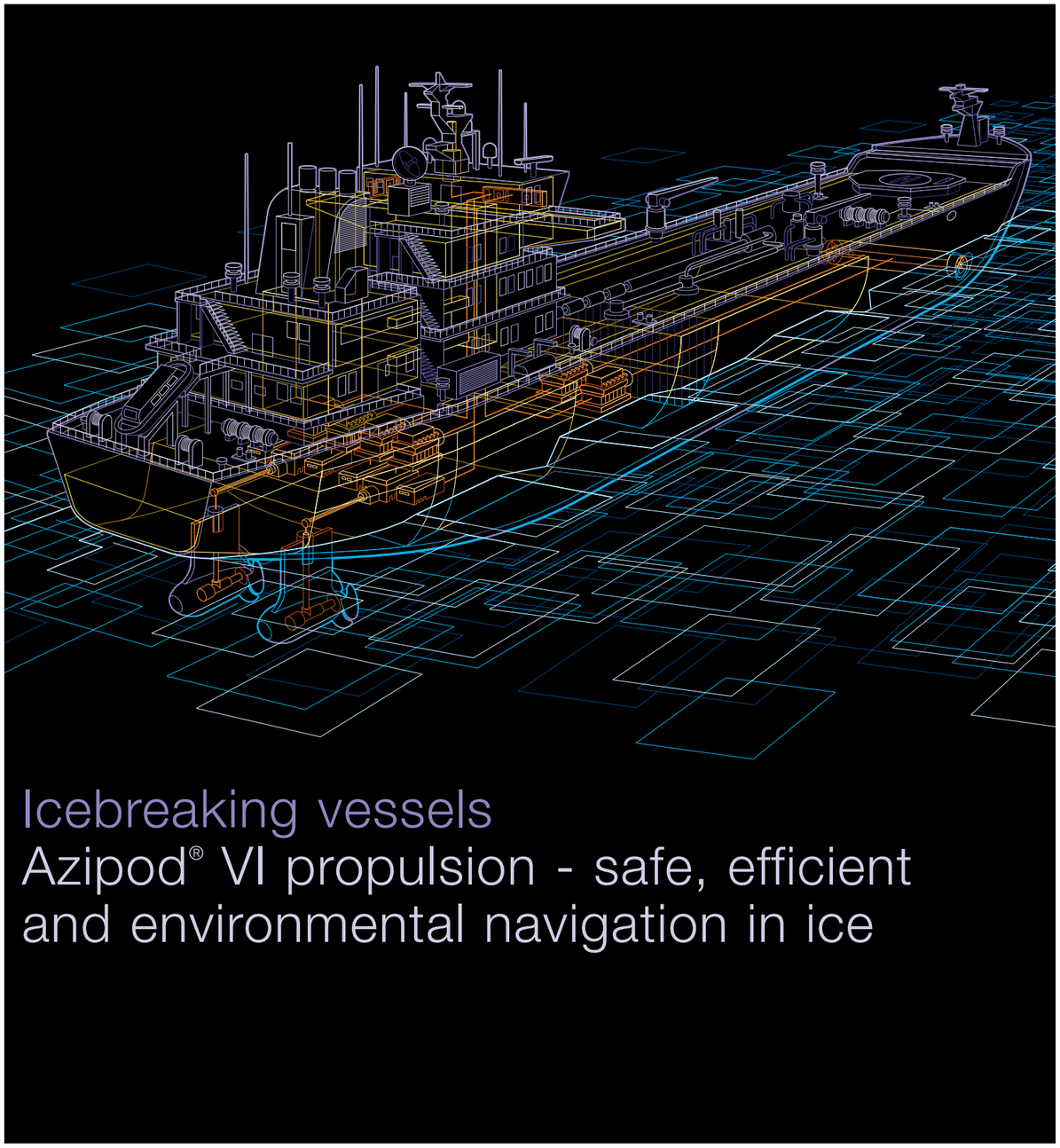
Contact us

ABB Oy
Marine
Merenkulkijankatu 1
P.O. Box 185
FI-00981 Helsinki
Finland
Phone: +358 10 2211
Fax: +358 10 222 2350

ABB AS
Marine
Bergerveien 12
P.O. Box 94
NO-1375 Billingstad
Norway
Phone: +47 22 87 20 00
Fax: +47 22 35 36 80

www.abb.com/marine



Icebreaking vessels
Azipod® VI propulsion - safe, efficient and environmental navigation in ice

Power and productivity for a better world™

Power and productivity for a better world™

Extreme conditions, extreme demands ...

