from us."

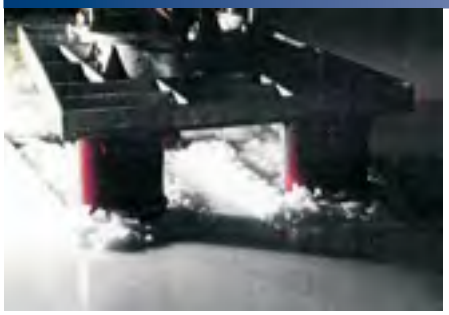
Offshore references

Aker Arctic started offshore conceptual design and model testing already in the mid 1970s. Since then the trend of offshore projects has been upwards. In the late 1980s and early 1990s Aker Arctic (at that time called MARC) took part in the design process of e.g. the **Sakhalin platforms** by developing and comparing in model scale several different conceptual alternatives.

Towards the end of 1990s, Aker Arctic's team also studied different offloading systems intensively for the **Pechora Sea.** Advantages and disadvantages associated with different loading towers, submerged loading systems and loading directly from the platform were studied and compared in several programs.

Another important reference is the development work of **Kemi I lighthouse.** The first design collapsed due to ice induced vibrations and Aker Arctic participated in designing and testing a new conical structure in the 1980s. First model testing was carried out and later full scale tests (picture 6), which gave fundamental new measurement data for the whole industry. With the measuring system installed at the lighthouse, new data on full-scale ice loads against a fixed conical structure was gathered. Still today these measurements have a significant impact when trying to understand how ice and structures interact. The measurements from Kemi I lighthouse are especially valuable in design work of arctic offshore windmills, as interaction between ice and windmills are typically very similar to this lighthouse.

During the past decade, AARC experts have been participating in the ▶



Model testing of Sakhalin platform concept alternatives (1989), left.. Kemi conical lighthouse structure model and full scale measurements.

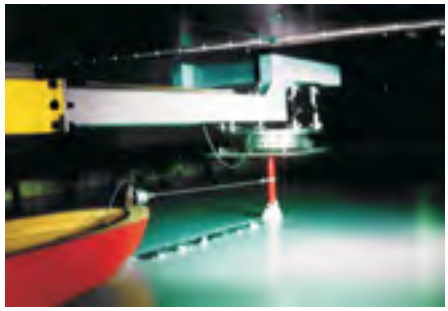
Model tests of the loading tower arrangement in Pechora Sea ice conditions (1996)

Shtokman-project where we have been part of the design teams studying ice loads for different structure alternatives as well as participating in detailed design and operational studies associated for example with risk evaluations. Model testing has naturally been part of these studies. Designing **Sabetta harbour** with the LNG piers in Yamal as well as ice management and escorting operations in the Yamal area represent a huge ongoing project, which Aker Arctic is currently involved in.

Drillships are another area where a lot of experience is already gained. One example of such projects was the 2006 upgrade and new hull for *Noble Discoverer*, which Shell was using last summer in the Beaufort drilling campaign in Alaska.

More than 1 300 tests

"Totally 81 different offshore and coastal structures have been tested in our facilities since the 1970s. The model test series comprise more than 1 300 different tests. Usually every structure is tested with various types of ice conditions, for instance managed ice, ice ridges and level ice. The structures tested include many kinds of arctic concepts such as GBS (Gravity Based Structures), different floaters, jack-ups etc. Also operational tests, e.g. loading and docking, have been made," Mr. Saarinen lists.



Varandey terminal (Pechora Sea): Model tests and real operation

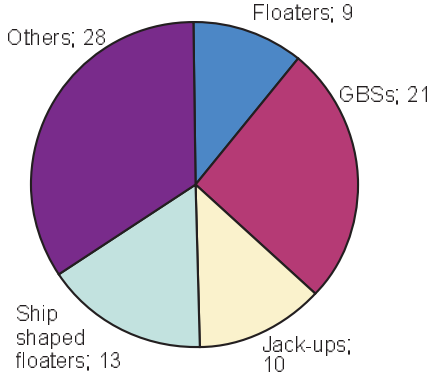
Full Scale testing with inclined cylinder installed at the bow of the ship

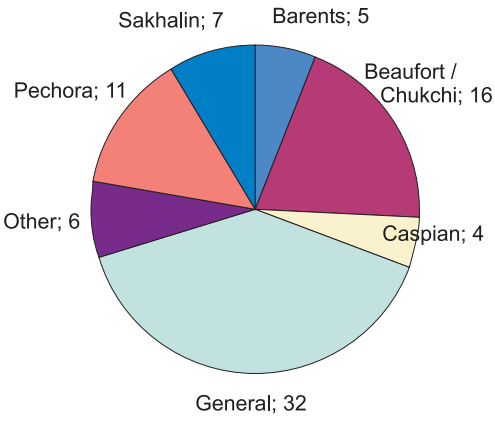
Table 1. *Conceptual design and testing projects since mid 1970s*

Concept Type	Number of different structures	Tested ice condition: Level ice	Floe ice / managed ice	Ridge / Rubble	Other ice conditions(2	Total
Floater	9	50	12	18	0	80
GBS	21	188	83	21	25	317
Jack-up	10	162	17	98	0	277
Ship shape	13	80	7	219	1	307
Other (1	28	107	46	133	72	358
Total	81	587	165	489	98	1339

1)Jackets, artificial islands, rubble generators, loading arrangements etc.
2)Ice channels, multi-year ice fragments etc...

A total of 81 structures (left) for different sea regions (right) have been tested in Aker Arctic's earlier and existing ice model testing facilities.





"The great amount of tests in different ice conditions with different structures has enabled us to form a deep understanding on ice behaviour and ice loading helping us and our customers to identify critical issues at an early phase of the project. We can take these into account already at the screening stage and share the advantages and disadvantages with our customers.

Our know-how in ice loading, ice behaviour and ice management gives our customers a reliable basis to proceed with their arctic projects."

Developing Polar icebreakers

Aker Arctic has taken a global role in the development of advanced Arctic technologies and solutions. Significant milestones for the Finnish icebreaker design and construction expertise have been the recent awards of designing the Canadian John G. Diefenbaker Polar icebreaker for the Canadian Coast Guard, the Polar Research vessel for the Polar Research Institute of China, the new *LK-25* design for FSUE Rosmorport and the European Research Icebreaker *Aurora Slim.*

Aker Arctic has a strong track record in development of polar icebreakers. *Taymyr* and *Vaygach* designed for the Russian Atomflot already more than two decades ago are valuable references and all new designs can be verified through the comprehensive full-scale tests made for them in the 1990s. Proven and tested techniques in polar icebreakers make them reliable to use, say the happy users at Atomflot.

These various designs cover solutionswith three shaftlines, one shaftline with two pods, two shafts with one centre pod and twin pods. “Our philosophy is to tailor solutions with different circumstances, for instance the Canadian Arctic is different from the Russian Arctic. We have the possibilities to do this because of our long history in developing ship hulls and propulsion systems. We also have a long history of working with governments in North America, Russia and China,” says Managing Director Mikko Niini.

Read more about the different polar icebreaker designs developed by AARC on the following pages.

