The Barents Observer

Nuclear Reactors in Arctic Russia

Scenario 2035

The nuclearification of Russian Arctic territories is by Moscow given highest priority for development in shipping, infrastructure and exploration of natural resources. Additionally, the number of navy military reactors in the north will increase substantially over the next 15 years. This scenario paper gives an overview of the situation. The paper is part of the Barents Observer's analytical popular science studies on developments in the Euro-Arctic Region.

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Introduction

At the peak of the Cold War some 150 nuclear-powered submarines were based on the Barents Sea coast of the Kola Peninsula. Many ships were transporting and storing nuclear waste and at shipyards and bases, spent nuclear fuel and radioactive waste was accumulated. In the Kara Sea, 14 reactors, several ships and barges, and thousands of containers with radioactive waste were dumped.

25-years of international cooperation with Russia on safeguarding decommissioned Cold War submarines and radioactive scrap in the north is a success story. Today, 25-years after the international cooperation started, a new wave of nuclear reactors are coming to the north. With the rearmament of the Arctic follows new nuclear-powered submarines and new weapon systems powered with reactors. A predicted sharp increase in shipping along the Northern Sea Route will be served by new and larger nuclear-powered icebreakers. In 2019, the first floating nuclear power plant will be towed to the remote port of Pevek to supply heat and electricity to the local community. There is also an increased interest towards utilization of nuclear energy with small power reactors for remote locations, either it is onshore, on platforms offshore, or even subsea.

The presence of more reactors in the Arctic will lead to more handling of radiological and nuclear material that together with the reactors themselves pose a risk for serious incidents that could harm both nature and people. The Arctic is a place with long distances, harsh weather conditions, few people, limited infrastructure and little emergency preparedness capabilities. Since many of the new reactors are military, access to information about possible incidents could be difficult to obtain. Likewise, questions regarding waste handling and future decommissioning could also be difficult to discuss.

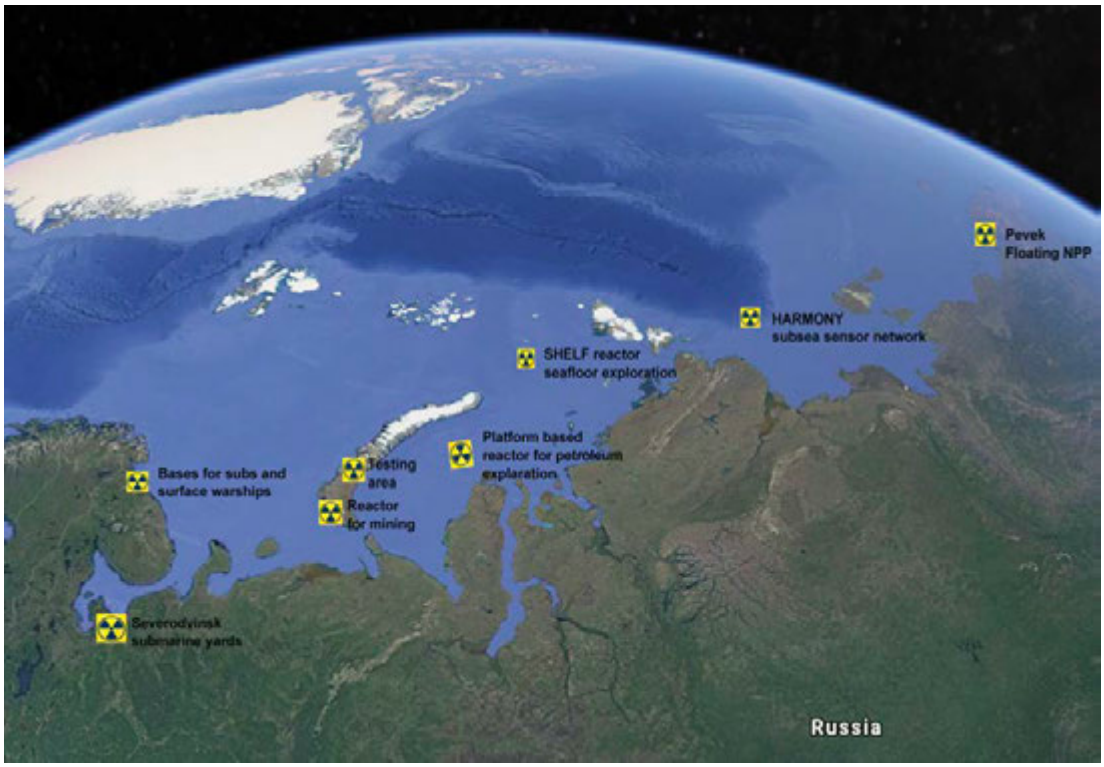
This paper looks into what to expect in regard to number of reactors and their use with a horizon until 2035.

When reading this overview, it is important to keep in mind that this is not a fixed blueprint of how the future will be. We have compiled available information about existing nuclear installations and their life-time expectancy. Listed are also the different nuclear-powered icebreakers-, submarines-, and surface warships, those under construction, those planned and those on the state armament program's long-term list. Then, we have listed the new nuclear-powered strategic weapons which the world has never seen before; the Poseidon underwater drone and the Burevestnik missile. On the top of all this comes new ideas on how to utilize nuclear power in the Arctic with a series of different small-power reactors, including for sea-floor installations.

International security developments, geopolitics, climate changes and Russian domestic economy are four factors that for sure will influence the plans for usage of reactors described in this paper. A good way to stay updated in the years to come is to read the Barents Observer; thebarentsobserver.com

The Barents Observer covers news from and about the European and Russian Arctic. In English and Russian languages, our news site will always provide you with the latest information about what happens in regard to nuclear reactors, either it is on board ships and submarines, or onshore installations like nuclear power plants.

Geography



Half of the Arctic is in Russia, with a northern coastline 24,140 km stretching over 10 times zones from Murmansk in the West to Kamchatka in the East. Murmansk is world's largest city north of the Arctic Circle with about 300,000 inhabitants. With an economy dependent on extraction of natural resources, mainly oil and gas, Russia gives high priority to the Arctic where about 90% of all gas production takes place. Most of the Russian oil and gas are produced from onshore fields, but ambitions are clear towards offshore exploration, especially in the Kara- and Laptev Seas.

Today, most nuclear naval reactors are concentrated in the area from Murmansk to the Litsa fjord on the Kola Peninsula and in Severodvinsk by the White Sea. Icebreakers have Murmansk as homeport, but operate on voyages in the northern Kara Sea, Laptev Sea and East Siberia Sea. The Northern Fleet's strategic missile submarines patrol the Eastern Barents Sea and the Arctic Ocean, while multi-purpose submarines are regularly sailing the Norwegian Sea and the North Atlantic. New submarines sail on sea trail in the northern White Sea and in the deep-sea waters between North Cape and the Bear Island where the Barents Sea meets the Norwegian Sea.

