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Conditions and perspectives of the Russian and foreign Arctic research fleet



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Abstract. The article is devoted to the conditions of the Russian and foreign research fleet able to work in the Arctic waters according to its technical specifications. The study has revealed that a modern common trend is construction of multi-functional research and expedition vessels, able not only to conduct research, but also to transport cargoes and to serve as icebreakers or carriers of aircrafts. The authors conclude that the Russian Arctic research fleet is the most numerous. However, it needs to be modernized because the most of the vessels were constructed in 1970s and 1980s.

Keywords: *the Arctic, research activities, fleet, research vessels, research and expedition vessels, ice class*

Introduction

The specificity of the Arctic scientific study requires the availability of advanced research fleet of the ice class. It is impossible to carry out hydrobiological, hydro chemical, meteorological, geophysical and other studies without proper supply. We offer an overview article on the scientific fleet of the countries most active in the exploration and study of the Arctic and most adapted for operation in the harsh climatic conditions of the region.

The analysis considered the vessels of the ice class not less than Arc 4 adapted for scientific research and study and relevant to the Russian Maritime Register of Shipping (RMRS) or equivalent class relevant to the classifications of the other Arctic states. The Arc 4 class vessels are used in the Arctic and Antarctic in summer, in waters with the ice destroyed by melting (residual) thin annual ice. The Regulations on Navigation in the Waters of the Northern Sea Route, approved by the Russian Ministry of Transport in 2013, allow the navigation for the vessels with lower ice class or even without it but in July — November 15 and with a significant restriction of the area of navigation [1, Tarovik O.V., p. 15].

The database of vessels with information on vessel's name, country, year of building, hull length, purpose, ice class and its equivalent according to the RMRS rules is in Appendix 1.

Russia

Today the Russian Federation possesses the largest research fleet designed to work in Arctic. It consists of 29 ships, which exceeds the total number of similar vessels of the United States, Canada, Norway, Sweden, Denmark, Finland, Germany, the UK, China, Japan and the Republic of Korea.

Most of the Russian ships belong to ice class Arc 4 or Arc 5. They are regularly used in a relatively favorable ice conditions (thin, residual or young ice) in the summer and autumn navigation. Difficult ice conditions are for the vessels “Akademik Fedorov”, “Akademik Treshnikov” and “Mikhail Somov” (ice class Arc 7 — independent navigation throughout the waters of the Northern Sea Route with all types of ice conditions in summer-autumn navigation or with icebreakers in the winter-spring navigation in the thick annual ice with thickness up to 1.8 m).

Among 29 Russian vessels, 26 were exclusively designed for research; the three other vessels (“Akademik Treshnikov”, “Akademik Fedorov” and “Mikhail Somov”) belong to the class of scientific and expedition ships, adapted for transportation of goods. This allows using them to supply the remote areas and polar stations.

The equipment of the vessels allows carrying out complex hydro chemical, hydrobiological and hydrometeorological studies. Twelve vessels are specialized in carrying out geophysical surveys of the seabed for mineral exploration. The geophysical vessels are used by business: JSC “Sevmorneftegeofizika” — 4 vessels, JSC “Morskaya arkticheskaya geologorazvedochnaya ekspeditsiya” — 3 vessels, JSC “Dalmorneftegeofizika” — 2 vessels, OJSC “Sovkomflot” — 1 vessel.

Despite the indisputable leadership in the number of Arctic research ships, Russia is facing an acute need for the fleet renewal. Today, 27 of the 29 ships were built before 1990 and are outdated. Their average age is 30.4 years in 2017. Russia has only one modern scientific and expedition vessel “Akademik Treshnikov” capable of research, icebreaker assistance, rescue work, and freight.

Almost all the Russian vessels were built on the shipyards of Finland and Poland in the 1970s and 1980s. Economic crisis and reduction in state funding in the 1990s led to the situation when some of research vessels had been sold or converted for cruise and other purposes (e.g., “Academician Shuleikin” and “Professor Vize”). Some vessels are still owned by the Russian state institutions and are used for marine scientific research, cruises in the Arctic and Antarctic or delivery of scientists to the polar stations (“Akademik Shokalsky”, “Professor Khromov”). The latter enables owners to maintain their scientific fleet in the proper condition.

