New Chinese polar research vessel under construction

Aker Arctic completed the basic design of a highly advanced icebreaking research vessel for the Polar Research Institute of China in the autumn 2017. The steel fabrication for the hull is now ongoing at Jiangnan Shipyard in Shanghai and the PC 3 ice class vessel is planned for delivery in 2019.

The steel hull is being welded at Jiangnan Shipyard in Shanghai.

The icebreaking research vessel ordered by the Polar Research Institute of China will be used for research and logistics tasks for the polar oceans, mainly in Antarctica, where China has four permanent research stations. It will be possible to transport cargo and scientists independently to and from the polar regions, as well as perform advanced scientific research on-board the ship, which is equipped with all the main scientific equipment needed. All the technical solutions chosen for both the vessel itself, and for research purposes, represent the most modern available on the market.

Design process

In 2012 Aker Arctic was selected for the conceptual and basic design of a new Chinese polar research vessel.
"After the concept design we carried out a substantial number of model tests both in open water and in ice to verify the performance of the vessel," says Kari Laukia, head of ship design at Aker Arctic. "Then followed a three-year period of feasibility studies together with the ship owner to ensure that the vessel was designed to meet its mission goals and the solutions chosen were adequate and the best available."

The basic design was completed in 2017 and the classification societies, China Classification Society and Lloyd's Register of Shipping, have both verified the design. Construction is now well underway with the steel hull being welded at Jiangnan Shipyard in Shanghai, China. "Although Aker Arctic has successfully finalised the basic design, we are also supporting the owner in areas which are typically important for an icebreaker's operation and reliability by participating in tests such as inclining tests, open water sea trials and other checks before ship delivery," Laukia says.

The vessel, named *Xue Long 2*, will be launched in 2018. According to the plans, it will be ready and delivered in summer 2019. Full-scale tests are planned to take place the following winter.

Advanced solutions

"While planning the vessel, the aim was to create a hull with good icebreaking performance and open water characteristics because the vessel will be travelling for long distances in open water on its way to Antarctica," Laukia explains. The PC 3 ice class vessel will be able to break ice which is 1.5 metres thick with snow cover of 20 cm. This can be performed bow first, which is the primary operation mode. In its astern mode the ship can move in difficult ice conditions effectively, but the ship is not designed to move astern continuously. A considerable amount of CFD (Computational Fluid Dynamics) calculations together with model testing were also made to take hydrodynamics into account. The ship's icebreaking performance was verified by conducting numerous ice model tests.

The vessel will be fitted with diesel-electric machinery and two azimuthing propulsors. For manoeuvring and maintaining position, two bow tunnel thrusters will be provided. The power generation station consists of four main diesel generator sets. The propulsion power is 2 x 7.5 MW and in the aft ship two skegs will protect the propulsion from multi-year ice floes. The vessel can maintain an economic transit speed of 12 knots in open water using one engine and 15 knots with two engines, and in difficult ice conditions all four engines can be used.

A DP-2 dynamic positioning system was chosen to assure both redundancy in general sea conditions and good performance in bad Southern Ocean sea conditions.

