First Arctic module carrier for Yamal LNG plant

Aker Arctic has actively been involved in researching and creating logistic and operational solutions for Yamal LNG since 2010. In addition to developing LNG-carriers, port icebreakers and assisting in designing the harbour of Sabetta on the Yamal Peninsula, we have helped in preparations for the new LNG plant. The plant construction is based on a modular principle, with modules manufactured all around the world, gathered in Europe and then transported to Yamal. Aker Arctic has recently been responsible for designing two Polar class heavy deck carriers for the safe transportation of these modules to the plant construction site. The development work has been carried out in close cooperation with ZPMC-Red Box Energy Services.

Main dimensions

Length	206.6 m
Breadth	43 m
Draught	7.5 (max 8 m)
Deck load	max 21 800 tons
Flat cargo deck area	7 500 m²
Propulsion	2 x 12 MW

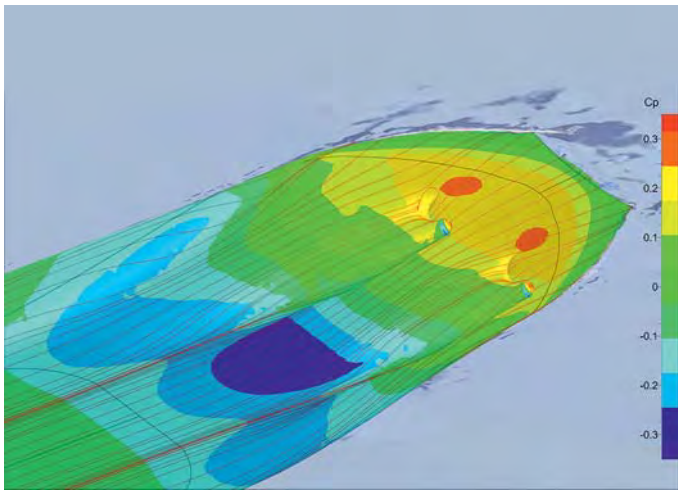
The Liquefied Natural Gas plant in Sabetta will be constructed of several hundred different modules, which are built at different locations around the world. These modules weigh up to 10,000 tons and will be gathered in a European harbour before shipment to Yamal. It will take about four years to deliver them all to the Arctic area. Due to the harsh conditions found in the area with temperatures down to minus 40 degrees Celsius for part of the year, no ordinary vessel is able to take care of this kind of transportation.

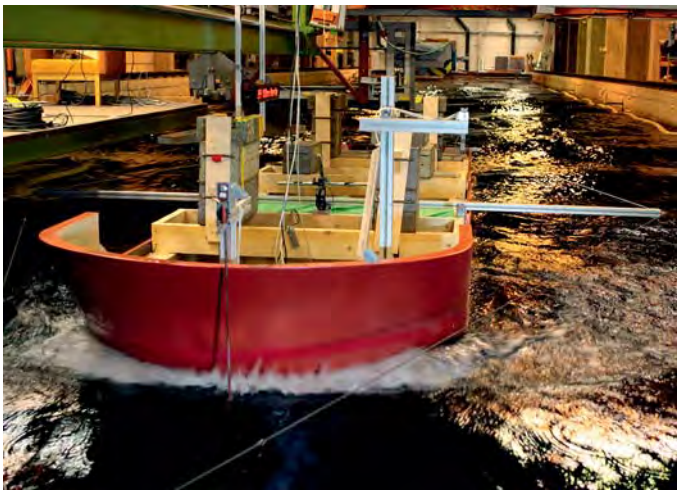
Cargo ship with Polar Class 3

Aker Arctic has now, in close cooperation with ZPMC-Red Box Energy Services, developed two module carriers, which can operate year-round in delivering the modules to Yamal. These carriers are different from anything designed and constructed earlier. They are typical heavy cargo ships with a wide cargo deck, but designed for exceptional ice circumstances as they need to be able to move in the Gulf of Ob round the year in order to keep the construction of the LNG plant on schedule. The ice class is therefore Polar Class 3.