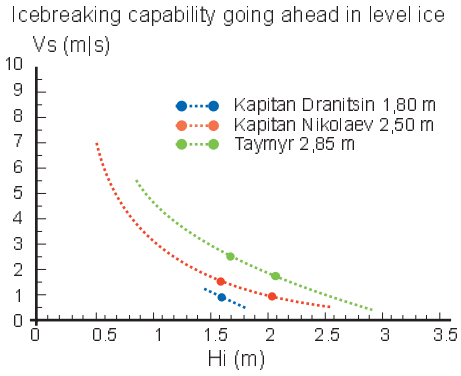
Taymyr - the first modern polar icebreaker

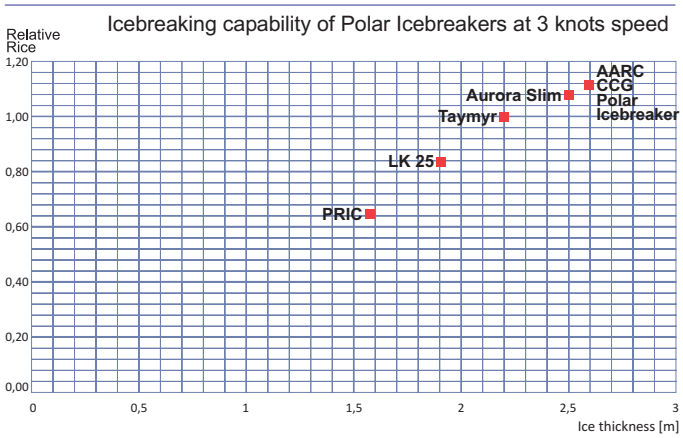
Taymyr and her sister ship *Vaygach* have been working in the Arctic already since 1990's. They are considered the first polar icebreakers with a modern ship hull and have an icebreaking capacity beyond earlier built vessels. All AARC's new polar icebreakers can be verified with full-scale tests made for these workhorses.

Taymyr is a well-known shallow draught nuclear icebreaker, which was designed and built at the shipyard in Helsinki, Finland. The nuclear reactor was installed in St. Petersburg and her maiden voyage was in 1990. She was designed to manage hard winter conditions in the river delta of Yenisei, which was too shallow for the existing nuclear icebreakers at that time, and has successfully assisted vessels for over two decades in thick ice in the polar seas. *Taymyr's* draft is 7.5 m, she has an icebreaking capacity of 2.5 m and her propulsion power is around 32 MW. “Different well proven elements have been used in the various new designs, although they differ substantially from each other, Tom Mattsson, Senior Specialist, Ice performance, explains“. The important thing is that we use proven and tested techniques in our polar icebreakers, which make them reliable to use. All new designs can be verified with full-scale tests made in the past and the fact that *Taymyr* and *Vaygach* have been working successfully in Arctic conditions for such a long time without problems. An example of their reliability is from two years ago when ice conditions outside St. Petersburg were extremely tough and *Vaygach* was called in to help vessels trapped in ice.”

Nuclear-powered shallow draft polar icebreakers Taymyr and Vaygach in the Yenisey Bay in 2006.

Full scale ice trial results for polar icebreakers Taymyr, Kapitan Nikolaev and Kapitan Dranitsyn.





Designing the Canadian polar icebreaker

For the past year Aker Arctic has been designing the new polar icebreaker for the Canadian Coast Guard as part of a team led by STX Canada Marine, which was awarded the design contract in October 2011. The multi-mission ship will be used to protect Canada's Arctic sovereignty in the North among other tasks. The second phase of the design is now being completed and the final design stage is expected to be ready in November this year.

The Canadian polar icebreaker is a step forward for Canada in icebreaker history with an icebreaking performance of 2.5 m level ice with 30 cm snow.

The Canadian Polar icebreaker *CCGS John G. Diefenbaker*, referred to as "the POLAR", is intended to replace the icebreaker CCGS Louis S. St. Laurent by 2017. The highly advanced ship will be a step forward for the Canadian Coast Guard both in terms of icebreaking capabilities, as she can move 3 knots in 2.5 m level ice with 30 cm snow, as well as in science performance.

STX Canada Marine is the prime contractor and has the overall responsibility for the design. Aker Arctic has taken a lead role in major ice related design issues such as the hull form development, hull strength, the power prediction to meet the icebreaking capability, winterization aspects (how the ship functions in low temperatures) and shafting design including propellers amongst others. Other design partners include: Imtech Marine / Techsol Marine, who are responsible for providing the electrical integration and knowledge to the project; and SNC-Lavalin who provide life-cycle, maintenance and logistics (supportability) engineering to ensure that the design team provides the Canadian Coast Guard with a design which is suitable for a service life of 40 years.

Active cooperation

"The design work has been split into three phases. The first phase was a confirmation of concept with the intention to review the concept design and make adjustments of key design criteria. The second phase, which is now concluding, is the preliminary design phase where decisions have been made on size, icebreaking capability, cargo, crew size and the ship form. In the third and final design phase the complete design package is finalized so that it is suitable for class approval and the Canadian Coast Guard can present it to Vancouver Shipyards for production design work," Project Engineer Rob Hindley says. Mr. Hindley is responsible for coordinating the different disciplines at AARC and making sure that the project runs smoothly from AARC's side.

"The Canadian Coast Guard has taken a very active role in the design work. They wanted to be able to understand the practical implications of design decisions made and we have supported the design effort with further studies to ensure the Coast Guard get a vessel that is fit for purpose. It has also been a chance for the Coast Guard to catch up on new technology as their last icebreaker was built over twenty years ago."

Icebreaking as the primary mission

"The Coast Guard made a key decision to optimise the POLAR's hull form for heavy icebreaking requirements. In addition we have taken into account open water characteristics and behaviour since the expected duration of open water transit is significant," Mr. Hindley continues.

"We have also used specialist systems for assisting icebreaking in the design, including an air bubbling system and an ice healing system. In addition a thorough study was made on the benefits and trade-offs from different propulsion solutions. We analyzed powering requirements in ice, but manoeuvring, sea keeping and open water performance were also included in the evaluation. Extensive model testing was carried out in Canada with two different propulsion configurations: A two wing shafts and a centre pod arrangement and a triple screw variant as well as some additional testing at AARC."

Aker Arctic Technology Inc. has a long history of cooperation with North America. A few years ago AARC worked with STX Canada Marine in designing the Arctic offshore patrol ship AOPS, which will soon be built in Canada. AARC have also been involved in the design of the Great Lakes icebreaker and icebreaker *Healy*, both for the US Coast Guard.

"We have a strong track record in the development of icebreakers for a range of missions and roles, which makes us a reliable partner for any customer wanting the best options for ice capabilities and winter operations," Mr. Hindley emphasizes.

Principal Particulars

Length Overall	149.3 m
Breadth	28.0 m
Depth	13.5 m
Design Draught	10.5 m
Displacement	abt. 23,700 metric tons
Complement	60 core crew + 40 program personnel
Classification	Lloyd's Register +100A1 Icebreaker+, Ice Class PC2, IBS, DP(AM), UMS, CCS, ICC, PSMR, IFP, Winterisation H(-35), A(-40)

Ship Performance

Maximum service speed: 18 knots
Icebreaking performance: 3 knots in 2.5 m level ice with 30 cm snow

Chinese icebreaker solves polar research needs

Aker Arctic was last fall selected for the conceptual and basic design of China's new Polar Research Vessel. The conceptual design stage is now finished and the next step, the basic design process starts later this year.