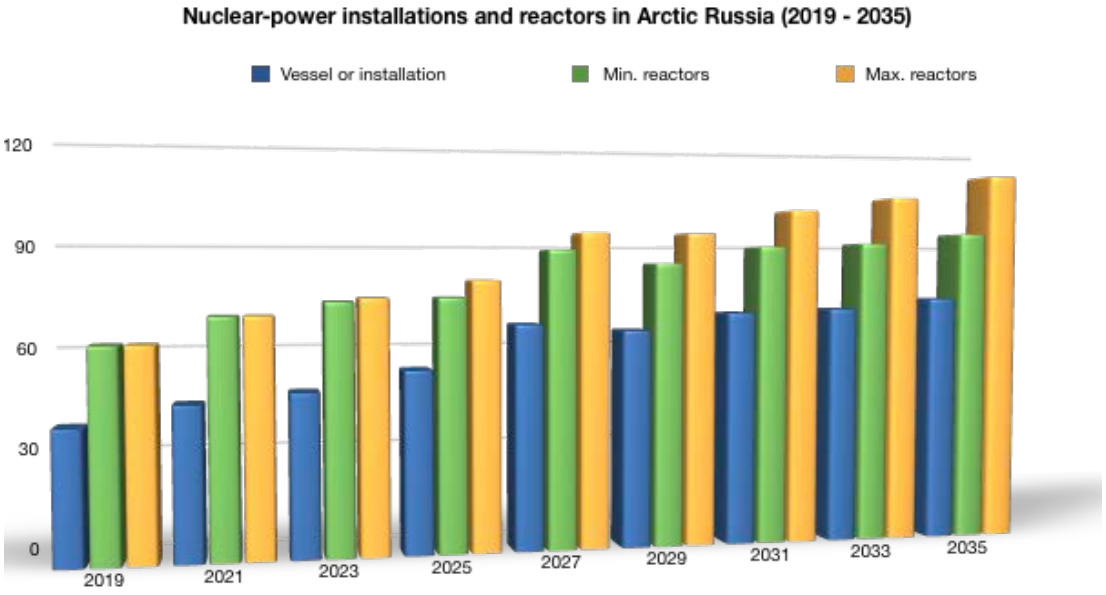
Russia's first floating nuclear power plant will be located to Pevek on the coast of the East Siberian Sea. A small-power reactor is suggested to provide electricity to the Pavlovsky zinc mine on Novaya Zemlya, and other sea-floor reactor installations could be used on the Arctic shelf, most likely in the northern Kara Sea and Laptev Sea where Gazprom and Rosneft have big hope for more oil- and gas.

Content

Summary

- By 2019 there are 39 nuclear-powered vessels or installations in the Russian Arctic, with a total of 62 reactors (31 submarines, one surface warship, five icebreakers and two power plants). Average age of the Northern Fleet's nuclear-powered submarines is today 28 years, the oldest average ever since the first (K3-Leninskiy Komsomol) was commissioned in 1958.

- By 2035 the number of nuclear-powered vessels and installations will likely increase to 74 with a total of 94 reactors. If to include new navy destroyers and maybe one aircraft carrier and add the plans for small-power reactors for extraction of oil, gas and other minerals, the number could be as high as 114 reactors (yellow in the diagram below). That is nearly a doubling from today.



- The Russian Arctic will by far be the most nuclearized waters on the planet.

- Life-time for many of the existing reactors are, or will be, prolonged. This includes Kola nuclear power plant, icebreakers and submarines. Some submarines built in the early 1980s will continue to sail until the late 2020s.

- The number of nuclear-powered icebreakers will double from today's five (including Sevmorput) to nine or ten by 2035. Russia is currently the only country in the world with a fleet of civilian nuclear-powered ships.

- The Russian Arctic will see many first-of-a-kind uses of new reactors technology; sea-floor reactors, underwater drones powered by reactors, reactor-powered cruise-missiles, civilian nuclear-powered submarines and small power-reactors on ice-strengthen platforms.

NUCLEAR-POWERED ICEBREAKERS

Russia is today the only country in the world operating a fleet of civilian nuclear-powered vessels, four icebreakers and one lighter / container carrier. All have Rosatomflot's service base (RTP Atomflot) just north of Murmansk in the Kola Bay as homeport. Here, maintenance, change of crew, changing of spent nuclear fuel, cooling water and radioactive waste management takes place. Two storage vessels for spent nuclear fuel, the «Imandra» and «Lotta» are based here, together with the «Rossita» a vessel giving priority to sail containers with Cold War submarines' spent nuclear fuel from the run-down site at Andreeva Bay in the Litsa fjord.

By 2035, the eight new nuclear-powered icebreakers will be added to the fleet, all to have Murmansk as homeport. The sharp increase in number of nuclear icebreakers follows Russia's aim to boost shipping along the Northern Sea Route up to 80 million tons annually, maybe even more as transit-cargo from Asia to Europe is expected to increase in the years to come.

Additional to breaking the ice for convoys of ships along the Northern Sea Route, the «50 Let Pobedy» sails with tourists to the North Pole during summer periods. Five such voyages are planned for June to August 2019. Previously, both the «Sovyetsky Soyuz» and «Yamal» have sailed North Pole passenger tours every summer since 1990.

Five nuclear powered icebreakers are taken out of operation. «Lenin» (1959-1991) serves as a museum in the central harbor of Murmansk. «Arktika» and «Sibir» are taken to Nerpa shipyard where decommissioning takes place. «Rossiya» and «Sovyetsky Soyuz» are still laid-up at Atomflot waiting for scrapping at the Nerpa yard.

Nuclear-powered icebreakers – Operational time frame

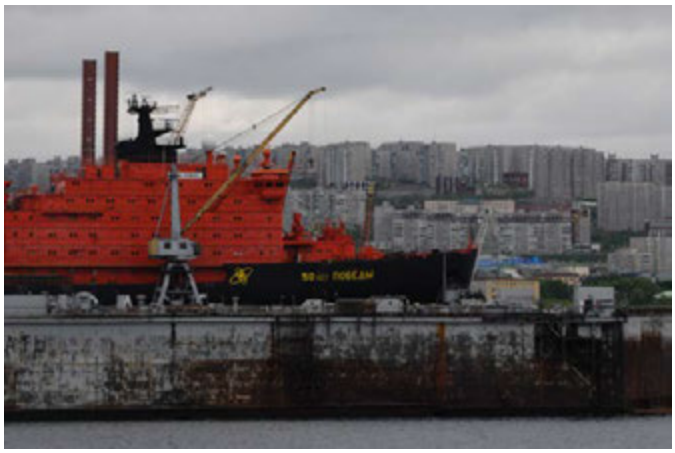
NAME	2019	2021	2023	2025	2027	2029	2031	2033	2035
TAYMYR	----------	---P--	-------	-------	---X				
VAYGACH	----------	---P--	-------	-----X					
YAMAL	----------P	-------	-------	-------	-------	-------	X		
50 LET P.	----------	-------	-------	-------	-------	-------	-------	-------	-------
----------									
ARKTIKA	S	-------	-------	-------	-------	-------	-------	-------	-------
SIBIR		S--	-------	-------	-------	-------	-------	-------	-------
URAL			S---	-------	-------	-------	-------	-------	-------
NO. 4				S---	-------	-------	-------	-------	-------
NO. 5					S----	-------	-------	-------	-------

LEADER 1							S----	-------	-------
LEADER 2								S----	-------
LEADER 3									S--

P = Lifetime prolonged X = To be decommissioned S = To be commissioned

Service base *Atomflot with Murmansk in the background. To the left is the laid-up icebreaker «Sovyetsky Soyuz» and spent fuel storage ship «Lotta». In the middle the floating nuclear power plant «Akademik Lomonosov». To the right at port the spent fuel storage ship «Imandra» and the nuclear-powered container ship «Sevmorput». Blue buildings are repair shops, including storage and handling rooms for spent nuclear fuel and solid- and liquid radioactive waste.*

Project 10520 – Arktika class



By early 2019, Rosatomflot operates two icebreakers of the Arktika class, the «Yamal» and the «50 Let Pobedy» («50 Years Victory»). The two are the newest in the serie originally consisting of six vessels, with the first one («Arktika») commissioned in 1975. For «Yamal» the operational period for the reactors will be prolonged by 200,000 hours so the icebreaker can continue to sail until 2030. By 2025, a similar 200,000 hours prolongation is planned for the «50 Let Pobedy», allowing the icebreaker to sail until 2035. All maintenance work, changing of the uranium fuel and hull docking takes place in Murmansk.

Reactor

Two OK-900A which delivers 171 MW each, providing some 56 MW (75,000 hp) to the propellers. With two reactors in each icebreaker, there are a total of four of the type in operation.

Characteristics

Displacement: 23,000 to 25,168 tons (the two still in operation is heavier and longer than the former in the same class). Length: 148 to 159,6 m. Beam: 30 m. Height: 11 m. Draft: 17,2 m.