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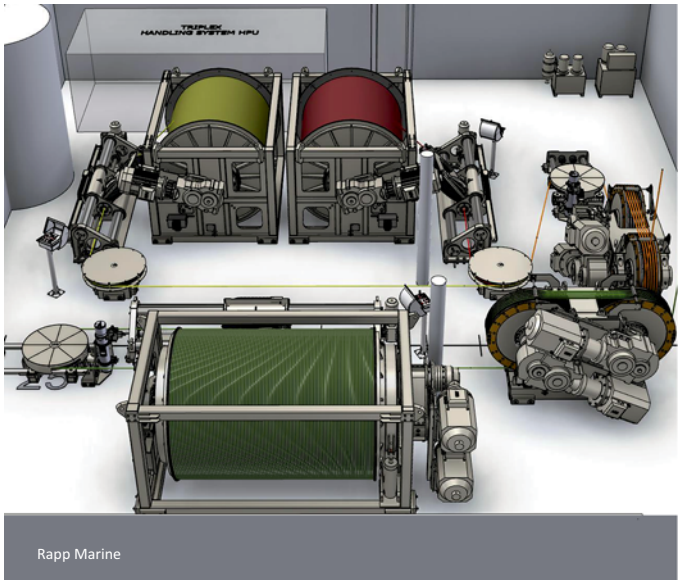
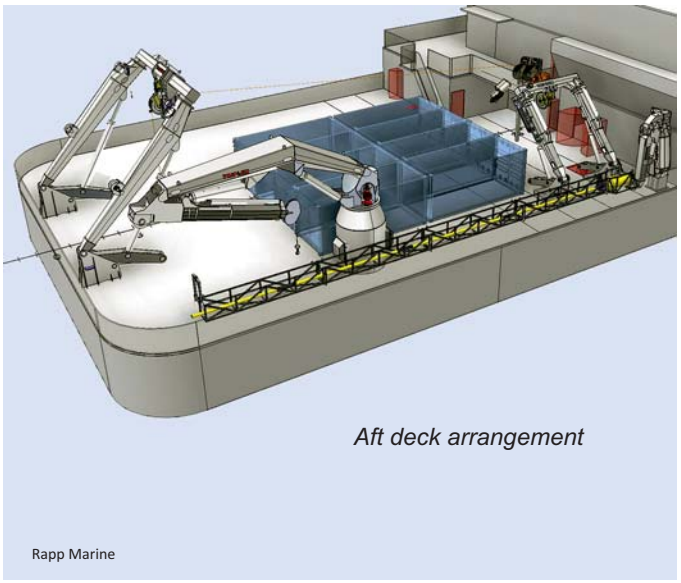
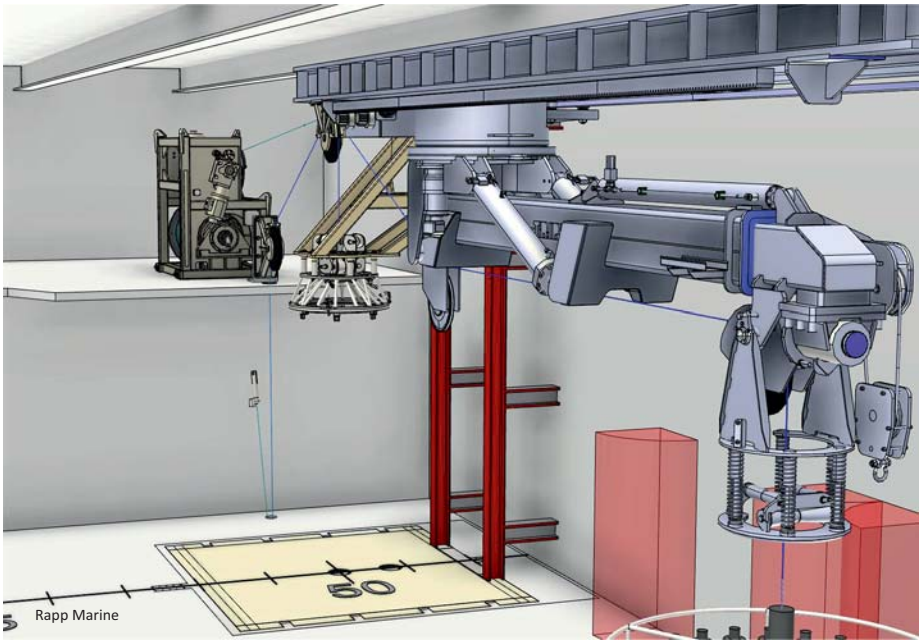
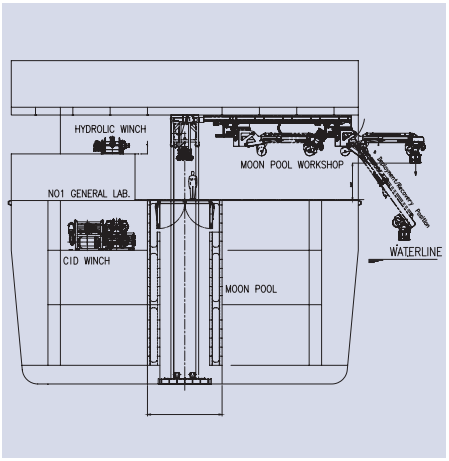


Winch room arrangement



Aft deck arrangement





Moon pool arrangement

Double classification ensures that the vessel complies with the rules from both China Classification Society and Lloyd's Register of Shipping.