Sovcomflot's Arctic shuttle tanker *MT Vasily Dinkov* and her sister vessels are equipped with 2 x 10 MW Azipod VI propulsion systems.

... darkness, isolation, and temperatures cold enough to freeze mercury. Massive ice loads on the hull and propulsion system. Conditions that place heavy demands on crew and vessels.

Growing fleet of icebreaking vessels

The last decade has seen a substantial growth in the construction of vessels for use in Arctic waters. The enormous oil and gas resource potential in this area is one of the driving forces. Another main driver is the commercial attraction of the shorter voyage through the ice-choked Northern Route or the North West Passage.

This new arctic fleet includes small and large tankers, container and bulk ships, LNG carriers and a wide range of offshore vessels. Reliability, and safety for people and the environment are paramount for these advanced ice-navigating vessels. It is therefore critical that they be based on proven marine technology and extensive Arctic knowledge and experience.

Azipod® VI - the result of 75 years leadership in ice propulsion

ABB delivered the first electric propulsion system to an icebreaker in 1939. Today icebreaking and icegoing vessels are a core business area for the company. In 1990 ABB revolutionized the industry with the launch of Azipod® - an electric podded propulsion system specifically developed for icebreaking vessels.

Azipod quickly became the propulsion of choice for ice-breaking vessels, and for the last 20 years Azipod has been a key contributing factor in the development of modern high ice-class vessels of all types.

Working with a wide variety of customers, vessel types and conditions in different geographic locations, ABB has accumulated unmatched knowledge in propulsion for ice-covered waters. Based on this experience ABB delivers total electric power plant and propulsion solutions designed for individual vessel requirements.

A remarable track record in ice:

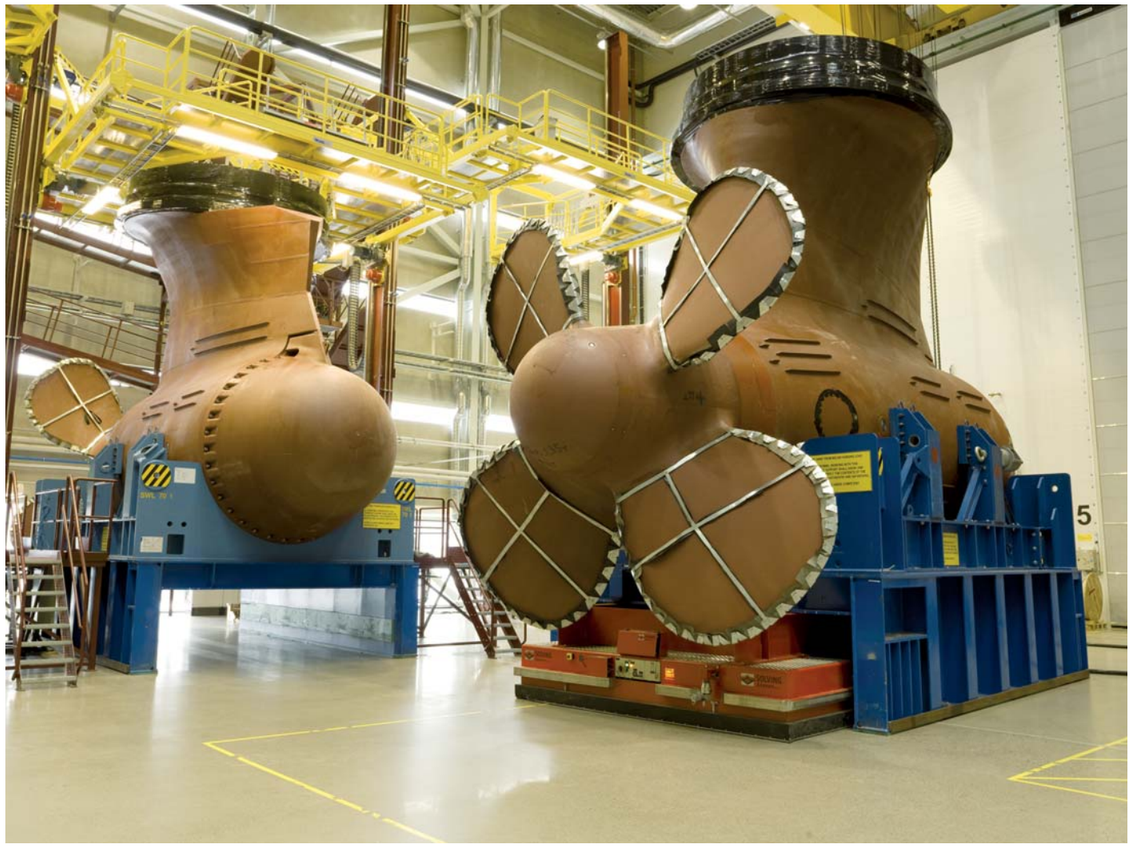
ABB has delivered electric propulsion to more than 80 icebreaking vessels