"Two of the major challenges in designing the vessels were firstly the weight of the modules and secondly the way they will be loaded onto the ship, as the ship needs to stay balanced at all times. We had to optimise the construction so that it did not become too heavy but remained strong enough to manage the weight," Project Manager Mika Hovilainen explains. "The ship draught had to be between 8-12 metres and loading needed to be done regardless of changing tides. Additionally, we had to take into account the Arctic weather and the schedule was tight. We began the project in autumn 2013, construction will begin autumn 2014 and delivery of the vessels will be at the end of 2015/beginning of 2016."

Rinse van Lievenoogen, Chief Technical Officer at ZPMC-Red Box Energy Services, and responsible for the ongoing collaboration between the ZPMC-Red Box and the Aker Arctic Design Teams states,

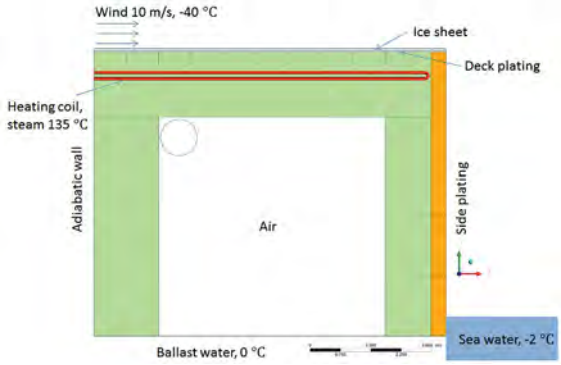


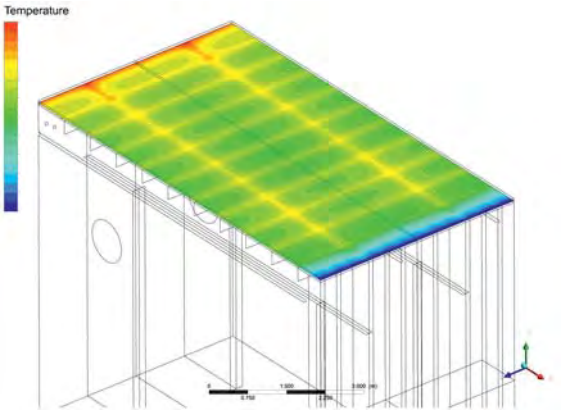


”The stability requirements of a vessel like this requires a highly sophisticated ballast system. The additional complexity of operating this ballast system above the Arctic Circle posed a major technical challenge in the concept design phase of these unique vessels. Maintaining equilibrium between the vessel deck and the loading quay throughout the tidal cycle while at the same time being able to precisely manage the trim of the vessel during the discharge of ultra heavy cargoes was a critical criteria in our required specifications.

ZPMC-Red Box contributed a new ballast system design which transfers ballast water internally in such a way as to improve the control and efficiency of discharge operations. The safe discharge of high value modules for energy infrastructure projects has been an area of constant focus to our Team at ZPMC-Red Box and we were extremely pleased with the close cooperation we enjoyed working with our partners at Aker Arctic on these PC-3 Module Carriers.

We were also pleased to see Aker Arctic incorporate our suggested Bridge design, which not only complies with the NAUT-AW requirements, it assures maximum visibility, from every position on the Bridge, allowing the safest possible Arctic navigation while maximizing the performance of the vessels in the most extreme arctic conditions."





The surface temperature field of the deck after the specified heating time. The highest temperatures are located above other structural members, whereas the lowest temperatures can be found near the cold side plating.

CFD calculations were used for optimising open water characteristics.

A special feature of the ship is the deck heating system. After extensive calculations and modelling, the final solution was to place steam pipes below the deck, which are turned on 24 hours before unloading.

Deck heating system

A special feature of the ship is the heating system of the deck. Spray blown off the sea and freezing immediately on contact with the ship can create snow and ice cover on the large 43 by 175 metre deck area. Ice in particular must be removed from the deck to ensure safe operation during offloading. Various options were studied in order to find the best solution for the removal of the ice.