Vessels

Name	Commissioned	Decommissioned	Current status
«Arktika»	1975	2008	Moored at Nerpa yard
«Sibir»	1977	1992	Reactors taken out (Nerpa)
«Rossiya»	1985	2013	Mored at Atomflot
«Sovyetsky Soyuz»	1989	2012	Moored at Atomflot«
Yamal»	1992	(estimated 2030)	In operation
«50 Let Pobedy»	2007	(estimated 2035)	In operation

Project 10580 – Taymyr class

The two icebreakers in the class, «Taymyr» and «Vaigach», are built for more shallow-water operations than the Arktika class. With a draught of 7,5 to 9 m, the vessels can sail in the northern part of the Yenisey river and in the Ob Bay. The icebreakers are both built in Finland, while the reactors are made in the USSR. When commissioned, the reactors were projected to run for 100,000 hours, but has since got prolonged life time. In 2018, the reactor on «Vaygach» reached 177,000 hours. By 2021, a decision to prolong operational lifetime for each of the icebreakers will be taken, keeping them in operation until 2026 and 2027.

Reactor

Single KLT-40 with a thermal output of 171 MW. The reactor is similar to the one onboard «Sevmorput» lighter carrier bringing the number of reactors of the class to three in operation. A modified version of the reactor, named KLT-40AS, is used onboard Russia's floating nuclear power plant, the «Akademik Lomonosov» (two reactors).

Characteristics

Displacement: 21,000 tons. Length: 151,8 m. Beam: 29,2 m. Height: 15,2 m.
Draft: 7,5 to 9 m.

Vessels

Name	Commissioned	Current status
«Taymyr»	1988	In operation (until 2027)
«Vaigach»	1989	In operation (until 2026)

Project 10081 – Sevmorput

«Semorput» («Northern Sea Route») is a one-of-a-kind nuclear-powered lighter- and container carrier with icebreaking capabilities.

Commissioned in 1988, the ship was sailing the Northern Sea Route, for the most between Murmansk and the Kara Sea coast. «Sevmorput» has also made voyages to the Far East and once even to Vietnam. Plans to use the vessel for cargo transport to other countries were cancelled because foreign authorities have denied port-calls due to its nuclear propulsion. The ship is well suited to deliver cargo along the north coast of Siberia, where little harbor infrastructure is developed. Sailing in the ice, lighters and other cargo can be unloaded on the ice outside the coast and towed to shore on the ice by trucks or bulldozers. For several periods in the 1990s and 2000s, «Sevmorput» stayed in port in Murmansk for years without sailing. In 2008, the ship was laid-up and in 2012 the plan was to scrap it. In 2013, however, it was decided to do renovation and in autumn 2015, the ship was again test-sailing in the Barents Sea. The following year, «Sevmorput» was back in regular service. By 2019, «Sevmorput» is sailing cargo from Arkhangelsk to petroleum development projects in the Ob Bay as well as bringing cargo to military installations in the Russian Arctic. It is also sailing with equipment to the Pavlovskoye lead-zinc mine development at Novaya Zemlya. «Sevmorput» can carry 74 lighters or 1324 containers. The ship can sail in up to 1-meter thick ice at a speed of about two knots, or at 20 knots in open sea. After upgrade and safety evaluations in 2015, the reactor's service life was prolonged with 150,000 hours with the aim of keeping the ship in operation until 2024.

Reactor

Single KLT-40M, 135 MWh. Reactor is similar to those onboard the icebreakers «Taymyr» and «Vaigach». A modified version of the reactor type, named KLT-40S, is used on the floating nuclear power plant «Akademik Lomonosov». The reactor core contains 150 kg of uranium and has been recharged only once.

Characteristics

Displacement: 61,000 tons. Length: 260 m. Height: 18,3 m. Beam: 32 m. Draft: 10,65 m.

Laid down	Commissioned	Current status
1982	December 31, 1988	In operation (until 2024)

Project 22220 – LK60Ya

Three new universal icebreakers of the class are currently under construction at the Baltisky Zavod (Baltic Yard) in St. Petersburg. Additional two are planned with contracts believed to be signed by autumn 2019. The icebreakers are the most powerful civilian vessels ever built and will be transferred to Murmansk for operation along the Northern Sea Route, presumably for the eastern part from the Taymyr Peninsula towards the Bering Strait where ice conditions normally are more severe (thicker ice) than in the Kara Sea. Maximum icebreaking capability is 3 m. Speed in non-icy waters is up to 22 knots. All vessels of the class have an operational horizon beyond 2039.

Reactor

Two RITM-200, with an overall power of 175 MW, delivering some 81,000 hp to the propellers via twin turbine-generators and three motors. The uranium fuel is up to 20% enrichment. If five vessels are built, there will be 10 reactors of the type in operation by 2028.

Characteristics

Displacement: 33,540 tons. Length: 173 m (568 ft). Beam: 34 m. Height: 15,2 m. Draft: 10,5 m.

Vessels

Name	Laid down	Launched	Commissioned
«Arktika»	November 5, 2013	June 16, 2016	(est. Q2 2020)
«Sibir»	May 26, 2015	September 22, 2017	(est. Q4 2021)
«Ural»	July 25, 2016	May 25, 2019	(est. 2022)
No. 4			(est. 2024-25)
No. 5			(est. 2026-2028)

Project 105010 – LK120Ya («Lider»)

With a growing fleet of LNG-tankers aimed for year-around sailing the eastern route from Yamal to Asia, the Russian Government gives go-ahead for the giant «Lider» class nuclear-powered icebreakers to be built at Zvezda shipyard in Bolshoy Kamen in the Russian Far East. Three icebreakers of the class are planned to be commissioned in the period from 2030 to 2035. Like the other nuclear icebreakers, also this class will be operated by Rosatom and have Murmansk as service base. The icebreakers, which are twice the size and 13,5 m wider than the Project 22220 icebreakers, will mainly be positioned in the eastern sector of the Northern Sea Route, breaking the ice in the East Siberia Sea from the New Siberia Islands to the Wrangel Island. Maximum icebreaking capability is 4,1 m, meaning they can practically sail everywhere in Arctic waters.

Reactor

Two RITM-400 with an overall power of 315 MWh, delivering some 120 MW to the propellers. The reactors are believed to be of similar design as the RITM-200, although larger in size and power. If all three vessels are built, there will be six reactors of the type in operation by 2035.

Characteristics

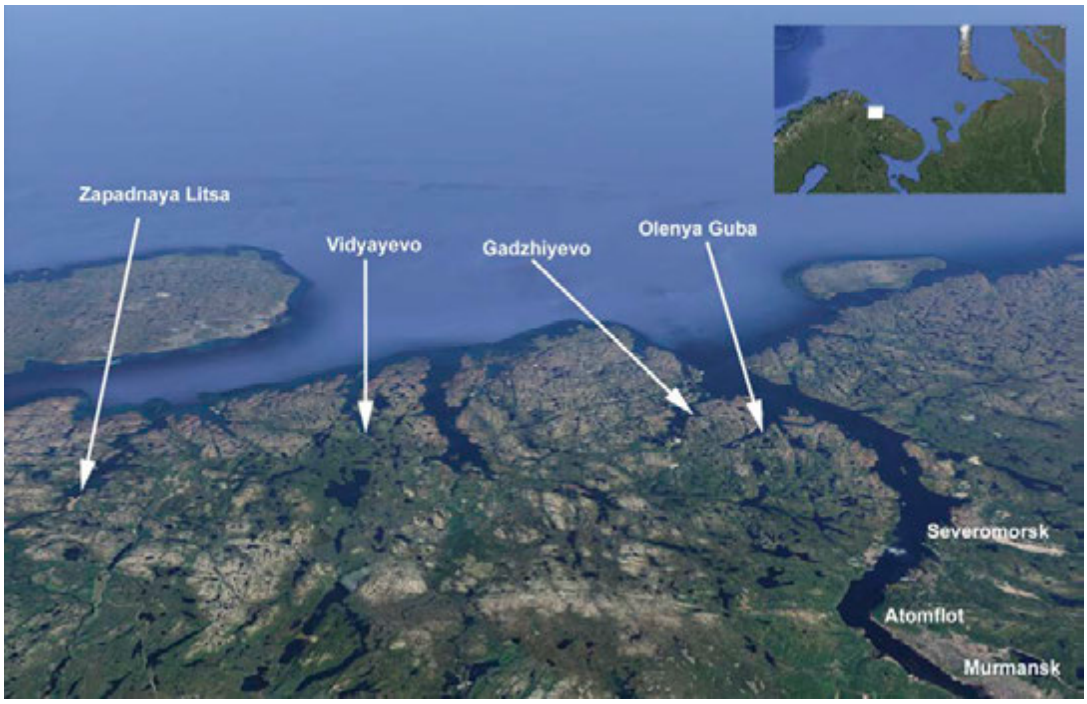
Displacement: 70,674 tons. Length: 209 m. Beam: 47,5 m.