First Azipod® delivered to icebreaking vessels in 1990

Since then 2 out of 3 high ice-class vessels have chosen Azipod®

Millions of operating hours in ice - no ice damage

Azipod VI propulsion units for *MT Vasily Dinkov* under production in ABB's modern Azipod factory in Helsinki, Finland.



Outstanding icebreaking capabilities

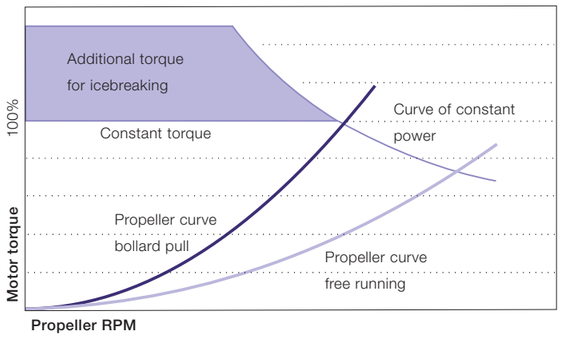
Azipod® VI is the leading propulsion system for icebreaking vessels and has proven its unique reliability and icebreaking capability in a wide range of ship types. Azipod® has widened the classic view of icebreakers, and is a perfect match for the new generation of commercial vessels which can operate independently in ice without the assistance of icebreakers.

Why electric propulsion?

The electric power plant and electric drive system are an important part of the Azipod concept. Vessels operating in ice need high torque at the propeller shaft, especially when the propeller is surrounded by ice. Unlike diesel engines, electric motors can be designed with a torque characteristic that gives maximum torque at low propeller speed, even when the propeller is stationary.

In addition, an electric propulsion system allows overtorque and in combination with the rugged Azipod unit these capabilities can be utilized to keep the propeller rotating in heavy ice conditions.

Typical torque-rpm characteristic of Azipod propulsion system.



Why Azipod®?

Azipod was developed to address the specific power and maneuverability requirements necessary for ships to operate effectively in ice. Throughout the years the product has been continuously refined, and today's Azipod VI represents cutting-edge ice propulsion technology.

The main benefits of Azipod include:

- **Enhanced maneuverability in heavy ice conditions.** 360-degree rotation provides full torque and thrust in any direction, even at zero propeller speed and in reverse.

- **Robust mechanical design.** No bevel gears and a single short shaft line mean that the torque capacity of the electric motor can be fully utilized.

- **Strength and stiffness.** The framed structure of the Azipod hull and the short rigid shaftline withstand sudden thrust changes and high impact loads during ice milling.

- **Freedom in ship design.** Azipod provides great design flexibility and the possibility to design ships with good operational characteristics in both ice and open water.

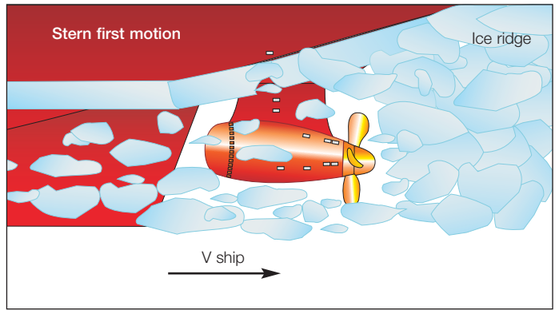
Azipod® and double acting ship operations

It has long been known that running a ship astern in ice improves its ice-going capability, due to the flushing effect from the propellers decreasing the friction. However, with traditional ships this has been difficult to exploit, because the rudder can be damaged and maneuverability is greatly reduced.