"A special feature for the ship is the use of an LNG driven generating set, which ensures clean air operation when needed. This posed some challenges in taking the impact of hazardous areas into consideration in the design," Laukia says.

"Another demanding design challenge was to combine the Polar Code requirements for ice damage and special purpose ship damage stability requirements."

Scientific equipment

The main task of the vessel is to carry out research operations in the polar regions. It is therefore fitted with highly advanced scientific equipment and instruments for marine geological and geophysical research, as well as marine biological and ecological research in addition to climate change monitoring and marine and seismic surveys. Laboratory space is abundant and there are several scientific winches.

"It is an extremely advanced research ship in addition to having icebreaking capabilities," emphasises Laukia.

When operating in icy conditions, researchers can make use of a moon pool to extend their research work. A special feature of the ship is a box keel below the ship. The location of the box keel was designed with the aim of achieving a minimal disturbance of the water flow while performing scientific tasks and for the minimum degree of ice contact during ice operation. This has required a significant amount of calculations, simulations and model testing.

Additionally, there are large cargo spaces in the bow, spacious cargo fuel tanks and a cargo crane for efficient cargo handling. A helicopter landing pad and a hangar accommodating two helicopters are located on deck 7.

The design has taken efficient internal logistics into account on board the vessel to ensure that all logistic operations are carried out easily and effectively.

Underwater noise, as well as inboard noise prevention have been significant design drivers. This has resulted in a double resilient mounting for the main engines and raising the diesel generator

Technical details

Length	122.5 m	Power plant	2 x Wärtsilä 16V32, 2 x Wärtsilä 12V32
Beam	22.3 m	Propulsion	Two azimuthing propulsors (2 x 7.5 MW)
Draught	7.85 m	Personnel	90

sets one deck higher than usual, for instance. Special noise insulation arrangements, as well as extensive vibration analyses were carried out in order to achieve low vibration and noise levels.

Expert in research icebreakers

"It has been an interesting long-term project to design and develop this advanced polar icebreaking research vessel with our Chinese customer," Laukia says. "We have both learnt a lot from each other. In this process we have learnt about research in polar waters and our customer has discovered how to utilise advanced ice technology in fulfilling the demands of a research vessel for polar regions."

China currently has one research icebreaker, *Xue Long*.

"Once this new advanced polar research vessel is delivered in 2019, China will be in an excellent position to service the stations in Antarctica as well as perform scientific research," Laukia adds.

In addition to the new, icebreaking research vessel, Aker Arctic has had an extensive role in designing the Canadian Coast Guard polar icebreaker CCGS *John G. Diefenbaker*, which also will have research missions once it is constructed. The company also worked on the basic design of a French polar logistics vessel *L'Astrolabe* which was delivered last year. In the winter of 2015, Aker Arctic further performed full-scale trials of the American research vessel *Sikuliaq* in the Bering Sea while conducting ice operational training of the officers. Aker Arctic was part of the design group for the vessel long before it was built.

”We took part in the design team supporting Glosten Design with ice issues and confirmed the ice performance with model tests before the *Sikuliaq* was built," says Aker Arctic CEO Reko-Antti Suojanen.

For the United States Coast Guard medium icebreaker USCGC *Healy*, delivered in 1999, Aker Arctic experts provided extensive conceptual development and design support, including hull form development and propulsion line engineering.

"Through our extensive experience we have gained essential competencies which can benefit new polar research vessel projects," Laukia emphasizes.