The renewal of the Arctic and Antarctic research fleet is reflected in the state program “Development of shipbuilding and equipment for offshore fields development in 2015–2030”. The document secures the priority of the state policy in the shipbuilding, the creation of a competitive specialized marine equipment, ships and vessels for the development of the continental shelf and the Northern Sea Route, the creation of high-tech medium-tonnage transport and support vessels, high-tech fishing vessels, marine and inland research and scientific expedition vessels.

The Sub-program “Expeditions in the World Ocean” of the Federal target program “World Ocean” for 2018–2023 involves the construction of the research expedition vessel of the Arc 7 ice class to replace the R/V “Mikhail Somov” and to study the Arctic and Antarctic seas and to maintain the remote polar stations. However, the Government of the Russian Federation has not approved the Federal target program by now.

The Russian Navy plans construction of the research vessels. By 2024, it plans to introduce two ocean-going research vessels with ice class. The main task of these vessels will be carrying out a wide range of scientific studies in the Arctic¹.

Canada

Now Canada has seven ice-class vessels for scientific research. In contrast to the Soviet Union and Russia, Canadian scientific and research fleet is at the disposal of the Canadian Coast Guard. Three of seven vessels are oceanographic research vessels and meet the ice class Arc 4 (CCGS ‘Hudson’, CCGS ‘John P. Tully’ and CCGS “Teleost”). Three more vessels (CCGS “Samuel Risley”, CCGS “Sir Wilfrid Laurier” and CCGS ‘Martha L. Black’) are multifunctional vessels of ice class Arc 5. These vessels also provide the icebreaking assistance to ensure the supply of beacons, are involved in rescue and other work. The highest ice class among the Canadian research vessels (Arc 6) has the CCGS Amundsen — the icebreaker, converted in 2002 for research purposes. In summer, the vessel is a research ship and in winter, it mainly provides the icebreaker assistance.

The main problem of the Arctic research fleet both in Canada and in Russia is the age. The average age of the vessels is 34.7 years. The youngest vessel was built in 1988. A limited number of ice-class vessels and a long coastal line in the Arctic have negative effect on the quality of research. That’s why, in 2015, the expedition on the ship CCGS Amundsen was forced to interrupt its research and change the route to ensure the icebreaking assistance².

¹ Voenno-morskoj flot poluchit dlya issledovaniya Arktiki dva sudna ledovogo klassa [Military fleet will get two ice-class vessels for the Arctic research]. URL: <http://sever-press.ru/vse-novosti/item/4300-voenno-morskoj-flot-poluchit-dlya-issledovaniya-arktiki-dva-sudna-ledovogo-klassa> (Accessed: 11 March 2017) [in Russian]

² Canada’s ocean science capacity is limited with resource constraints. URL: <https://cullenlab.ca/2015/07/27/canadas-ocean-science-capacity-is-limited-with-resource-constraints-the-globe-and-mail/> (Accessed: 11 March 2017)

In 2010, Canada started the construction of the oceanographic vessels to replace CCGS Hudson, which in 2017 turns to be 54 years old, CCGS Teleost and two more vessels without the ice class. The vessels supposed to be built by 2014, however, an unplanned increase in the cost estimates led to a tightening of delivery, which is expected in 2017–2018.^{3,4}

The USA

The US have a small but relatively well-equipped research fleet with the ice class — 5 vessels. The average age of the US fleet is 20.2 years; 4 of 5 vessels — built after 1990, including the newest research vessel R/V Sikuliaq with the class Arc 6 in the possession of the University of Alaska Fairbanks.

Two USCGC “Healy” (class Arc 7) and USCGC “Polar Star” (class Arc 8) are at the disposal of the U.S. Coast Guard and are used not only for research but also to provide the icebreaker assistance. High ice class allows the vessels to operate in two-year and perennial ice throughout the year.

Despite the small number of research vessels with ice class, the public sources do not contain any plans for the construction of such vessels and even no need in such vessels is indicated. Now, the priority of the US is the construction of powerful icebreakers that can operate in complicated ice conditions and ensure the US presence in the Arctic region⁵.