Vessels

No. 1	Planned for commissioning in 2030
No. 2	Planned for commissioning in 2032
No. 3	Planned for commissioning in 2035

Nuclear-powered Submarines and surface vessels

Russia's Northern Fleet is taking major steps to modernize its fleet of nuclear-powered submarines and have in the longer-term plans to build several nuclear-powered surface vessels. All vessels have homeports along the coast to the Barents Sea from the Severomorsk in east to Zapadnaya Litsa in the west, a distance of about 100 kilometres. At a distance of only 65 kilometres, Zapadnaya Litsa is the base nearest to the Norwegian border.



By 2019, the submarine force consists of 31 vessels with an average age of 28 years. Although many are upgraded over the years, it is important to take notice of the fact the Northern Fleet's nuclear-powered submarines have never been older in average than today. As an example; the Delta-IV ballistic missile submarines sail with the more than 50-years old 2nd generation reactors (first came in 1967). Also, the three submarines of the Viktor-class have 2nd generation reactors, while the Sierra, Typhoon, Oscar and Akula classes all have 3rd generation reactors. Borei and Yasen classes have 4th generation reactors, the first introduced in post-Soviet times. With Russia's focus on rearmament, many of the older submarines supposed to be taken out of service are instead repaired and will continue to sail for another decade, some even longer. Simultaneously are newbuilding in full swing at the Sevmash yard in Severodvinsk as new submarines of the Yasen and Borei classes are put on water in a speed not seen since the late 1980s.

Project 671 RTM – Victor-III class

Victor-III (Named Shchuka in Russian) is the latest version of the most numerus nuclear-powered attack submarine built for the Soviet navy. Of the 41 Victor class submarines, 26 were Victor-III. Three of them are still operational for the Northern Fleet with homebase in Vidyaevo or Zapadnaya Litsa on the Kola Peninsula. The Victor-III class is along with the Delta-IV class, the only remaining 2. generation submarines in operation. The three submarines are built in the very late days of the Soviet Union, from 1988 to 1992. The reactors, though, are of the same design as the Victor-I and Victor-II classes, built from the mid-1960s. Keeping these old submarines in active service is cheaper than building new ones. The «Daniil Moskovskiy» is said to be written off by 2021. «Tambov» is undergoing modernization, indicating it could be sailing for another four to six years. It is unclear for how long «Obninsk» will stay in service. Average age of the Viktor-III class submarines is 28 years.

Reactor

Two VM-4 with OK-300 reactor core, each 75 MWh.

Charateristics

Displacement: 6,990 tons surfaced. Length: 106 m. Beam: 10 m. Draft: 7 m.

Vessels

Name	Laid down	Commissioned	Current status
«Obninsk» B-138	1988	December 30, 1990	In service
«Daniil Moskovskiy» B-414	1989	December 30, 1990	In service till 2021
«Tambov» B-448	1991	September 1992	Being modernized

Project 945 / 945A – Sierra I / II class

Sierra I / II class (Russian name Barrakuda) is an attack submarine with a hull of titanium alloy. Six vessels were built of which two are still in operation with the Northern Fleet based in Vidyaevo. The two are the «Nizhniy Novgorod» and «Pskov». Two others, «Karp» and «Kostroma» are awaiting modernization, although work has been delayed since 2015 and current status is unclear. «Pskov» was re-launched after a four-years overhaul at the Nerpa yard in December 2015, while «Nizhny Novgorod» was upgraded in 2008. The average age of the Sierra-class submarines is 30 years.

Reactor

Single VM-5, OK-650 reactor core. 190 MWh. This is third-generation submarine reactor, similar to the ones used onboard other third-generation submarines.

Characteristics

Displacement: 7,600 tons surfaced. Length: 110 m. Beam: 14,2 m. Draft: 9,5 m.

Vessels

Name	Laid down	Commissioned	Current status
«Karp» B-239	1979	1984	Laid-up,
«Kostroma» B-267	1984	1987	Laid-up
«Nizhniy Novgorov» B-534	1986	1990	In service
«Pskov» K-336	1989	1993	In service

Project 971 – Akula I / II / III class

Akula class (Russian name Shchuka) is a third-generation multi-purpose submarine. 15 are built, of which six are sailing for the Northern Fleet, among them four Akula I, one Akula-II and one Akula-III. One Akula is on lease to the Indian navy «INS Chakra» (former «Nerpa» K-152), while the rest belongs to the Pacific fleet. Two of the Pacific fleet's Akulas are in for overhaul at the yard in Severodvinsk. The Northern Fleet Akulas are based in Gadzhiyevo and Vidyaevo, being part of the 24th Submarine Division. Those are built in the period 1985 to 2001. In early 2019 it was announced that the Akulas could be sailing for yet another 25 to 30 years after each one of them being upgraded, a prosess already started. If sailing another two to three decades, the Akulas will be 50 to 60 years old before taken out of operation sometime between 2044 to 2049. Today, the oldest Akula sailing for the Northern Fleet is «Pantera» commissioned in 1990. The newest is «Gerpard» commissioned in 2001. Average age of the Akula-class submarines is 25 years.

Reactor

Single VM-5 with OK-650 reactor core. 190 MWh. Similar to other reactors onboard other third- generation submarines.

Characteristics

Displacement: 8,140 - 8,470 surfaced. Length: 110 - 113 m. Beam: 13,6 m. Draft: 9,7 m.

Vessels

Name	Laid down	Commissioned	Current status
«Pantera» K-317	1986	December 27, 1990	In service
«Volk» K-461	1987	December 29, 1991	In service
«Leopard» K-328	1988	December 30, 1992	In service
«Tigr» K-154	1989	December 29, 1993	In service
«Vepr» K-157	1990	November 25, 1995	In service
«Gepard» K-335	1991	December 3, 2001	In service

Project 949A – Oscar-II class

13 Oscar-II (Russian name Antey) third-generation multi-purpose submarines were built of which three are still sailing with the Northern Fleet, based in Zapadnaya Litsa. One sank in the Barents Sea on August 12th, 2000 (K-141, «Kursk»), four are decommissioned, while the five others sail for the Pacific Fleet. All three Northern Fleet subs of the class had major overhaul and were relaunched in the period 2011 to 2017. The overhaul and modernization will give the three vessels a prolonged lifetime of 20 years, meaning they are likely to sail until 2031 to 2037. Average age of the Oscar-II class submarines is 28 years.

Reactor

Two VM-5 with OK-650b reactor cores, each 190 MWh. Reactor type has same design as the Sierra and Akula class submarines.

Characteristics

Displacement: 14,700 tons surfaced. Length: 155 m. Beam: 18,2 m. Draft: 9 m.

Vessels

Name	Laid down	Commissioned	Current status
«Voronezh»	1986	December 29, 1989	In service
«Smolensk»	1986	December 1990	In service
«Orel»	1989	December 30, 1992	In service

Project 941 – Typhoon class

Typhoon (Russian name Akula) is the world's largest submarines, built to carry 200 nuclear warheads on 20 ballistic missiles. Six of the class were built in the period 1976 to 1989, all sailing for the Northern Fleet. Today, only one oldest of the Typhoons are in service, the «Dmitriy Donskoi» which is based in Severodvinsk and serves as a test-platform for missiles and other equipment relevant to submarine navigation. Three Typhoons are decommissioned, while the two last, «Arkhangelsk» and «Severstal» are laid-up at the yard in Severodvinsk. The future of the two has been debated whether to modernize them or to decommission them. Today, it seems most likely that they will be scrapped.