The advanced icebreaking research vessel ordered by the Polar Research Institute of China will be used for polar oceans research and logistics tasks mainly in Antarctica, where China has three permanent research stations. Scientists will be able to move independently to and from the polar area as well as perform advanced scientific research on the ship, which is equipped with all the scientific equipment needed. All the technical solutions chosen for the vessel itself and for research purposes represent the most modern available. The needs of polar research are all the time increasing and the Chinese icebreaker is a step ahead to solve this. The vessel is also able to operate in Arctic areas.

Dual classification

The shipbuilding process includes five phases; the conceptual design, the basic design, the detailed design, the production design and finally the construction of the vessel. Aker Arctic's responsibility is the conceptual design which is ready and the basic design which will start soon. MARIC, China's governmental design office was in October 2012 contracted to perform the detailed design and the constructing shipyard will take care of the production design.

"The vessel will be able to break 1.5 m level ice with a 20 cm snow cover. This can be performed bow first or moving astern. While planning the ship hull, our target was to have a bow with both good open water characteristics as well as good icebreaking performance. A substantial amount of CFD (Computational Fluid Dynamics) calculations were made when planning the ship hull in order to take into account hydrodynamics," Lars Lönnberg, Chief Designer of the ship tells about the planning process.

"A new special feature of the ship is a box keel below the ship. In order to perform scientific research, measuring tools need to have minimum disturbance from the water flow. The box keel enables this, but at the same time there was a challenge to ensure that the box keel does not increase ice resistance."

The vessel is fitted with diesel-electric machinery and two azimuthing propulsors. For manoeuvring and position keeping, two bow tunnel thrusters are provided. The power generation station consists of four main diesel generators sets. Propulsion power is 2 x 7.5 MW and in the aft ship there are two skegs protecting the propulsion machinery from multiyear ice blocks. With one engine the vessel can advance 12 knots, with two engines 15 knots and in ice all four engines are used as needed.

The vessel will have a dual classification and conform to China classification society rules and Lloyds Shipping rules. The design has been verified with ice model tests and sea keeping tests. Final open water tests will be performed during basic design.

Advanced research vessel

The main task of the vessel is research operations in Polar areas. 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 onboard and several scientific winches. When operating in ice conditions researchers can make use of a moon pool. 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 design has taken into account efficient internal logistics on the ship to ensure that moving equipment on board the ship is smooth. This special purpose ship has accommodation for 90 persons.

Mr. Lönnberg points out that this is the most advanced research vessel AARC has designed so far.

"The expanded concept design stage had quite an intense schedule but cooperation with our Chinese partners went very well," say both Mr. Lönnberg and Design Manager Kari Laukia. "We would especially like to mention our main negotiator Mr. Qin from Chinese Antarctic Administration (CAA) and Mr. Yuan from Polar Research Institute (PRIC) for their advices and assistance and we look forward to continuing with the next step in the design process."

Main dimensions:	
Length over all	122.5 m
Length on design waterline	117 m
Breadth max	22.3 m
Draught, at design waterline	8.0 m
Draught max	8.3 m
Depth to main deck	11.8 m

Lars Lönnberg has been working with general ship design for the past 15 years. He started his career at Helsinki Shipyard in 1997 and transferred to Aker Arctic in 2006. He studied Naval Architecture at Helsinki University of Technology (today Aalto University) and graduated in 2001. In 2004 to 2006 he was the Project Engineer for the renowned Norilsk Nickel project.

In the Chinese icebreaker project he is the Chief Designer and responsible for general design issues as well as coordinating the different design disciplines. In his free-time Lasse enjoys sailing, swimming and spending time at the leisure cottage with his wife.

The new generation European Polar Research Icebreaker

The European Research Icebreaker Consortium is an EU-funded project with the purpose to set up the framework and design for a new multi-disciplinary polar research icebreaker with core drilling capability. On the requirements set by the project and concept, *AURORA SLIM*, a cost-effective and technical solution was developed, designed and tested by AARC.

The European Research Icebreaker Consortium (ERICON -AB) project was one the 35 projects identified in the 2006 roadmap of the European Forum on Research Infrastructure (ESFRI) as a new Research Infrastructure of pan-European interest. It was the largest project in the environmental sciences. Funded by the European Commission for a period of four years, the ERICON project generated the scientific, strategic, legal, financial and organisational frameworks required for advancing the decision-making process of national governments to commit financial resources for the construction and running of a European Polar Research Icebreaker.

First design too costly

The ERICON AB initiative started in 2004 with a technical feasibility study followed by conceptual design of the ship. The design of the *AURORA BOREALIS* integrated the concept of three different vessels, a research vessel, a drilling vessel and an icebreaker into one vessel, making her a new state-of-the-art polar research drilling vessel capable of operating year-round in all Polar Regions.

The design, however, appeared to be very costly (estimated cost 800 M €), which led European Commission to drop the project from the ESFRI list of prioritized pan-European projects. However, as a lot of good results had been achieved in other parts of the project (science missions, co-operation models, legal structures etc) the ERICON-AB Stakeholder Council in 2011 asked Aker Arctic to study the possibilities for a more cost-efficient version for the task.

Having received a positive response from ABB for the possibility to use PC1 ice class pods as propulsion devices in the concept, AARC created a "slim" version for the vessel and ended up in a cost estimate under 500 M €, without compromising any of the scientific goals.

The triple azipod solution enables the possibility to clean the ice around the hull by steering the propeller wake in the needed direction. The solution also effectively prevents ice from going under the bottom, protecting the sensitive science equipment and allowing research work through the moon pool in hard ice conditions.

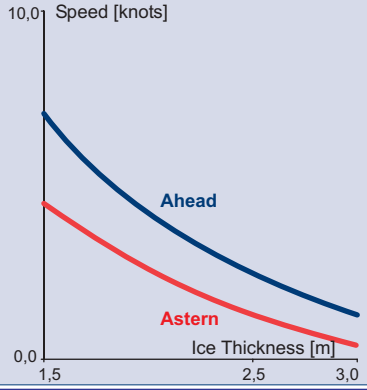
The *AURORA SLIM* by Aker Arctic is operated on the Aker Arctic DAS™ principle, is based on triple 15 MW pods and has a displacement of only 42.000 tons instead of the old 65.000 tons. Similarly the installed power has been reduced from 101 MW to 58,5 MW. A reduction of close to 45% in operating costs was estimated. The new version also incorporates the possibility to run the icebreaker for one week with LNG fuel, stored in containers on the deck.

Platform for innovation

The European research icebreaker project fulfils also another important goal; the vessel serves in an efficient way as a platform for new technical innovation, and thus meets the goals of other EU FP7 program targets. The *AURORA SLIM*, with the new pod drives and use of LNG as clean fuel, is an example of such efforts, bringing an opportunity to the European maritime industry to introduce new state-of-the-art solutions, thus strengthening the European industries' competitiveness and leading role in technological developments.