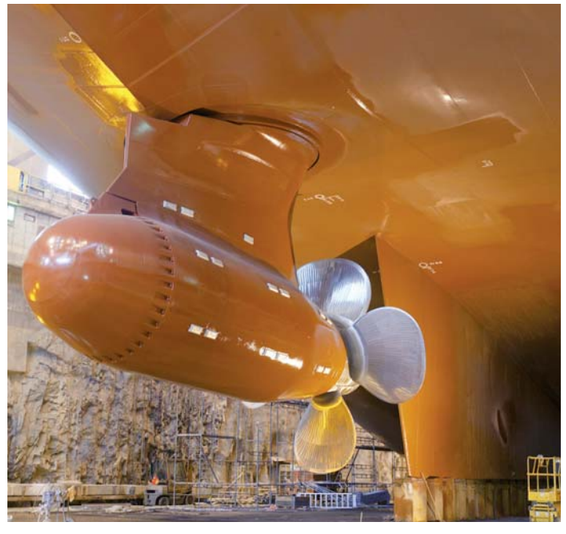
With the help of Azipod, double acting ships have become a success. These ships are designed with superb icebreaking and steering performance going astern, and the bow can be optimized to give excellent open water performance.

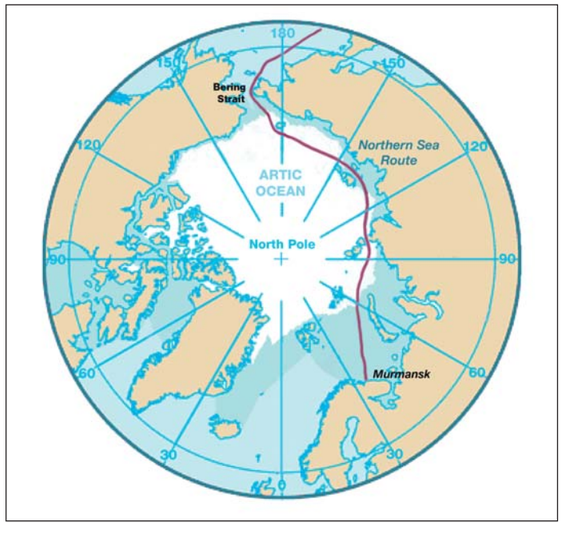
The main benefit of stern-first operation is a tremendous reduction in power demand. Typically, a tanker with an open water power demand of 10 MW will need 20 MW installed power to operate with bow first in ice. If designed to go stern first in ice, the power demand is reduced to 12 MW.

Running astern with the propeller first is particularly effective in areas with severe ice ridges. The propeller mills the underneath of the ridges into pieces that are flushed away by the propeller wash, and the ship moves steadily through the ice without ramming.



The *Norilskiy Nickel* container carrier is one of six Arctic vessels built for MMC Norilsk Nickel, all with single 13 MW Azipod propulsion units.





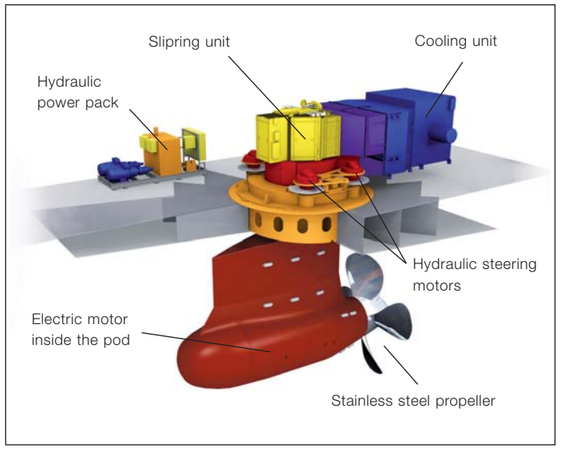
Container carrier *Monchegorsk*, a sister ship to *Norilskiy Nickel*, was the first commercial vessel ever to make a round-trip voyage using the Northern Sea Route without the assistance of an icebreaker.

Azipod® VI - superior to mechanical solutions

Azipod VI propulsion units are presently supplied for the power range from 1.5 to 17 MW.