Reactor

Two VM-5 with OK-650 reactor cores, each 190 MWh. Similar to other third-generation submarines.

Characteristics

Displacement: 24,500 surfaced. Lenght: 175 m. Beam: 23 m. Draft: 12 m.

Vessels

Name	Laid down	Commissioned	Current status
«Dmitriy Donskoi»	1976	December 23, 1981	In service
«Arkhangelsk»	1983	December 15, 1987	Laid-up
«Severstal»	1985	December 19, 1989	Laid-up

Project 677 BDRM – Delta IV class

The Delta I-IV classes of submarines are the most numerous ballistic missile submarines built in the period from 1973 to 1990 and are second-generation nuclear-powered subs. Today, the Northern Fleet operates six Delta-IV class vessels (Russian name Delfin), commissioned in the period 1984 to 1990, and armed with up to 16 ballistic missiles. Homeport is Gadzhiyevo. At sea, the Delta-IV mainly patrols the eastern Barents Sea and under the ice in the Arctic Ocean. All six Delta-IV submarines have been upgraded and given a prolonged lifetime till the late 2020s. Average age is 32 years.

Reactor

Two VM-4 with OK-700 reactor core. 90 MWh. This is a second-generation naval reactor with a design that first came into use in 1967.

Characteristics

Displacement: 13,500 tons surfaced. Length: 167 m. Beam: 12,2 m. Draft: 8,8 m.

Vessels

Name	Laid down	Commissioned	Current status
«Verkhoturye» K-51	1981	December 28, 1984	In service
«Ekateringburg» K-84	1982	December 30, 1985	In service
«Tula» K-114	1984	October 30, 1987	In service
«Bryansk» K-117	1985	September 30, 1988	In service
«Karelia» K-18	1986	October 10, 1989	In service
«Novomoskovsk» K-407	1987	November 27, 1990	In service

Project 885 / 885M – Yasen class

Fourth-generation multi-purpose submarines. Two are so far commissioned, «Severodvinsk» and «Kazan», while five others are at different stages of construction. For now, the plan is to have all seven submarines of the class in service by 2023. Likely, three or four will sail for the Northern Fleet and the other for the Pacific Fleet. The first vessel, «Severodvinsk», had a very long construction period due to economic challenges for the Russian military in the first decade after the breakup of the Soviet Union. The sub was laid-down in 1993 and was commissioned 20 years later, in 2013. Like other prototype submarines in the Northern Fleet, «Severodvinsk» has homeport in Zapadnaya Litsa. «Kazan» and the following submarines are of the improved 885M project. «Kazan» was launched in 2017 but has experienced several challenges during testing and will likely not be transferred to the navy before early 2020.

Reactor

Single KPM reactor with OK-650V reactor core. The prototype «Severodvinsk» has 190 MWh while the following subs in the class have 200 MWh. This is fourth-generation Russian naval pressure-water reactors.

Characteristics

Displacement: 8,600 surfaced. Length: 139,5 m. Beam: 13 m. Draft: 8,4 m.

Vessels

Name	Laid down	Commissioned	Status
«Severodvinsk» K-560	1993	December 30, 2013	In service
«Kazan» K-561	2009	(estimated early 2020)	Sea trails
«Novosibirsk» K-573	2013	(estimated 2020)	Under construction
«Krasnoyarsk» K-571	2014	(estimated 2020)	Under construction
«Arkhangelsk» K-564	2015	(estimated 2021)	Under construction
«Perm»	2016	(estimated 2022)	Under construction
«Ulyanovsk»	2017	(estimated 2023)	Under construction

Project 955 / 955A – Borei I / II class

The Borei class is fourth-generation ballistic missile submarines, successor of the Delta-IV and Typhoon class. Armed with up to 16 Bulava missiles, the Borei-class will be the core of the naval component of Russia's nuclear triad for at least the two next decades. The three first subs (Borei-I) are already in operation, one with the Northern Fleet and two with the Pacific Fleet. The first upgraded Borei-II (955A) will be launched in 2019, while the four following subs in the class are at different stages of construction at the yard in Severodvinsk. By 2021, eight Borei subs will be in service, presumably three with the Northern Fleet and five with the Pacific Fleet. Priority is given to the Pacific Fleet as Borei replaces the elderly Delta-III while in the Northern Fleet, the newer Delta-IV will sail for another decade. Two additional subs of the Borei-II class are planned and mentioned in the 2018-2027 state armament program. There are also reports about additional four, bringing the total number of Borei-I and II to 14 by the end of next decade. In the Northern Fleet, strategic missile submarines of the Borei- and Delta-IV classes are all based in Gadzhiyevo.

Reactor

Fourth-generation single reactor with OK-650B core. 190 MWh.

Characteristics

Displacement: 14,720 tons. Length: 170 m. Beam: 13,5 m. Draft: 10 m.

Vessels (Northern Fleet)

Name	Laid down	Commissioned	Status
«Yury Dolgorukiy»	1996	January 10, 2013	In service
«Generalissimus Suvorov»	2014	(Estimated 2020)	Construction
«Knyaz Pozharsky»	2016	(Estimated 2021)	Construction
No. 9	2024	(Estimated 2026)	Planned
No. 10.	2024	(Estimated 2027)	Planned

Special purpose submarines

From a base in Olenya Bay (see satellite photo) north of Murmansk, Russia Main Directorate for Deep Sea Research (GUGI), a branch directly under the General Staff of the Armed Forces, operates the 29th Special Submarine Squadron with a fleet of eight nuclear powered subs. The mini-submarine classes are Paltus (incl. X-ray), Uniform (Rusisan name Kashalot) and Losharik. Several of the mini-subs are in Severodvinsk for repair and upgrade. Two of the vessels in Olenya Bay are former ballistic missile submarines rebuilt to carry mini-submarines. The two are «Orenburg» (B-136) rebuilt from a Delta-III class and «Podmoskovye» (BS-64), a rebuilt Delta-IV class. Yet another large carrier will join the squadron in 2019, the «Belgorod», a rebuilt Oscar-II class that was put on water in Severodvinsk in spring 2019. With an extended hull 184 m long, the submarine is the world's longest. «Khabarovsk» (see next page) is also a special purpose submarine.

Reactors

All mini-submarines have a single-reactor, while the converted «Orenburg» «Podmoskovye» and «Belgorod» have two reactors each similar to the Delta-III / IV class and Oscar-II class submarines.

Vessels

Class	Name	Launched	Reactor	Status
Project 10831	AS-12 (Losharik)	1997	One 15 MWh	In service
Project 1910 Uniform	AS-13	1994	One 10 MWh	In service
	AS-15	1982	One 10 MWh	In service
Project 1851 Paltus	AS-23 (X-ray)	1982	One unkown	In service
	AS-21		One unkown	In service
	AS-35		One unkown	In service
Rebuilt Delta-III	«Orenburg» B-136	1981 (2002)	Two VM-4	In service
Rebuilt Delta-IV	«Podmoskovya» BS-64	1986 (2016)	Two VM-4	In service
Rebuilt Oscar-II	«Belgorod» KS-139	April 23, 2019	Two VM-5	Construct.

Project 09851 – «Khabarovsk»

The «Khabarovsk» is a one-of-a-kind nuclear-powered submarine under construction in Severodvinsk. It will be the main launching platform for the new Poseidon (NATO name KANYON) nuclear-powered underwater drone (see page 23). Additionally, the submarine will be able to carry deep-sea stations to be placed on the sea-floor in the Arctic, including small-size nuclear-powered reactors. The «Khabarovsk» is built with a hull similar to the Borei class submarines, although shorter since there isn't any ballistic missile section onboard. Likely, it could carry six Poseidon drones to be launched like torpedoes from the forward part of the submarine. Construction started in July 2014. The Sevmash yard reported in spring 2018 that the submarine was passing hydraulic- and structure tests. Launching is scheduled for spring 2020 and transfer to the fleet is expected to happen in 2022.