AURORA SLIM is a technically unique design, based on Aker Arctic Technology's experience and knowledge of ice going vessels. She is a combined multi-disciplinary research, deep-sea drilling and heavy icebreaking vessel and can operate in polar areas to obtain climate-related data during all seasons. In addition to heavy ice conditions, she is also intended for worldwide ocean research. To date no other single-ship, year-round polar expedition platform exists. The construction schedule has not yet been decided.

Ice breaking performance in level ice



Main dimensions (preliminary)

Length overall	163.3 m
Length waterline	152.4 m
Beam overall	37.4 m
Beam dwl	37.4 m
Draught dwl	11 m
Draught max	12 m
Depth to main deck	16.15 m
Shaft power	45.000 kW
Deadweight dwl	9100 t
Displacement dwl	42100 t
Displacement max	47400 t
Ice class	Polar class 1
Classification	GL, LR

First Aker Arctic multi-screw DAS® hybrid propulsion application

AARC was responsible for Russian icebreaker LK 25, which was last year contracted to OOO Baltic Shipyard. Icebreaker LK 25 was designed for the Russian icebreaker and port operator FSUE Rosmorport in 2008.

AARC was part of the design team and was responsible for developing the ship hull, propulsion configuration and ice model tests. Petrobalt was the main design contractor and coordinator.

On October 10, 2012 an official keel-laying ceremony was held in the presence of Prime Minister Dmitry Medvedyev for the new generation 25 MW diesel-electric icebreaker, known as Project 22 600.

"Construction of the icebreaker has started in St. Petersburg. On October 10, 2012 an official keel-laying ceremony was held in the presence of Prime Minister Dmitry Medvedyev for the new generation 25 MW diesel-electric icebreaker, known as Project 22 600," Project Manager Lasse Lönnberg tells.

Crane for subsurface work

Rosmorport plans to use the icebreaker for independent escort of ships, auxiliary icebreaker operation as part of convoys along the Northern Sea Route as well as for independent ship escort in shallow waters of the Arctic seas and in river estuaries. She will be supporting cargo unloading on coastal ice, towage of ships and other floating facilities in ice conditions and in open seas, serve in emergency and rescue operations in ice and open water, act as fire-fighter for other ships, drilling and oil production facilities. The icebreaker will also carry equipment for cleaning up oil spills. For the first time, this class of ships are slated to have a lifting crane able to hoist up to 150 tonnes for the purpose of subsurface technical work in areas where drilling and oil-production platforms are operating and in regions where underwater pipe is being laid. She is also intended for transport of scientific expeditions to the Arctic and Antarctic regions and has accommodation for 90 people, more than 300 m² of premises for scientific laboratories and is able to take two heavy helicopters like MI-8 or KA-32 onboard.

The vessel is scheduled for completion in November 2015. The contract worth RUB 7.25 billion was signed in December 2011 in the presence of (at that time) Prime Minister Vladimir Putin.

First Multi-Screw DAS® Aker Arctic hybrid propulsion solution

The Project 22.600 icebreaker LK-25 will replace two outdated icebreakers; the *Ermak* and the *Kapitan Sorokin* (built in Finland in 1974 and 1977) in the Gulf of Finland. The vessel differs significantly from those of the previous generation in terms of its specifications and abilities. It boasts the world's first applied Aker Arctic-developed Multi-Screw DAS® hybrid propulsion solution. The propulsion system will include two Azipod thruster units, each of 7.5 MW, and one centreline shaft with a FP propeller providing an additional 10 MW output. The Azipod propulsion units for the vessel are designed for extreme Arctic ice class RMRS Icebreaker-8 and will make it possible to reduce fuel consumption by up to 20%. The icebreaker is able to proceed continuously both ahead and astern at the speed of 2 knots in compact ice field up to 2 m thick with 20 cm of snow cover and temperatures as low as minus 35 degrees Celsius.

General characteristics of LK-25	
Length	142 m
Breadth	29 m
Depth	16.2 m
Maximum draught	9.50 m
Full displacement	22,130 t
Gross tonnage approx.	20 450
Main DG power output	4 x 8 700 KW
Crew	38
Specialized personnel	90
Class notation: KM Icebreaker 8 [2] AUT1-ICS OMBO FF2WS DYN-POS-2 EPP ANTI-ICE ECO-S HELIDECK-H WINTERIZATION (-40) Special purpose ship.	

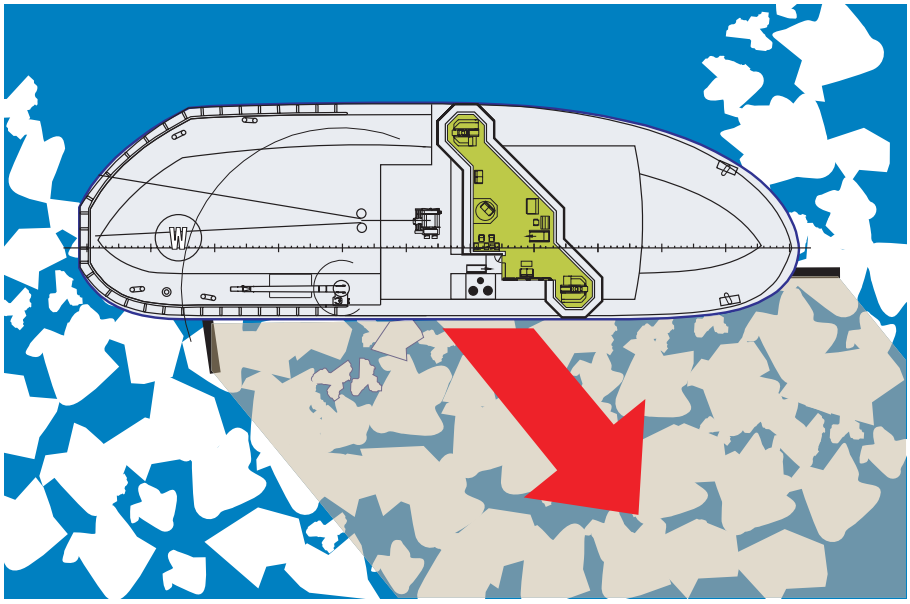
St. Petersburg-based OOO Baltic Plant-Shipbuilding (Baltic Shipyard) is one of the largest shipbuilding enterprises in Russia. The shipyard specializes in the construction of diesel and nuclear-powered icebreakers, ice-class vessels, heavy lift vessels and warships. Baltic Plant-Shipbuilding Ltd is a legal entity formed in December 2011 to take over new builds order book and workforce from Baltic Shipyard, which was at the time facing insolvency.

In August 2012, Baltic Shipyard, a subsidiary of United Shipbuilding, won another $1.17 bln order from Atomflot to build the first new generation nuclear-powered icebreaker, the LK-60. With a capacity of 60MW, the LK-60 is expected to be the largest and most powerful icebreaker vessel ever built in the world. AARC conducted ice model tests also for this project in the early development phase.

LK - 25 February 2013

Oblique icebreaker for Arctic use

The oblique icebreaker concept is an excellent example of the innovative thinking at Aker Arctic on how to find completely new solutions to a problem.



The entire length of the oblique icebreaker can be used for collecting oil, which makes it much more efficient than the traditional way of using oil booms on the sides of a ship.