Until 1990, shaftline propulsion was the dominant propulsion system for all types of ice-going and icebreaking vessels. However, lack of maneuverability was a serious weakness of this system. The alternative was mechanical thrusters, but these were built to a complex mechanical design which diminished their strength and reliability. This paved the way for Azipod®.

Azipod VI propulsion system.



Azipod® VI design overview

Azipod is a unique azimuthing propulsion solution providing both propulsion and steering in a single unit. With a built-in high-efficiency AC motor and fixed-pitch propeller mounted directly on the motor shaft, Azipod stands out from other thruster solutions.The main difference lies in the power transmission. While mechanical thrusters have complex transmission with gears and shafts, the Azipod has only electrical cables between the power source and the electric motor. This makes it possible to build an extremely robust propulsion device with the simplicity, strength and reliability for the most challenging ice conditions, and to any ice class.

Proven performance

Azipod is currently the only truly proven thruster solution for use on icebreaking vessels. ABB has supplied single and twin Azipod solutions to a wide range of different ship types and has references from all major classification societies and ice classes.

Full scale ice-load measurements and testing

The methodology to estimate actual ice loads on ship hull and pods is not a simple task. ABB therefore started extensive full-scale ice-load measurements on vessels with Azipod propulsion, early in the 1990s. This is still an ongoing activity providing invaluable data used in the continuous development of the Azipod VI unit.

Comparison between Azipod VI propulsion and mechanical z-thrusters

- Both thrusters with open propeller (no nozzle)
- Mechanical z-thruster driven by an onboard electric motor

		Azipod VI	Mechanical z-thruster
General aspects	**Design**	Originally designed for icebreaking. Mechanically simple	Iceclass requirements fulfilled by overdimensioned gears. Complicated vulnerable mechanical design
	Icebreaking references	Extensive, including several double acting vessels	Limited. No installations on double acting vessels
	Power range - icebreaking	1.5 - 17 MW in Arctic ice classes. No mechanical limitations	Maximum power around 8.4 MW. Power limit due to mechanical limitations
	Mechanical losses	0.5%	Typically 7 - 9%
	Vibration and noise	Low vibration and noise even at high speed	High vibration and noise
Icebreking performance	**Over-torque capability**	Unlimited. According to customer specification	30-50% above bollard pull. Limited by bevel gears
	Reverse torque / rpm	Unlimited. Robust and simple shaft line design - no gears	Torque 50% limitation, rpm 50% limitation. Power restriction typically 25% due to gear protection
	Rpm decreasing and propeller stopping	High over-torque, better rpm stability, less propeller stopping	Low over-torque, rpm decreases easily, propeller stops more easily
	Icebreaking capability running astern	Excellent. Advantage of pulling-type propeller	Limited capability. No documented experience of double-acting ice operations
Reliability	**Overall reliability**	Good reliability, uncomplicated design	Complicated and more vulnerable design
	Seals	Minimal seal problems	More seal problems
	Bearings	Only 2 shaftline bearings. Very good track record	At least 9 shaftline bearings. Higher failure risk
	Bevel gears	No bevel gears	Bevel gears - heavily overdimensioned. Vulnerable to damage
Machinery design	**Engine room**	Less space needed	More space needed - shaft lines, electrical motor, etc.
	Tip clearance to ship hull	Example: 8 MW unit typically 1.25 - 1.35 m	Example: 8 MW unit typically 0.8 - 0.95 m
	Lubrication oils	Hundreds of liters	Thousands of liters

Total ABB solution improves overall vessel performance

By choosing a total electric power and propulsion solution from ABB, customers gain a thoroughly proven functional solution based on unified, high quality ABB technology. This eliminates problematic interfaces, and single-point supply clearly defines responsibility during the project and operational phase.

ABB is the only supplier to manufacture a total electric power & propulsion solution for icebreaking vessels. All main products in our solutions are produced in-house, which enables us to control and secure complete deliveries, and to simplify lifetime maintenance and service.

Customers utilize our ice competence

ABB has gained broad experience and deep understanding of the Arctic environment, ice conditions, and not least, the forces and ice-loads on ships and the Azipod in frozen waters. Customers exploit this unique competence in designing and dimensioning the propulsion system for new icebreaking vessels. Our know-how in vessel power control and power plant design provides protection and minimizes the risk of black-outs in demanding Arctic operations.