Reactor

Most likely a single OK-650b reactor core similar to the one onboard the Borei class submarines with 190 MWh. Additional will be the six small-size reactors, one in each of the Poseidon drones.

Characteristics

Due to the secrecy about this special submarine, very little technical information is available to date. (Approx.) Displacement: 10,000 tons. Lenght: 120 m. Beam 13 m.

Project 1144 - Kirov class battle cruiser

It is the world's largest battle cruiser, the nuclear-powered Kirov class (Russian name Orlan). Four vessels were built in the period 1973 to 1998, but only one remains in service: «Pyotr Velikiy» (Peter the Great). Based in Severomorsk, the vessel is the flagship of the Northern Fleet. As of today, «Pyotr Velikiy» is the only nuclear-powered surface vessel in operation in the Russian navy. While the two laid-up ships "Admiral Ushakov" (at the yard in Severodvinsk) and «Admiral Lazarev» (Pacific Fleet) will be scrapped, upgrading work is going on with the «Admiral Nakhimov» at the yard in Severodvinsk. The battle cruiser is expected to be re-launched for the Northern Fleet in 2021 after being at the yard since 1997. When "«Admiral Nakhimov» starts sailing, "«Pyotr Velikiy» will be docked for major overhaul.

Reactor

Two KN-3 reactors. 300 MWh providing 140,000 hp.

Characteristics

Displacement: 28,000 tons. Length: 251 m. Beam: 28,5 m. Draft: 9,1 m.

Vessels

Name	Laid down	Commissioned	Status
«Pyotr Velikiy»	1986	1998	In service (overhaul 2021)
«Admiral Nakhimov»	1983	1988	Relaunch planned for 2021
«Admiral Ushakov»	1974	1980	Awaiting scrapping
«Admiral Lazarev»	1978	1984	Awaiting scrapping

Project 23560 - Lider class Destroyer

The Leader class is a planned new advanced guided missile destroyer that most sources claim to be nuclear-powered. Russia's Defense Ministry approved the conceptual design in 2017 the ships are mentioned in the State Armament Program for 2018-2027, although construction is delayed, it could start after 2020. The plan is to build eight vessels of the class, to be divided between the Northern Fleet and the Pacific Fleet. Alternatively, the Leader class destroyers could be powered by gas-turbines.

Reactor

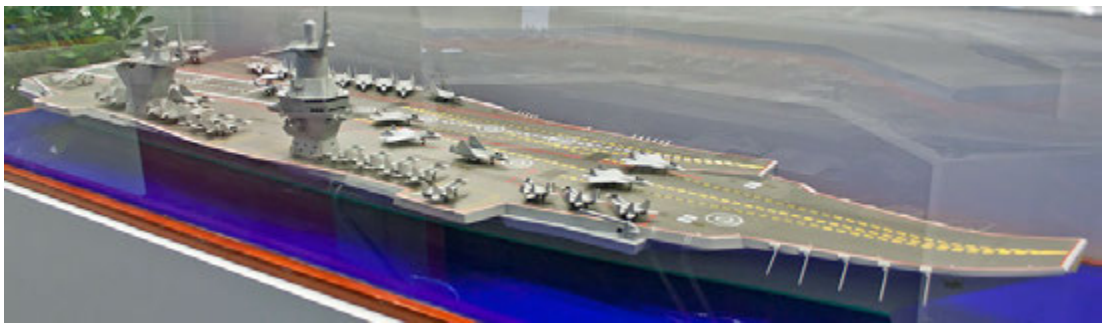
No public data on decisions regarding reactor type, but the RITM-200 is suggested. RITM-200 is the reactor to be built for the Leader class (Project 105010) icebreakers and the rector is also mentioned as prolusion for a possible future aircraft carrier. A total of eight reactors will be with the Northern Fleet (four vessels, two reactors each).

Project 23oooE – Aircraft carrier

The concept plans for a new aircraft carrier (Russian name Shtorm) is not approved, although such carrier is mentioned in the State Armament Program 2018-2027. Two sizes are possible, either a conventional powered carrier in about the size of today's "Admiral Kuznetsov" carrier, some 70,000 tons, or a larger nuclear-powered version. The carrier will be based in Severomorsk with the Northern Fleet. Construction is estimated to start in the second half of the 2020s, suggesting the carrier could be in operation around 2035 and have a service life of up to 50 years.

Reactor

RITM-200 is likely, similar to the Leader destroyers and icebreakers. No decisions made.



Nuclear-powered Drones and Missiles

Poseidon nuclear-powered underwater drone

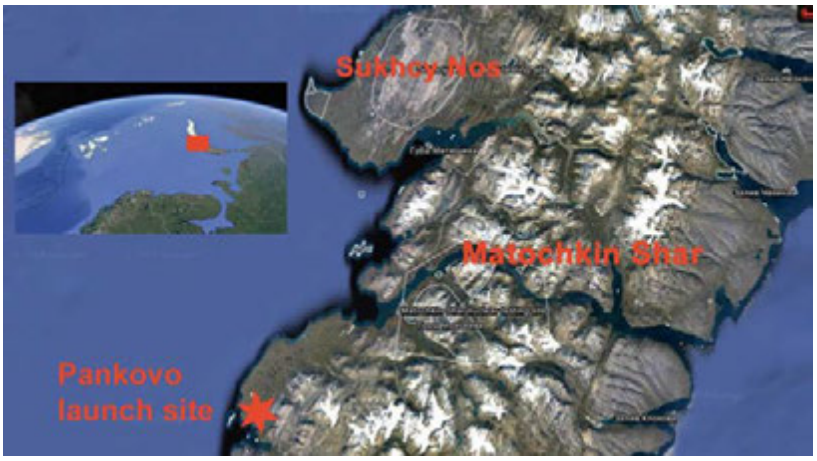
The Poseidon is a new, not-yet deployed, nuclear-powered and nuclear-armed autonomous torpedo designed to cross oceans and strike coastal targets. From a nuclear deterrence point of view, this is a second-strike weapon that although sailing at a speed of 60 knots will use days from it is launched in the Barents Sea till it hits the east coast of north-America. Poseidon is 24 m long and about 1,6 m in diameter. The Poseidon drone could either be carried onboard a submarine (like the «Belgorod» and «Khabarovsk») or deployed at subsea installations inside Russian territorial waters in the Barents Sea or Arctic Ocean. The Severodvinsk based submarine «Sarov» has likely been used as a test-platform for Poseidon. The ship «Zvezdochka» in Severdovinsk has also been carrying test-versions of Poseidon (see photo below). 32 Poseidon drones will be deployed, 16 with the Northern Fleet and 16 with the Pacific Fleet. U.S. media, with sources in the intelligence community, estimate the drone to be operative by 2027.

Reactor

Little is known about the reactor, but given the diameter size of the drone, it is a very small and simple (single-use purpose) reactor of about 1 MW. Maybe gas-cooled like the TEM reactor (1 MW) under development for Russia's nuclear electric rocket spaceship program.

9M730 Burevestnik nuclear-powered missile

The Burevestnik (NATO name Skyfall) is a cruise-missile said to have "unlimited" range and be powered by a small-size nuclear reactor. President Vladimir Putin in his annual State of the Union speech gave first public information about the existence of the development program in 2018. The missile has been tested several times at the Pankovo test range at Novaya Zemlya, as well as at the Kapustin Yar test range in Astrakhan Oblast. It is believed the missile use a gasoline-powered engine for takeoff before switching on the reactor up in air, but despite Putin claiming the missile has proved its capabilities at a test in late 2017, it is unclear if the reactor actually worked during the Novaya Zemlya tests. U.S. media with references to intelligence reports claim the missile was flying 22 miles before losing power and crashed, either in the Barents Sea or on land at Novaya Zemlya. In January 2019, though, another media report refers to a successful test of the nuclear reactor unit, this time at Kapustin Yar test range.



The reactor is light and small size. There is limited information about numbers to be deployed, locations of deployment or when the missile will be ready for deployment.