“We used CFD tools to model both radiation and convection from possible heating systems to the deck. ▶

Icebreaking port tug ARC 125 underway

The basic design process of an icebreaking port tug for Yamal LNG is underway with model testing already done. In the beginning she will assist the Arctic module carrier in harbour operations and later other vessels. Her primary tasks are escorting services, icebreaking, assistance in harbour operations and ice management functions.

She is designed for year-round operations in the Sabetta harbour area. Her ice strengthening enables independent operations in pre-broken thick first year ice and her hull form is designed for operations in thick brash ice conditions, while still maintaining adequate operability as an escort and harbour tug.

The tug is able to proceed at a speed of 2 knots in both 1.0 metre level ice and 4 metre thick brash ice with consolidated layer on top in limited water depth, which prevails in Sabetta harbour.

Aker ARC 101 design IBSSV "Fesco Sakhalin" at an oil platform in the Sakhalin-1 project.

The challenge was to optimise the heating system so that it is efficient, but does not create too much weight," Structural Engineer Teemu Ikonen tells. "The final solution was to place steam pipes below the deck, which are turned on 24 hours before the arrival. The heat melts the ice enough to create a thin water layer below it so that the rest can be shuffled away mechanically."

Extensive model testing

The vessel will have an operation profile where most of the voyage will be sailed in open water and following a route along the Norwegian coast with challenging wave conditions. An extensive amount of model testing was made in order to ensure that the requirements of both good open water features and ice performance were met without construction prices becoming excessive. Slamming pressure measurement was particularly important. CFD calculations were used extensively for optimising open water characteristics.

“Our aim was to develop a carrier with a good performance combination both for open water and ice, and we succeeded in this," Mr Hovilainen adds. "The carrier can proceed at a speed of 3 knots in 1.5 metre thick ice with 2 x 12 MW propulsion power."

Expertise at all stages

"In this project, we have been able to offer our know-how at all stages, making the initial feasibility studies of the Yamal area, developing LNG transport solutions, assisting in the harbour design, planning various assisting vessels, and now continuing with delivering a design for this arctic module carrier for the constructing shipyard Guangzhou Shipyard International in China," Project Manager Heikki Sipilä emphasises.

"For the module carrier, we were first responsible for the design concept and we are continuing now with the basic design process. All development work is carried out in close cooperation with the shipowner ZPMC-Red Box Energy Services.

Once the vessels are built we will take care of the full-scale ice trials. This is an important reference for us, which shows how we can serve our customers throughout a project. It is also an example of how both our theoretical and practical expertise can be combined."

Special vessels needed for supply operations in the Arctic

The Arctic area is challenging, not only because it is remote, conditions are harsh for a substantial part of the year, but also because there is no infrastructure in place. The vessels needed in this area have to be specially designed for the prevailing conditions.

During the warmest summer months, lower ice-class vessels can be used but as soon as temperatures drop, the operative window closes if vessels are not adequately designed. Also, supply operations need special vessels.

"These kinds of vessels are typically not available for charter as they have to be tailor-made, which means that the delivery time is long. As the operative window is narrow in the Arctic, it can become very costly if investment decisions are delayed and consequently the time frame extends, not only by a few months but even by a year because of the operative window. Our core know-how is how to plan successfully for operations, logistics and supply functions in the Arctic, so we welcome customers who have investment plans to come forward and talk to us for advice in all these matters at an early stage," explains Marketing Manager Arto Uuskallio.

Meet Heikki Sipilä

Heikki Sipilä joined Aker Arctic last year in April. He has worked all his life with ship development and ship engineering in Turku, Finland, first with Wärtsilä, then Masa Yards and lastly at STX Life cycle services before beginning his employment at Aker Arctic.

He lives in Turku with his wife and drives between the Turku and Helsinki offices, often several times per week. Apart from work, he takes an interest in forestry at his leisure cottage in the Tampere area. Heikki is responsible for the basic design of the Arctic module carrier.