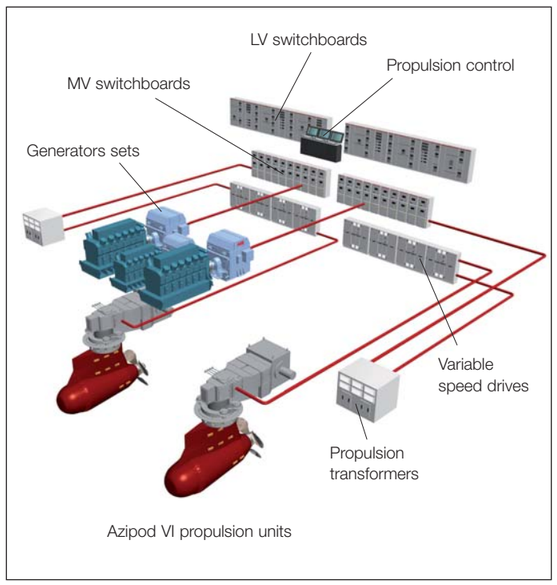
ABB provides total electric power and propulsion solutions engineered to meet specific vessel requirements.

Total solutions...

ABB's scope of supply to an icebreaking vessel typically includes the following systems:

- Azipod VI propulsion units
- Variable speed propulsion drives
- Electric power generation system
- Electric power distribution system
- Bow-thruster electric motors
- Remote propulsion control system

All our solutions are built to perform in rough Arctic conditions and represents the pinnacle of modern, energy-efficient marine power technology. Certification by leading classification societies ensures compliance with all major international standards.



Azipod VI propulsion units

...total responsibility

ABB is a total system integrator, and an important element of our scope of supply is the portfolio of services we provide throughout the vessel life cycle. These services include:

- Project management, including overall responsibility for the delivery
- Project engineering, documentation and studies needed for vessel construction, installation, commissioning, and for the classification society to certify the electric power plant and propulsion system
- Site support, depending on customer preference – typically commissioning and sea trials but also site management, installation or installation supervision, and engineering support
- Warranty and after-sales support

By using ABB throughout the vessel, we ensure that the right specifications, configurations and dimensioning are implemented to achieve optimal system interaction and functionality.

Service and support wherever you need it

ABB has a worldwide network of local Marine Service Centers. In addition, we have established a network of dedicated Azipod Regional Service Centers providing specialized personnel, workshops and tooling to support Azipod customers. Our services includes site surveys and condition monitoring, preventive maintenance and dry-dock services, spare parts, on-call services, modernizations and training.

Remote diagnostic services

To enhance the quality of our monitoring services and reduce service costs, ABB offer a satellite-based Propulsion Condition Monitoring System. This allows service specialists and engineers at ABB Service Centers to remotely monitor critical components of the Azipod propulsion system and provide operational support and guidance for onboard crew and ship management.

State-of-the-art icebreaking vessels ...

1

2

3

4

1. *Newbuilding* – icebreaking PSV. 2 x 6.5 MW Azipod propulsion. Owned by Sovcomflot, and built by Arctech Helsinki Shipyard.
2. *Yenisei* – arctic product tanker. 1 x 13 MW Azipod propulsion. Owned by Norilsk Nickel, built by Nordic Yards.
3. *Tempera* – arctic tanker. 1 x 16 MW Azipod propulsion. Owned by Neste Shipping, built by Sumitomo Heavy Industries.
4. *Mackinaw* – icebreaker. 2 x 3.4 MW Azipod propulsion. Owned by U.S. Coast Guard, built by Marinette Marine.

...all equipped with Azipod® propulsion systems

5

6

7

8

5. *Botnica* – multipurpose icebreaker. 2 x 5 MW Azipod propulsion. Owned by Arctia Shipping, built by STX Finland.
6. *Polar Pevek* – icebreaking tug. 2 x 5 MW Azipod propulsion. Owned by Rieber Shipping - Polarus, built by STX OSV Langsten.
7. *Svalbard* – icebreaking coast guard vessel. 2 x 5 MW Azipod propulsion. Owned by Royal Norwegian Navy, built by STX OSV Langsten.
8. *Articaborg* – icebreaking platform supply vessel. 2 x 1.6 MW Azipod propulsion. Owned by Wagenborg, built by STX Finland.