Despite the small size of the oblique icebreaker, it can create a wide channel for large-size vessels as well as be used for efficient oil spill combat in heavy seas. The asymmetric hull enables a sideways movement both in ice and open water. One side of the ship is inclined enabling it to be used for icebreaking and the other side has a hatch for brush skimmers to be used in oil spill recovery. The oil recovery can be performed in up to 2 metres significant wave height for the current Baltic version. It is also exceptionally flexible to operate in ice because of the hull form and propulsion system with two aft propulsors and one in the front. We are now further developing the concept for Arctic use.

The innovation process

The oblique icebreaker concept was a result of an internal innovation contest in the late 1990's. An analyze was at that time made on what kind of vessels needed assistance in the Baltic Sea and how the situation would develop in the years to come when new oil terminals were to be built in the Gulf of Finland. The conclusion was that the oil transportation would use Aframax-size tankers with a beam of over 40 metres and they would need to be assisted by at least two icebreakers due to their large size. That would become very expensive and an innovation contest for the staff was initiated on how this problem could be solved.

The first version of the sideways moving icebreaker came in the end of 1996 and first model tests were made in 1997. The oblique icebreaker concept was patented already the same year. The decision to build Primorsk oil terminal was made in 1999 and later that year the oblique icebreaker's hull was updated and ice model tests were made. Then came the idea to use the ship for oil spill collection and the oil spill response patent was received in 2002. Systematic further development took place jointly with the Finnish Maritime Administration, The Finnish Environment Institute SYKE, ABB and us, partly funded by Finnish Technology Fund Tekes.

In 2003 the newly developed project was introduced to authorities in Finland and Russia. The vessel received wide-spread attention due to the exceptional concept, but it wasn't until 2010 when Sovcomflot's CEO Sergey Frank - the former Minister of Transport in Russia - finally made the initiative for a memorandum of cooperation on the further development of the oblique icebreaker vessel. The following year however, plans were changed and the Russian Ministry of Transport became the contractor of the ship and in October 2011 Arctech Helsinki Shipyard and Yantar JSC were jointly awarded the contract to build the first oblique icebreaker, known as ARC 100, which should be ready for delivery in the end of 2013. The vessel will be used at the oil terminals on the eastern shores of Gulf of Finland for assisting tankers and vessels in terminals, rescue operations and oil spill combat in the Baltic Sea.

Efficient oil spill recovery

The oblique icebreaker is very efficient in oil spill collection because as she moves sideways, the entire length of the ship can be used as a sweeping arm, “oil boom” for oil recovery, which makes it much more efficient than the traditional way with oil booms on the side of a ship

Water movement on the brush collector becomes calm as the ship hull protects from waves and the oil is skimmed in a transverse tunnel and directed into tanks. When using the traditional method with oil booms on vessels' sides, the waves can easily flush over and under and oil collection is not as efficient.

Arctic concept

““Our next step is to design an Arctic version of the oblique icebreaker. We believe it could be very useful for ice management functions in Arctic operations. The exceptionally flexible steering would bring safety to drilling operations as none of the vessels in use today can move in the same way. The vessel can even turn around on the spot in ice. Her strength in oil spill combat is another feature needed in oil drilling,” Sales and Marketing Manager Arto Uuskallio tells.

“The first issue we have to solve is ice resistance, propulsion power and hull strength and then decide on the ship size. Wave characteristics in the Arctic differ from the Baltic Sea and therefore the Arctic ship has to be tailor-made for Arctic circumstances. Also the Arctic areas differ from each other so the best option is to have a specific area in mind when designing the vessel. From experience we know that the development process advances much faster when there is an interested customer waiting for the result. We therefore encourage interested parties to contact us if they have needs in this area,” Mr. Uuskallio invites.

New modelling tools for ice management

AARC's new advanced calculation and simulation tool is now available for planning ice management operations. First ice simulator is now underway for Aboa Mare training center in Turku, Finland.

Many Arctic operations are associated with ice management activity. Pre-planning by using simulation and risk evaluation provide the way to right and safe decisions already in early phases of the decision-making.

The basic problem a ship operator faces in Arctic operations is the varying demands of ice management for different areas and different projects. It is hard to find the optimal ships for a specific task because there are many options available and the different combinations are hard to compare. Depending on the task and available icebreakers there can be a choice of even up to four icebreakers performing the ice management function. Also the best operation pattern varies with the ship characteristics combined with ice thickness.

Optimal ice management

At Aker Arctic, we have approached this issue by first creating a model for Ice Management operation patterns. The patterns are divided in four categories; traditional circular icebreaking, zigzag icebreaking, parallel formation for difficult conditions and double circular icebreaking pattern. In order to find the best operation concept for each ice management situation we have further developed mathematical models which can be used to calculate every combination's capacity and the optimal operation pattern. With the help of the results, we can then resolve the amount of ships, the icebreaker type, performance and power needed and choose the optimal icebreaking pattern depending on the ice conditions.

We also co-operate with AKAC Inc. of Canada, which is working with the analytical tools and also has a vast experience of real data from the early operations in the Beaufort Sea and Sakhalin waters. They have also participated in verification of our test cases.

"The efficiency of the ice management can be calculated as well as the operation's cost by using our calculation models , says Reko Suojanen, responsible for R&D and developing the ice simulator. "Calculations indicate for instance that using a traditional circular icebreaking pattern in demanding ice circumstances requires more icebreakers than if using other patterns."

The next step when a customer wants to investigate more precisely the solution for his ice management operation plan is to use our real time ice simulator system. This system has just recently been developed to such a level that it can be used for advanced ice management studies. With the real time simulator system the bigger picture in ice management can be studied, including the practical issues, human effect and communication aspects. The simulated circumstances need to be determined case by case including the icebreaker models and environmental conditions e.g. wind, current water depth and ice.

"If there is a very specific need on the vessel models, we recommend verification with model tests in our testing basin. Ice model testing is a reliable tool and with the combination of the test results and simulated modelling various options can be studied," Mr. Suojanen advices.

Optimal operation patterns depend on the ice conditions. Our mathematical models can be used to calculate the optimal pattern for each situation.

Verified models

The real time ice simulator has been developed in partnership with Finnish software and system development companies Imagesoft and Simulco and the work has been supported by the Finnish Technology Fund Tekes.

"In order to verify our mathematical models on how ships behave in different ice situations, we have used a vast amount of model test results and full-scale test results for validation.

Aker Arctic is known for its huge data-base gathered for decades, so we can proudly say that our simulator models are the most accurate in the world," Mr. Suojanen tells. All types of icebreakers can be simulated, both with propeller rudder propulsion systems and azimuthing propulsion systems. The machinery system is modelled realistically and takes into account machinery load response. Different types of ice can be simulated, including unbroken ice, ice floes, brash ice and pack ice with ridges. The ice simulator also has a sophisticated visual system. Different ship models, ice situations as well as weather conditions are clearly visualised.

"We are now further improving the simulator by adding models which can simulate propeller wash effect and effects of ice cracking," Mr. Suojanen adds.

First agreement signed

The real time ice simulator is not only an excellent tool for finding optimal ice management solutions. It can also be used in operative training especially when accurate and reliable models on how a ship operates are needed. Icebreaker crew training is crucial and will benefit from simulation.