Norway

Despite the great attention to the Arctic at the government level, Norway has a small research fleet with the ice class. The Norwegian Polar Institute owns the research vessel “Lance”, class Arc 4, built in 1978. Another research vessel in state ownership was built in 1988 — “Helmer Hanssen”, class Arc 4. Both vessels were originally designed for fishing and then converted for oceanographic research and marine biology studies.

The Norwegian company GC Rieber owns the vessel “Polar Empress” class Arc 5, built in 2015. The vessel is designed for geophysical surveys of the seabed.

In 2012, the Norwegian government decided on the construction of the vessel “Kronprins Haakon” to address the problem of lack of modern research vessels. The vessel is adapted for op-

³ CCGS Hudson good to go after repairs. URL: <http://thechronicleherald.ca/metro/1311676-ccgs-hudson-good-to-go-after-repairs> (Accessed: 11 March 2017)

⁴ Shipbuilding strategy needs work to get ballooning costs under control, ministers told. URL: <http://www.cbc.ca/news/politics/shipbuilding-procurement-action-plan-1.3336604> (Accessed: 11 March 2017)

⁵ Changing Arctic demands new fleet of polar icebreakers. URL: <http://www.seattletimes.com/opinion/changing-arctic-demands-new-fleet-of-polar-icebreakers/> (Accessed: 11 March 2017)

eration in the Arctic. It is scheduled to launch in 2017 and will get high ice class PC3 (class Arc 7 according to the RMRS classification)⁶.

The UK

The British Antarctic Survey is a research unit of the UK Natural Environment Research Council (NERC) and includes two vessels with the ice class adopted for research. The research vessel RRS “James Clark Ross” class Arc 5 had equipment for biological, oceanographic and geophysical research. Multifunctional ship RRS “Ernest Shackleton” is used mainly to transport cargo and passengers in Arctic and Antarctic, as well as for oceanographic research.

Now, the NERC is building a modern research vessel, capable of operation in the ice with the thickness up to 1m⁷. It is planned to finish the project by 2019.

Other European countries

Among the other European countries, the most powerful and equipped research vessels are in Sweden (“Oden”) and Germany (“Polarstern”). Both vessels were designed for research and icebreaking. Along with the American civil icebreaker USCGC “Polar Star”, they have the highest ice class (Arc 8 and Arc 9) among the considered vessels. Less powerful research vessels are in Finland (“Aranda”, class Arc 5) and Denmark (“Dana”, class Arc 4). All these vessels were built in the 1980s. In 2002–2010 there were plans for the construction of the European research icebreaker “Aurora Borealis” with the highest ice class PC1 (Arc 10)⁸. In 2010, it was decided to stop the project in favor of its less expensive version — “Aurora Slim”. Currently, there is no public information about the construction of the vessel. Also in 2019, it is planned to complete the new German research icebreaker to replace the “Polarstern”⁹.

Asian countries

The most active Asian countries in the study and development of the Arctic own or plan the construction of the research ice-class vessels. Chinese multipurpose vessel “Xue Long”, class Arc 4 was purchased in Ukraine in 1994 and converted into a research ship [2, p. 130]. In 2019, it is expected to complete the second Chinese vessel with the higher ice class, which is also going to be used for research¹⁰.

⁶ Kronprins Haakon — icebreaker research vessel. URL: <http://www.npolar.no/en/about-us/stations-vessels/kronprins-haakon/> (Accessed: 11 March 2017)

⁷ About the ship. URL: <https://nameourship.nerc.ac.uk/about.html> (Accessed: 11 March 2017)

⁸ Aurora Borealis Polar Research Vessel. URL: <http://www.ship-technology.com/projects/aurora-borealis-polar-research-vessel/> (Accessed: 11 March 2017)

⁹ A new age of polar research. URL: <http://www.motorship.com/news101/ships-and-shipyards/a-new-age-of-polar-research> (Accessed: 11 March 2017)

¹⁰ Construction starts on second, high-tech icebreaker. URL: http://www.chinadaily.com.cn/china/2016-12/21/content_27729621.htm (Accessed: 11 March 2017)

In 2009 the Japanese icebreaker “Shirase” was built and replaced the vessel with the same name [3, Morozov Yu., Klimenko A.F., p. 183]. In the same year, a South Korean research vessel “Ar-aon” was put into operation [4, Zhuravel V.P., p. 125]. Both vessels have the ice class Arc 6 and are intended to conduct scientific expeditions.