Nuclear-power plants, small power reactors and Civilian submarines

Kola nuclear power plant

Russia has two nuclear power plants located in the Arctic region. Bilibino (48 MW) near Pevek on the Chukotka Peninsula will soon be closed down and replaced by the first floating NPP. Kola Nuclear Power Plant (1760 MW) will then be the only on-land nuclear power plant north of the Arctic Circle. The plant is a two hours' drive south of Murmansk near the town of Polyarny Zori on the shores of Lake Imandra. The industrial towns of Monchegorsk, Apatity, Kandalaksha, Kirovsk, Olenegorsk and Kovdor are all within a radius of 120 kilometers from the nuclear power plant. Parts of the electricity produced is also exported out of the region. Construction of Kola NPP started in 1970 with the first reactor in production from 1973. Previous plans to build a second nuclear power plant on Kola, to be located some few kilometers from the existing, seem to be postponed indefinitely. Meanwhile, lifetime of the existing reactors is prolonged several times, keeping the plant operational beyond 2035.

Reactors

Kola Nuclear Power Plant operates four reactors. The two oldest are first generation Soviet design pressure water reactors (PWR) of the VVER-440/230 type designed in the 1960s, while the two newest are second generation of the type VVER-440/213 introduced in the early 1980s. All four has a gross capacity of 440 MW each. Unit 1 and 2 are in hall one, while Unit 3 and 4 are in the second hall at the power plant.

Units:	Operation started	Original shutdown plan	License expires
No. 1	28th December 1973	2003	2033
No. 2	21st February 1975	2005	2034
No. 3	3rd December 1982	2012	2026
No. 4	6th December 1984	2014	2039

Bilibino Nuclear Power Plant

Located on the tundra outside the small town of Bilibino on the Chukotka Peninsula, some 150 kilometres from the coast of the East Siberia Sea, the nuclear power plant is the world's northernmost. The plant has four reactors, of which three are still in operation. Though, the short-term plan is to switch off the remaining reactors as soon as electricity from the coming "Akademik Lomonosov" floating nuclear power plant to be placed in Pevek can reach Bilibino via an upgraded power grid. Pevek is about 200 kilometres in distance from Bilibino. The floating NPP "Akademik Lomonosov" is scheduled to be connected to the grid by December 2019, hence a shut-down of the remaining reactors at Bilibino NPP could be expected by 2020, or at earliest when today's closed-loop power grid system is connected. The nuclear power plant supplies the town and nearby mining sites with steam, hot water and electricity. The plant's EGP-6 reactors are the smallest in the world used in a commercial nuclear power plant and it is also the only nuclear power plant built on permafrost. After shutdown, the plan is to cool down the reactor cores, before the spent fuel assemblies will be transported to the coast and shipped along the Northern Sea Route to Murmansk for further handling.

Reactors

The four reactors are light water graphite moderated reactors (LWGR) of the EGP-6 type. This is in principal a scaled down version of the larger Soviet design RBMK graphite moderated reactors (Chernobyl-type). Each of the three remaining reactors at Bilibino NPP has a capacity of 12 MW power.

Unit	Capacity	Commercial Operation	Status
No. 1	12 MW	1st April 1974	Shutdown (14. Jan. 2019)
No. 2	12 MW	1st February 1975	In operation (closure 2020)
No. 3.	12 MW	1st February 1976	In operation (closure 2020)
No. 4	12 MW	1. January 1977	In operation (closure 2020)

Floating Nuclear Power Plants

Russia has one floating nuclear power plant (FNPP), the «Akademik Lomonosov». The plant will provide electricity to the local grid in Pevek, a port town on coast of the Chukotka Peninsula as today's onshore Bilibino nuclear heat and power plant will be shut down. Theoretically, the plant can be towed to other remote locations at a later stage. Change of uranium fuel will take place on site every four year. For major overhaul the barge will be towed to either Severodvinsk in the White Sea or to Atomflot, the service base for nuclear powered icebreakers in Murmansk. This work will be done every 12 years. Construction of «Akademik Lomonosov» started in 2007 at Sevmash yard in Severodvinsk, was moved to the Baltic yard in St. Petersburg in 2008 and in 2018 the plant was towed to Murmansk for loading of uranium fuel and testing of the reactors. Towing to Pevek is scheduled for summer 2019 and the plan is to connect it to the local grid in December 2019. It is unclear if more floating nuclear power plants of similar design will be built. Regional authorities on Chukotka have signed contract of intention with Rosatom to add another few FNPPs to the region. Also, the city of Vilyuchinsk on the Kamchatka Peninsula has been listed as possible location. No construction, though, has yet started.

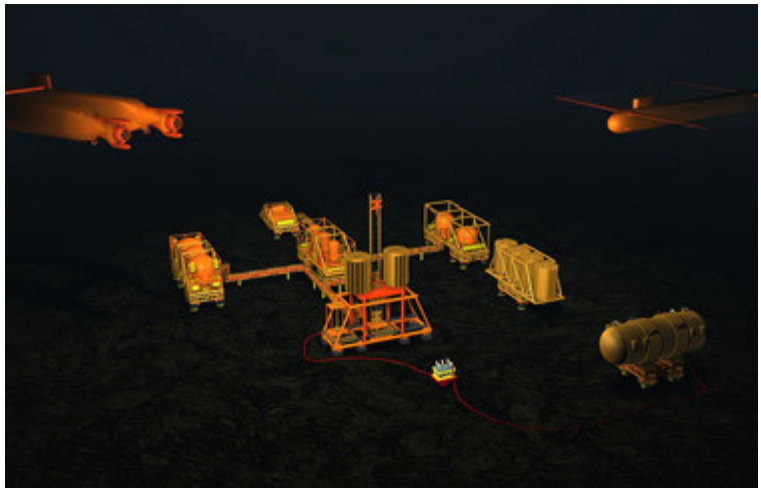
Reactors

Two KLT-40S reactors providing up to 70 MW (2x35) of electricity of 300 MW (2x150) of heat. The reactors are of same type as the reactors onboard Taymyr class icebreakers and the «Sevmorput» container carrier. To meet international proliferation standards, they use low-enriched uranium at 14%.

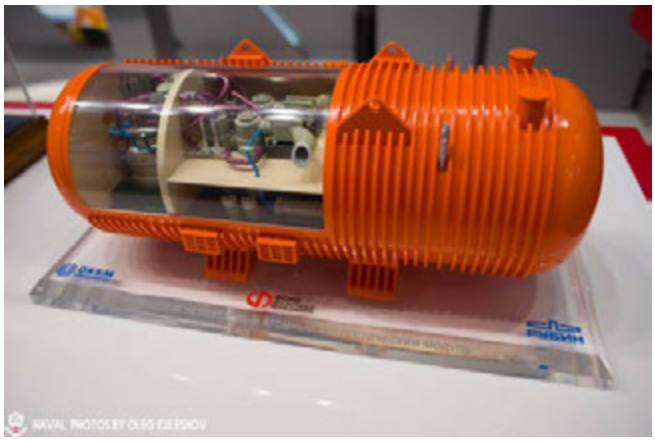
Characteristics

Displacement 21,500 tons. Non-self-propelled barge 144 m long. Beam: 30 m. Height: 10 m. Draft: 5,6 m.

Subsea low-power nuclear reactors



Several Russian design institutes and production centres within the nuclear industry are working on developing small-sized, low-power reactors for subsea and under-ice installations. This could be for oil- and gas drilling installations, pumping stations for pipelines, future sea-floor mining or military sensor network on the Arctic continental shelf. Such reactors would be able to operate autonomous with inbuilt turbo generators in either one block or a series of blocks with electric power capacities ranging from as little as 1 MW up to 250 MW. Reactor installations could be placed on the sea-bed by nuclear submarines, like the ones sailing for the Main Directorate for Deep Sea Research (GUGI), by new civilian nuclear-powered submarines or by surface vessels sailing during ice-free seasons. Some of the reactor designs developed are able to work down to 400 meters, enabling them to be suited for the shelf in most parts of the Barents Sea, Kara Sea, Laptev Sea and East Siberia Sea. Since 2015, Rubin Central Design Bureau for Marine Engineering has had a dedicated project team developing a proto-type 24 MW reactor aimed at powering sea-bed installations for Rosneft and Gazprom. The reactor will have an autonomous operation period of at least 8,000 hours providing power to both drilling for petroleum and future mining exploration on the Arctic shelf. The reactor unit is named SHELF is up to 14 meters long and 8 meters in diameter. Reactor core is said to work up to 30 years before the uranium fuel elements have to be reloaded. Depending on design, electric power capacity would range from 8 to 25 MW.