The Finnish Maritime Academy Aboa Mare in Turku has realised the potential in training and have in February signed an agreement to install and start using this high-level real time ice simulator in their training facility.

Mr. Suojanen tells that preparations are now also under way to install a smaller simulator bridge system at Aker Arctic's own premises so that it can easier be used in customer projects both for optimising ice management and tailor-made operative studies before hand-over of ships we have designed. It will also support our ship design team while developing new vessels. The simulator will be sold separately for training purposes.

"All in all, the ice simulator is a magnificent tool and offers elements for various use; planning of ice management operations, ship design and training."

Future trends in Finnish transports and icebreaking

The Finnish Transport Agency is responsible for transport connections and development of the transport system in Finland. This includes the road, railway and water networks. New Director-General Antti Vehviläinen tells about future trends in transports and icebreaking.

Director-General Antti Vehviläinen. Mr Vehviläinen and AARC staff have been working together in several logistic improvement projects like year round winter sailings in the Saimaa lake waterways, experimental barge carrier operations for paper products and most recently in the development of the special ECU paper carriers for Stora-Enso.

Mr. Antti Vehviläinen is since 1st January this year, the new Director-General of the Finnish Transport Agency. Previously he worked 35 years in the private sector, first 10 years for the Finnish shipping industry in various administrative, economic and logistics tasks in Finland, Germany and South-America and then 25 years for the Finnish forest industry as Vice President, logistics at Enso Gutzeit, which later became Stora Enso.

"During my career I have received a global view of the entire logistics chain, which is a valuable knowledge in my current position," Mr. Vehviläinen tells. "As responsible of logistics at Enso Gutzeit and Stora Enso, I learnt to know all Finnish transport connections as we transported our goods by road, rail and waterways. I also learnt to know all modes of transport and what are the advantages and challenges in each of them, as well as the European and international transport network. Especially valuable is the contact network I was able to build up during those years, which I believe will be useful in my work at the Finnish Transport Agency."

"Another important aspect I bring to the Transport Agency is the need to see things from a customer perspective. Everything we do is because our customers need it and our role is to maintain a transport network for our customers."

Future trends

The Transport Agency is responsible for maintaining and developing the transport networks. Regarding the important waterways and port services, Mr. Vehviläinen sees the need to review existing services.

"With new regulations in shipping, e.g. the sulphur directive, environmental efficiency design index (EEDI), NOx restrictions just to mention a few, transport costs may rise at the same time when vessel power is decreasing, leading to an increased need of icebreaking services at ports in Finland. For us, this will be a challenge which has to be solved. One possible solution could be to restrict the Agency's liability to provide icebreaking only for the main waterways "the sea highways", whereas the ports themselves could take care of icebreaking from the port connecting to the main "highway". In this way the costs to keep the Finnish waterways open would remain acceptable for the Finnish government."

Finland is part of the European Union and has agreed to provide traffic arrangements in accordance with the rest of EU. But being a country in the periphery, and additionally surrounded by ice in winter time, we have to bear higher logistics costs than other European countries. Already in the EU accession contract, we have received a special status in a Joint EU Declaration on Safeguarding Finland's Transport Links because of our winter circumstances, but this has never really been highlighted.

"The fairness of this is something which has to be explored and whether part of the rising costs could be supported by the EU," Mr. Vehviläinen ponders.

Trade balance is shifting

The trade balance in e.g. the forest industry is changing from Europe towards east. Container traffic is increasingly moving towards transports to e.g. Russia, Ukraine and China. USA and Western Europe are decreasing their consumption while Eastern countries are increasing theirs. Mr. Vehviläinen believes this trend will continue and will apply also to other industries.

"In the future more and more cargo will move through the Baltic countries and Russia. In the long run the Trans-Siberian Railway will become significant when prices become more reasonable and the Russian waterways will come to use when infrastructure is developed. This trend is also a possibility for the Finnish transport industry due to our location."

New icebreaker

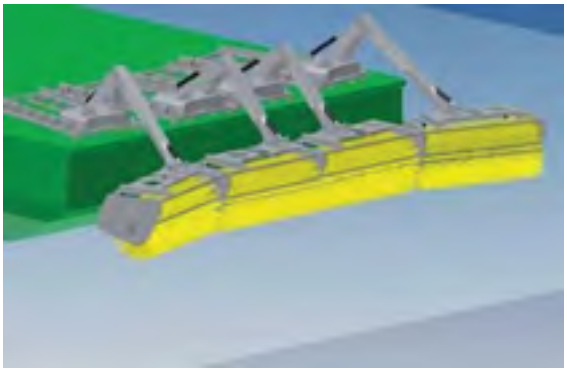
The Finnish government has not been investing in icebreakers in recent years but the Transport Agency is now building a new icebreaker for the Baltic Sea, which is planned to be ready in early 2016.

"The Agency and the icebreaker could be a platform for new technology, supporting innovations as long as they fit into the economical limits. We also have a huge amount of know-how within the Transport Agency which ought to come into better use in the future," Mr. Vehviläinen says.

Finland has about 3900 km of merchant shipping lanes. Coastal fairways constitute about 8200 km and inland waterways 8000 km which comprises 41 lock canals. In Finland there are 23 ports that are kept open around the year, which handle about 80% of all freight traffic. Logistics cost account for 15-20% of the gross national economy.

Inventions for Arctic oil spill recovery

Oil spill accidents are always environmental disasters, but they may turn to catastrophes if oil spill recovery is not successfully prepared for. One of the main environmental concerns in the maritime industry today is oil spill recovery in fragile areas and inventions are badly needed.



SYKE- developed ice brush skimmer packages that could be a standard outfit for any Arctic support vessel in the future.

Oil spill recovery is a serious environmental issue and oil spill recovery in ice is a challenge, which has been discussed for decades since the February 1979 MT *Antonio Gramsci* grounding caused the largest crude oil spill (6.000 tons) in the frozen Baltic Sea so far. After the more recent serious accident in Gulf of Mexico three years ago, oil drilling permissions have been slow to process and no permissions are granted in e.g. Alaska for drilling during ice periods. Major oil companies have now realised that oil spill combat could be a show stopper limiting their possibilities to drill in the sensitive areas and new equipment for efficient oil spill recovery especially for freezing waters is needed quickly.

Innovations in Finland

The Finnish maritime cluster has together with the Finnish Environmental Institute SYKE been working hard to find solutions to these challenges. The Baltic Sea is very fragile with its shallow waters and network of small islands that form the archipelago and need to be protected in case of an oil tanker accident. In winter the sea is also ice covered. After the *Antonio Gramsci* oil spill, of which only 15 per cent was collected from the shores, purpose built oil spill response vessels and equipments were acquired by the Governments. After years of hard work, Finland has now become in a world leading position in this matter. Since those days two new large oil export terminals have been opened in the Baltic Sea and 100.000 tdw tankers sail across the sensitive Baltic Sea daily. Due to these intense tanker passages a national investment and development program was formed a few years ago by the Ministry of Environment. Finland decided to invest in three heavy, ice-class oil combat vessels. The goal was set to clear an oil spill of 30.000 tons in magnitude. Also Russia and Estonia were encouraged to make their own response plans.