In 2014, the government of India decided to buy a polar research vessel to support the work of two Indian Antarctic stations and the Himandri station on Svalbard¹¹.

Conclusion

Today, in the conditions of increased attention to the Arctic region, modernization and building of the research fleet with the ice class are on the agenda of the leading Arctic and non-Arctic states. These vessels are designed not only for scientific research, but they also ensure the effective state presence in the region. The common trend of the development of the Arctic research fleet is the construction of multifunctional scientific vessels that can be used for research and provide the icebreaker assistance, be the aircraft carriers and transport goods.

Norway, the UK, Germany, China and India are building new vessels adapted for operation in the Arctic. Modern exploratory vessels of an ice class are in Japan, Korea and the USA. Despite the commissioning of the research “Akademik Treshnikov” in 2012, Russian needs to update its research fleet, which was mostly built in 1970s and 1980s. The strategic importance of the Arctic for Russia makes the construction of modern research vessels with ice class one of the most urgent tasks in the development of the region.

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¹¹ Acquisition of a Polar Research Vessel. URL: <http://pib.nic.in/newsite/PrintRelease.aspx?relid=110933> (Accessed: 11 March 2017)

Russian and foreign ice class research vessels

No	Name	Year	Length, m	Purpose, area of scientific research	Ice-class	The RMRS ice-class
RUSSIA						
1	R/V "Academic Treshnikov"	2012	133.53	The vessel is of unrestricted navigation area, combines the functions of an icebreaker, tanker, cargo ship, passenger and research vessel, has a reinforced ice hull, equipped with modern navigation equipment, two helipads and a hangar, equipped with research laboratories that allow the efficient processing of results of oceanographic research, sensing of the atmosphere and other scientific experiments.		Arc7
2	R/V "Academic Fedorov"	1987	141.2	The vessel is for delivery of personnel, scientific equipment and goods to the Russian Antarctic stations and scientific research in the Arctic and Antarctic waters. The R/V "Akademik Fedorov" is equipped with 11 labs: the weather research; reception of satellite hydrometeorological information (APPI); hydrographic (surveying); oceanographic "dry"; oceanographic "wet"; hydro chemical; environmental; ice research; and densimetric. A helipad and control tower provide the operation of two helicopters based in a special hangar.	ULA	Arc7
3	R/V "Mikhail Somov"	1975	133.13	It is used for shipment of personnel, equipment and supplies to remote research stations and other remote objects in the Arctic, as well as for marine scientific research. It has an equipped research lab and a helipad.	ULA	Arc7
4	R/V "Academic Mstislav Keldish"	1980	122.2	Scientific equipment: Automatic synoptic station "VAISALA MIDAS 32"; hardware vertical profiling "NBIS" installed in the "Rosett" system; Lab scanner "GUILDLINE"; Deep-sea manned submersibles; Scientific labs: meteorological; hydrological; geological-biological; biochemical; geochemical; filtration; microbiology; and a photo-lab.	L1	Arc4
5	R/V "Academic Sergey Vavilov"	1988	117.1	The vessel is a mobile receiver of the super-weak hydro acoustic signals. It has 12 laboratories for comprehensive oceanographic research with total area of 380 m ² . In addition, the vessel can accommodate up to 3 container labs.	L1	Arc4
6	R/V "Academic Ioffe"	1989	117.1	R/V "Academic Ioffe" — a mobile emitter of hydro acoustic signals in the frequency range 25–500 Hz, power up to 150 W. The vessel has 12 labs with modern equipment for comprehensive oceanographic research. It is possible to put up to 3 additional container labs.	L1	Arc4
7	R/V «Professor Shtokman"	1979	68.87	The vessel is designed for oceanographic, geological and physical research in the oceans, in tropical and arctic climate On Board: 6 labs, total area — 95 m ² .	L1	Arc4
8	R/V "Academic M.A. Lavrentev"	1984	75.5	The vessel has 8 labs, total area — 270 m ² .	L1	Arc4
9	R/V "Academic Oparin"	1985	75.5	The vessel is designed for hydrological, hydro physical, and above all, hydrobiological studies of marine organisms in the World Ocean. It has 8 labs, total area — 270 m ² : 3 biochemical labs; a spectroscopic lab; physical and chemical lab; lab of hydrobiology; lab of biosynthesis; computers; darkroom; and a diving complex.	L1	Arc4