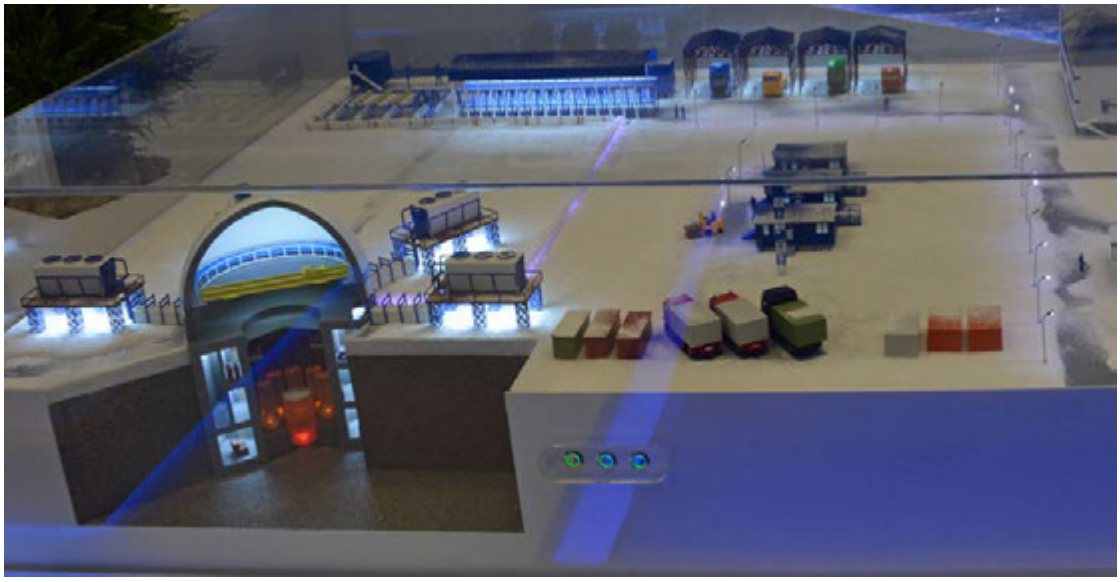


Areas of use:

- Powering the HARMONY multi-sensor Arctic shelf submarine detection network.
- Powering pumps for gas pipelines, like suggested for the Shtokman-field.
- Powering sea bed oil and gas drilling installations.
- Powering sea bed mining exploration.

Small-power reactors, onshore and offshore

There is a growing interest for small-size nuclear power reactors for development of the Russian Arctic. This interest is driven by a need for power supply to remote projects for extraction of natural resources in combination with a believe that nuclear power is a cheaper and more reliable energy source that other options, such as fossil fuels and alternative energy such as wind-, solar and geothermal power. Also, with Rosatom in charge of approving infrastructure investments along the Northern Sea Route, there is an in-house driven self-interest in giving priority to nuclear power.

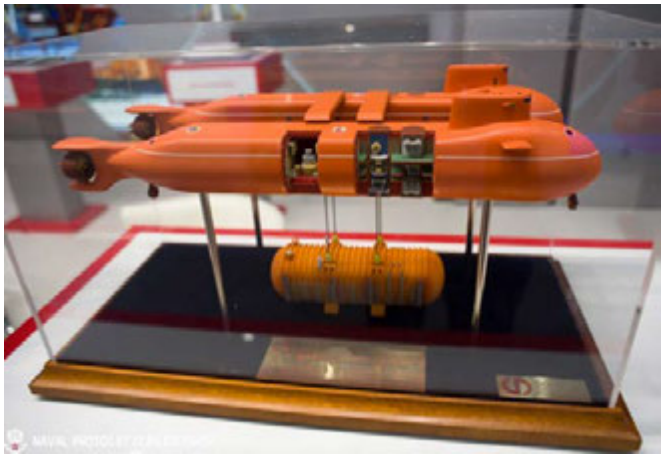


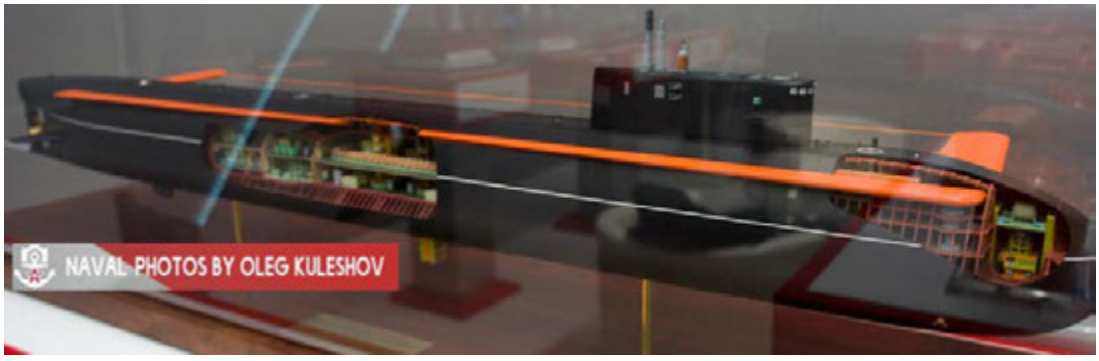
Several tens of conceptual designs for different purposes have been presented by actors in the nuclear industry. Today the list under represents the most likely to go-ahead. Three main categories are outlined; small transportable reactor modules, reactors on fixed offshore platforms and stationary onshore reactors. The reactors in this category are all designed for little maintenance and long-lasting operations, which in some cases includes 25-years before fuel elements need replacement.

Reactor	Type	Power
Vityaz	Water-cooled, transportable	Up to 1 MW
ATGOR	Gas-cooled, transportable	0,2 – 8 MW
SHELF	Ground-based or underwater	5 MW
Unitherm	Water-cooled, stationary	6,6 – 30 MW
NIKA	Water-cooled, stationary or on barge	75 - 100 MW
Elena-M	Water-cooled, stationary	68 kWe

Civilian nuclear-powered submarines

Ideas of building nuclear-powered submarines for various civilian purposes have existed since Soviet-times. In recent year, though, dust has been brushed off old plans and new projects are proposed in lines with the increased focus on exploration of natural resources from the Russian Arctic shelf. The advantage of using nuclear-powered submarines are both that they could sail under the ice, thus operate in all weather and ice conditions, as well as function as a platform for placing sub-sea installations on the sea-floor (photo left) and transport minerals to shore port facilities. The set of submarines are powered by a newly developed 24 MW marine reactor. Russian design institutes working on the plans are the same as having decades of experiences in designing navy submarines, like the Rubin design bureau that has presented a submarine for seismic surveys on the Arctic shelf. With sonar receivers mounted on foldable wings (photo under) low frequency sounds would penetrate the sea floor also in areas covered by ice where normal seismic survey vessels can't sail. The submarine is in size of the navy's Borei-class which is powered by one reactor.





Another design bureau, Malachite, has presented an 82-meters long nuclear-powered submarine with icebreaking capabilities. With a special bow and strengthened hull, the submarine can operate between a surface vessel sailing in ice-covered waters and installations on the sea-floor. The idea is also here to support future extraction of oil and gas or mining of other minerals from the Arctic shelf. Even an idea to build a nuclear-powered submarine LNG-tanker has been presented by the well-known Kurchatov institute.

Although many plans, no agreements are yet signed with neither any petroleum companies nor others involved in exploiting the Arctic shelf. Undoubtful difficult to find economical feasible today, the above-mentioned plans should not be excluded from happening in the future, either being heavily subsidised by the state, like the nuclear-powered icebreakers, or being linked to highly profitable future sea-floor mining projects.

NOTES:

The Barents Observer