Last year, the first of the Finnish protection vessels was ready and entered into service. FNS *Louhi* represents state-of-the art technology in responding to marine oil and chemical spills. She is able to collect oil from the sea during storms and also in ice conditions with the aid of stern-mounted brush skimmers.

The second vessel is an LNG fuelled icebreaking offshore patrol vessel for the Finnish Border Guard. The vessel is being built at Rauma shipyard and will be ready this year. Aker Arctic and Elomatic conducted the feasibility verification and the concept design work in partnership. The vessel will be on duty 24/7 for border safety and rescue operations and is able to collect oil spills also in winter conditions.

"The decision to build the third vessel has been made recently and according to plans it should be ready for use in early 2016. We have just recently submitted the necessary background design materials for the vessel to the Finnish Transport Agency," says AARC's Managing Director Mikko Niini.

"Russia has also showed responsibility and decided two years ago to invest in our new Oblique ARC - 100 icebreaker concept, which is now being built in Russia and finalised in Finland later this year. The vessel is expected to be used in the newly built Ust-Luga terminal on the southern shore of Gulf of Finland. The concept of the oblique icebreaker is exceptional due to its asymmetric hull, which enables icebreaking sideways and efficient oil combat in hard weather. We are now planning to introduce an Arctic concept of the vessel." (Read more on page 13).

The impossible becomes possible

Aker Arctic's idea is to offer new inventions to the market that solve impossible issues. One example is the Double Acting Ship-concept, which has enabled economically viable shipments in areas previously considered impossible. "Now we want to do the same for oil spill combat. During twenty years ship designers have tried to find efficient solutions to oil spill combat. Now something has to happen. In Finland we have the winter circumstances and the best starting point. At AARC we have the experts, the experience and the testing facilities. All this put together means that we can find an efficient solution to this problem. Our motto is to enable sustainable solutions in the Arctic and we intend to live up to it," Mr. Niini emphasizes.

"A testimony of our strength is the Oil and Gas Producers Association's recent decision to choose Finnish partners for three feasibility studies as part of their joint development project for Arctic oil combat."

Full-scale testing facility for oil spill combat needed

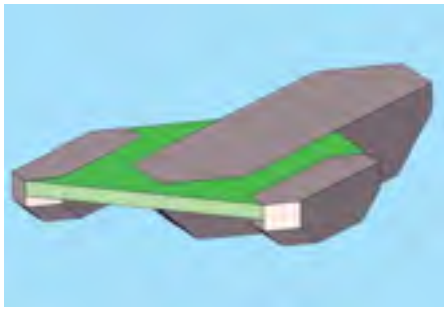
There is no testing facility in the world available for full-scale testing of oil spill recovery equipment in winter conditions. All tests are made in theory as we can nowhere in the world spill out oil in nature only for testing purposes. The only full-scale activities so far have been during accidents. Development work advances therefore slowly. The Finnish Environmental Institute SYKE has also acknowledged that there is a demand for a full-scale testing facility and it could possibly be built in Finland. Aker Arctic is promoting to construct one next to our facilities, where there is an old dock basin currently unoccupied that could be suitable. "Port of Helsinki has been approached but we are still waiting for green light. International oil majors have already showed interest in joining the project," Mikko Niini tells.

Dimensioning loads for icebreaking trimarans

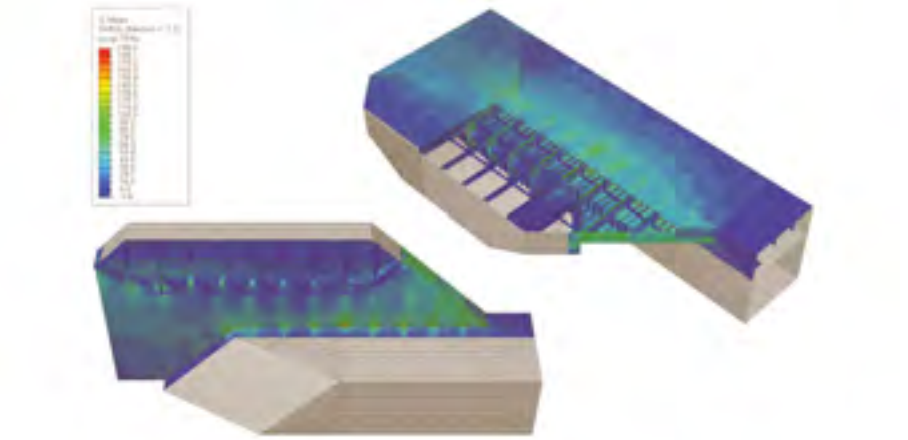
Mr. Ville Valtonen conducted his Master's thesis studying the dimensioning principles of cross-deck structures of icebreaking trimarans. The methods he chose for calculating the dimensioning loads were derived for the conditions of the Baltic Sea for both open water and first-year ice.

These methods were examined by calculating the loads for an example ship with the length of 75 m and a beam of 40 m. The structural responses from the loads were compared with a finite element model.

The Trimaran hull used for concept development



Simplified ship hull used for determining dimensioning loads



Results from calculating maximum ice loads during the vessel's lifetime using finite element method

The load cases studied in open water included still water, wave and slamming loads. Wave loads were calculated with the static-balance method and the classification rules of GL and LR. Rule formulas of the LR trimaran rules could not be used for the icebreaking trimaran, because the size of the side hull exceeds the applicability limits of the rules. Thus a static roll angle method from direct calculation procedure was used instead. In the calculations made with the example ship, the largest of all loads were the wave loads. All used calculation methods for wave loads provided fairly similar loads. Slamming loads may also be significant and further research is necessary to determine if slamming should be considered in dimensioning of the cross deck.

Impact of ice loads

The studied loads in ice included loads from icebreaking, compressive ice, beaching and manoeuvring. Icebreaking loads were of the same magnitude as wave loads, and only slightly lower. Thus icebreaking loads are significant in dimensioning. Loads from beaching on ice ridges were significantly smaller than icebreaking loads and are not significant in dimensioning. The loads from both compressive ice and manoeuvring were lower than icebreaking loads, manoeuvring being the larger of these two. Due to the different orientation of these forces, the larger of these two has to be considered in dimensioning.

As the trimaran can operate both ahead and astern, ice loads were calculated in both operating modes. Calculations of ice loads were based on data from long term measurements and Aker Arctic's database and experience, which includes a wide range of measurements gathered by icebreakers over decades. Results were also verified against this data.

The dimensioning loads for the example ship are wave loads, icebreaking and manoeuvring in ice. The results suggest that the cross deck structure of an icebreaking trimaran similar to the example ship can be feasibly built. The dimensioning methods developed can also be used for icebreaking trimarans with different main dimensions.

Arctic trimaran

Employed now by AARC, Mr. Valtonen will continue to study the dimensioning loads for an Arctic trimaran. “For an Arctic trimaran, local ice conditions have to be taken into account in addition to the ice loads I have used in this study. Ice loads from multi-year ice are different to first-year ice loads and for instance Caspian Sea has the additional challenge of shallow waters. The best option is to tailor every vessel for its intended use.”

Trimaran concept for oil spill combat

One of the latest innovations in icebreaking and mechanical oil spill combat is the use of a trimaran concept. Model tests have given encouraging results and the development work continues.