10	R/V "Academic Nickolay Strahov"	1985	75.5	Specialized vessel for geophysical exploration.	L1	Arc4
11	R/V "Ivan Petrov"	1989	49.9	The vessel is for carrying out scientific research in the field of oceanography, meteorology, hydrochemistry, biology and monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation	L1	Arc4
12	R/V "Victor Byinitsky"	1986	49.9	The vessel is designed for the hydro-meteorological research in the Arctic seas of Russia and monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation.	L1	Arc4
13	R/V "Pavel Gordienko"	1987	49.9	The vessel is for sonar, geological, oceanographic and environmental research in the Arctic and far Eastern seas of Russia, monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation.	L1	Arc4
14	R/V "Professor Molchanov"	1982	71.06	The vessel is for scientific research in the field of oceanography, meteorology, hydrochemistry, biology in any area of the World Ocean and monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation	UL	Arc5
15	R/V "Nickolay Trubyatchinsky"	1988	65.0	A specialized vessel for geophysical exploration.		Arc5
16	R/V "Geolog Dmitry Nalivkin"	1985	71.7	A specialized vessel for geophysical exploration.		Arc5
17	R/V "Professor Kurentsov"	1976	68.75	A specialized vessel for geophysical exploration.		Arc4
18	R/V "Academic Golitsyn"	1984	71.6	"Akademik Golitsyn" is equipped with a dynamic positioning system that allows staying on the point of underwater technical works at the wave height up to 6 m. Marine technical means and special equipment allow monitoring of the seabed, laying and operation of underwater pipelines and other complex underwater engineering works at depths up to 3000 m.	UL	Arc5
19	R/V «Vyachelav Tikhonov"	2011	80.81	A specialized vessel for geophysical exploration.		Arc4
20	R/V "Academic Nemchinov"	1988	84.4	A specialized vessel for geophysical exploration.	UL	Arc5
21	R/V "Academic Shatskyi"	1986	81.85	A specialized vessel for geophysical exploration.	UL	Arc5
22	R/V "Academic Lazarev"	1987	81.85	A specialized vessel for geophysical exploration.	UL	Arc5
23	R/V "Geo Arctic"	1988	81.85	A specialized vessel for geophysical exploration.		Arc5
24	"Orient Explorer"	1988	81.85	A specialized vessel for geophysical exploration.	UL	Arc5
25	"Zefir 1"	1987	81.85	A specialized vessel for geophysical exploration.	UL	Arc5
26	R/V "Academic Fersman"	1986	81.85	A specialized vessel for geophysical exploration.	UL	Arc5
27	R/V "Professor	1983	71.58	The vessel is for scientific research in the field of oceanography, meteorology, hydrochemistry,	UL	Arc5