The new ship concept was developed after initial testing of a trimaran for icebreaking in general and after having found the right location and size for the side hulls, a preliminary icebreaker concept was created and tested. The surprising conclusion was that a trimaran was able to operate in thick ice conditions and could create a rather clean channel twice as wide as a traditional icebreaker with the same propulsion power! With rising fuel costs and tightening demands on emissions, this is indeed very interesting and promising for future icebreaking.

Oil spill collection tested

The Finnish Environment Institute and Mobimar Ltd. joined AARC in a project for assessing the suitability of the concept for oil spill combat in icy waters. We developed and patented a grid which was placed between the main body and the side hulls. The purpose of the long grid was to push the ice down under the water so that the oil would rise to the surface, then be collected and directed into tanks in the main body.

"When the Arctic Council's delegations negotiating in Helsinki for the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic - which is to be signed this forthcoming May - had their meeting in Finland last June, we invited them to supervise our oil spill model test. We filled the ice testing basin with plastic balls the same density as oil and demonstrated how the trimaran made a wide channel in the ice while collecting "oil" with the aid of the grids on each side of the main body. It was surprisingly efficient," says Topi Leiviskä, Manager of Research and Testing Services. "The trimaran model is now available for further testing. It can also be equipped for wireless testing so that several models can be tested simultaneously in the testing basin if needed.

This is useful for instance when simulating ice management as it visualises the entire operation." (Multi model testing was presented in Passion News 2/2012.)

Construction verified

A step in the development project was to study the dimensioning principles of cross-deck structures of icebreaking trimarans to establish how the steel structure should optimally be constructed as well as to ensure that the constructiondoes not become too heavy. Mr. Ville Valtonen conducted his Master's thesis on this topic. The conclusions are encouraging and suggest that the trimaran is suitable for icebreaking and oil spill combat. (page 5).

Aker Arctic will now continue developing the trimaran further, hoping to find interested partners to join in developing a trimaran for Arctic use.

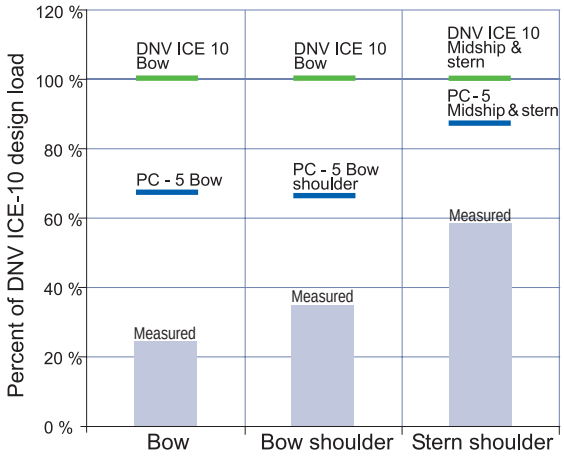
Our oil spill recovery test showed that grids placed between the main body and the side hulls separated oil from ice and collected oil efficiently. It could then be directed into tanks in the main body.

Front cover: More information on aft shoulder ice impacts

S.A. Agulhas II is a South African icebreaking polar supply and research ship built in Finland last year. Aker Arctic had a strong involvement in the development and design of the vessel and now participates in a Joint Industry Project in which among others ice load and underwater noise measurements in Antarctic ice are being arranged. The ice trials in the Gulf of Bothnia last year have already given valuable new data to AARC.

AARC's focus areas in the research plan are the aft shoulder ice load analysis as well as underwater noise created by icebreaking. Already the preliminary results from the measurements on aft shoulder ice impacts are revealing a weak point, as was expected, in the current ice class rules. In normal vessel operation in soft spring ice the loads at the aft shoulder region are relatively high compared to loads measured from the bow and bow shoulder regions and close to the allowable level according to the rules. It is also to be observed that the new PC rule values are lower than more traditional DNV.

"*S.A. Agulhas II* has just arrived from her first mission in Antarctica and measurements on the ship were done also during this trip. The project continues until summer 2014. We will start to analyse data gathered from measurements in Antarctic ice conditions soon and compare them to the measurements gathered from ice trials in Bay of Bothnia. In addition to ice loads in different sea regions, it will bring us useful knowledge about ice load behaviour in various hull regions during different ship manoeuvres," Project Manager Sami Saarinen tells.



The preliminary results from the Gulf of Bothnia measurements on aft shoulder ice impact show relatively high loads compared to loads measured from other areas. The blue lines show the level of PC 5 and green lines DNV Ice-10 dimensioning criteria. The final report may lead to class rule improvements.

Finnish Vikings on the road

Mauri Lindholm showed true Viking spirit in the thousand-year-old axe-throwing competition.

Anders Mård and Mirkka Hayashi dressed in traditional Viking outfits.

Last November, AARC's employees relaxed at the Viking Centre in beautiful Finnish archipelago after a full day of interesting company visits.

The recent teambuilding trip took AARC employees on a tour to south-western Finnish shipbuilding companies. The first stop was at Konepaja Häkkinen, a company specialising in subsea production and pod structures. Turku Shipyard was next on the programme, where the new LNG-fuelled cruise vessel for the Baltic Sea, *Viking Grace*, was being built. Mobimar Ltd. is a cooperation partner and has joined us develop the icebreaking Trimaran concept. A visit to their factory acquainted us with the smaller trimarans they are producing, as well as fast rescue vessels currently in production. After a bus ride to Teijo, we visited Western shipyard and Marine Alutech. The new superfast Watercat M18-AMC vessel for the Finnish Navy was presented.

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In the evening a waterbus took the group to Rosala Viking Centre, which is a unique Viking village out on an island in the archipelago where the Viking past and the Iron Age come to life. After getting dressed in traditional outfits, we enjoyed a delicious dinner with Viking age program in the reconstructed Chieftain hall Rodeborg. An experience everyone will remember was no doubt the thousand-year-old axe-throwing competition. Nobody got hurt.

"The trip was excellent with plenty of interesting company visits and the cultural experience to round the day off," says Graphic Designer Kari Selonen.

The Viking past and the Iron Age come to life in the reconstructed Chieftain hall Rodeborg, where we enjoyed a traditional Viking dinner.

Konepaja Häkkinen specialises in subsea production and pod structures. AARC employees are studying drilling risers.

Marine Alutech manufactures fast pilot boats and military transport vessels for the Baltic Sea.

Meet us here!

We will participate in the following events:

6.-7. March
Offshore Support Vessel North America Conference
Houston, USA

10.-11. April
4th annual Arctic Oil and Gas North America
St John's, Canada

23.-25. April
The 9th annual Arctic Shipping Forum
Helsinki, Finland

6.-9. May
OTC 2013, Offshore Technology Conference
Houston, USA

9.-13. June
POAC 2013, The International Conference on Port and Ocean Engineering under Arctic Conditions
Espoo, Finland

25.-28. June
MIOGE 2013, 12th biennial Moscow International Oil & Gas Exhibition
Moscow, Russia

30. June -5. July
ISOPE 2013, the 23rd International Ocean and Polar Engineering Conference
Anchorage USA

24.-27. September
Neva 2013
St. Petersburg, Russia