	Multanovskiy"			biology in any area of the World ocean and monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation		
28	R/V "Academic Shokalskiy"	1982	71.06	The vessel is for scientific research in the field of oceanography, meteorology, hydrochemistry, biology in any area of the World Ocean and monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation	UL	Arc5
29	R/V "Professor Khromov"	1983	71.06	The vessel is for scientific research in the field of oceanography, meteorology, hydrochemistry, biology in any area of the World Ocean and monitoring of internal waters, territorial sea, exclusive economic zone and continental shelf of the Russian Federation	UL	Arc5
CANADA						
1	CCGS "Amundsen"	1979	98.3	An icebreaker; in 2002, it was converted into a research vessel. The following labs are on board: filtration, geochemical, refrigeration, benthos, geology, paleology, nutrients, solemar, zooplankton, and others.	Arctic Class 3	Arc 6
2	CCGS "Hudson"	1963	90.4	An oceanographic vessel with hydrographic, geochemical and oceanographic labs.	Arctic Class 2	Arc 5
3	CCGS "John P. Tully"	1984	67.9	An oceanographic vessel with 2 labs on board.	Type A	Arc 4
4	CCGS "Teleost"	1988	63.0	An oceanographic vessel with oceanographic, biochemical and other labs.	Type A	Arc 4
5	CCGS "Samuel Risley"	1984	69.7	A multifunctional ship with the oceanographic lab.	Arctic Class 2	Arc 5
6	CCGS "Sir Wilfrid Laurier"	1986	83.0	A multifunctional ship with 1 lab on board	Arctic Class 2	Arc 5
7	CCGS "Martha L. Black"	1985	83.0	A multifunctional ship with the hydrographic lab.	Arctic Class 2	Arc 5
THE USA						
1	R/V "Sikuliaq"	2014	73.1	A research vessel with the ice class for hydrometeorological, geological, hydrographic, and biological research.	Polar Class 5	Arc 6
2	USCGC "Healy"	1999	128.0	An icebreaker for scientific research with 5 labs on board: biology, chemistry, weather etc.	PC 3	Arc 7
3	USCGC "Polar Star"	1976	122.0	The icebreaker with the possibility of geological, vulcanological, oceanographic, glaciological and other studies. Currently it is used in the Antarctic.	PC2/PC3	Arc 8
4	R/V "Lawrence M. Gould"	1998	70.2	A research vessel with the ice class for hydrometeorological, geological, hydrographic and biological research. Currently it is used in the Antarctic.	ABS A1	Arc 5
5	R/V "Nathaniel B. Palmer"	1992	94.0	A research vessel with the ice class for oceanographic, geological, geophysical and biological research. Currently it is used for work in the Antarctic.	ABS A2	Arc 6
NORWAY						
1	R/V "Lance"	1978	60.8	R/V Lance was built as a fishing and commercial vessel. In 1992, it was converted into a research vessel for the Norwegian Polar Institute. The vessel is equipped for the research in the field of Oceanography and marine biology.	DnV ICE-1A	Arc 4
2	"Helmer"	1988	63.8	The vessel "Helmer Hanssen" was a fishing trawler and then became a research vessel in 1992.	DnV Ice 1A	Arc 4

	Hanssen" (before — "Jan Mayen")			It has equipment for geological, oceanographic and marine biological research.		
3	"Polar Empress"	2015	112.6	A research vessel. The Norwegian company Dolphin Geophysical uses it for seismic surveys.	1A*	Arc 5
THE UK						
1	RRS "James Clark Ross"	1990	99.0	A research vessel equipped for biological, oceanographic and geophysical research.	IAS	Arc 5
2	RRS "Ernest Shackleton"	1995	80.0	A multifunctional ship with the oceanographic equipment.	DnV Ice 05	Arc 4
SWEDEN						
1	"Oden"	1988	107.8	An icebreaker was built for research and equipped for marine geology, oceanography, ecology, and atmosphere studies.	DNV POLAR-20	Arc 8 / Arc 9
FINLAND						
1	"Aranda"	1989	59.2	A research vessel equipped for biological, physical, chemical and geological studies.	1A Super	Arc 5
DENMARK						
1	"Dana"	1981	78.4	A research vessel equipped for biological, climatic, ecological and geological research.	ICE 1A	Arc 4
CHINA						
1	MV "Xue Long"	1993	167.0	It was built as a cargo ship for Arctic, reequipped and became a scientific and supply vessel with labs for maritime physics, chemistry, biology, meteorology and other research.	CCS B1	Arc 4
JAPAN						
1	"Shirase"	2009	138.0	An icebreaker able to host 80 researchers.	PC5	Arc 6
SOUTH KOREA						
1	R/V "Araon"	2009	109.5	An icebreaker equipped for oceanographic, sonar, geophysical, biological and other research.	DNV Polar-10	Arc 6
GERMANY						
1	R/V "Polarstern"	1982	117.9	An icebreaker equipped for oceanographic, geophysical, biological, geological, glaciological, chemical and meteorological research.	Arc3	Arc 8 / Arc 9