Russia's 2nd-Generation Floating Nuclear Power Plant (FNPP) – the Optimized Floating Power Unit (OPEB)

Peter Lobner, 15 May 2021

1. Introduction

Announced in January 2021, Russia's 2nd-generation FNPP will be known as the Optimized Floating Power Unit (OPEB). The vessel is designed by the Iceberg (Aisberg) Central Design Bureau, which is a subsidiary of United Shipbuilding Corporation JSC. The OPEB will be equipped with two 175 MWt / 50 MWe RITM-200M integrated pressurized water reactors (PWRs) developed by OKBM Afrikantov, which is a subsidiary of Rosatom.

2. OPEB vessel design

Iceberg's chief designer, Gleb Makeev, described the OPEB as follows:

> "Compared to *Akademik Lomonosov*, OPEB is structurally simpler, the composition of auxiliary equipment and ship devices has been optimized, and the number of personnel has been reduced. The lifetime and turnaround time of the main equipment will be significantly increased. At the same time, the OPEB is more powerful, so its economic efficiency will also be higher."

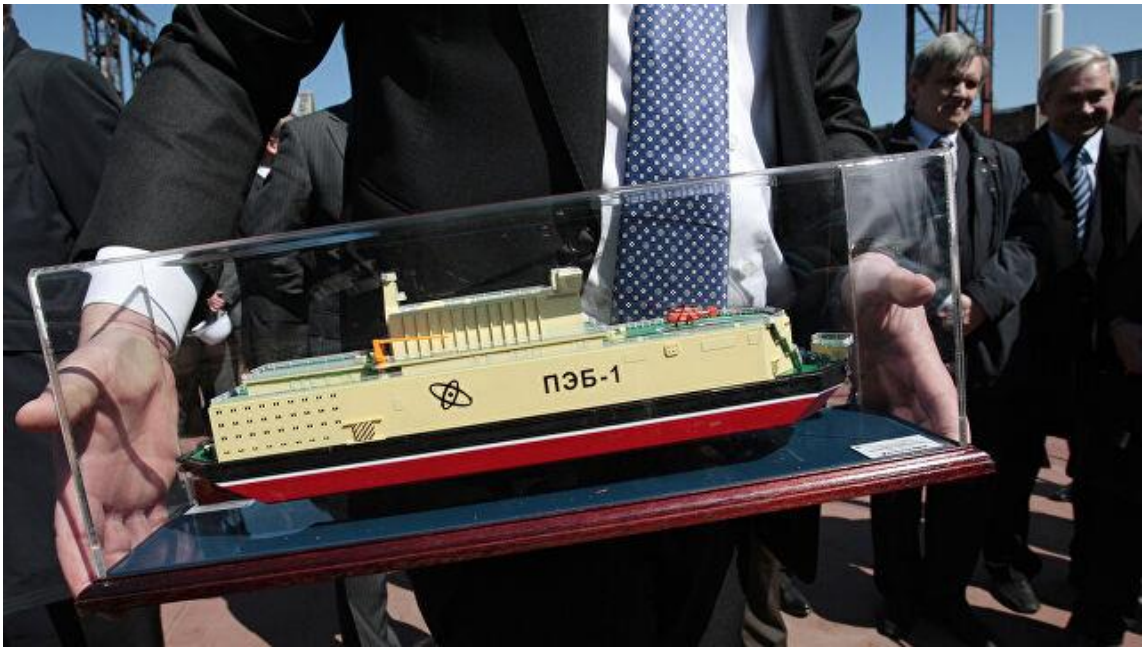
The basic FNPP vessel will be an unpropelled, transportable barge designed to be moored at a protected pier with interface facilities to connect to the local / regional electrical grid and other facilities for low-temperature process heat utilization and/or seawater desalination. The pier will provide a secure mooring during all conditions, including severe weather and winter ice.

For offshore applications, the FNPP vessel may be self-propelled with dynamic positioning capabilities for use in open water areas.

The OPEB will be about 25% shorter and narrower than the *Akademik Lomonosov*, and will require a smaller crew to operate the reactor and ship systems. The OPEB's crew will live in a shoreside facility, eliminating the need for onboard accommodations.

The OPEB will be designed for refueling at about 10 year intervals that will coincide with the regular shipyard visits for scheduled maintenance and repairs that will occur throughout the vessel's 60 year service life. Refueling will take place in the shipyard. Unlike *Akademik Lomonosov*, there will be no refueling equipment of spent fuel storage aboard the OPEB.

The cumulative effect of the OPEB design simplifications results in a vessel with a displacement almost four metric tons less than the *Akademik Lomonosov's* displacement of 21,500 metric tons.

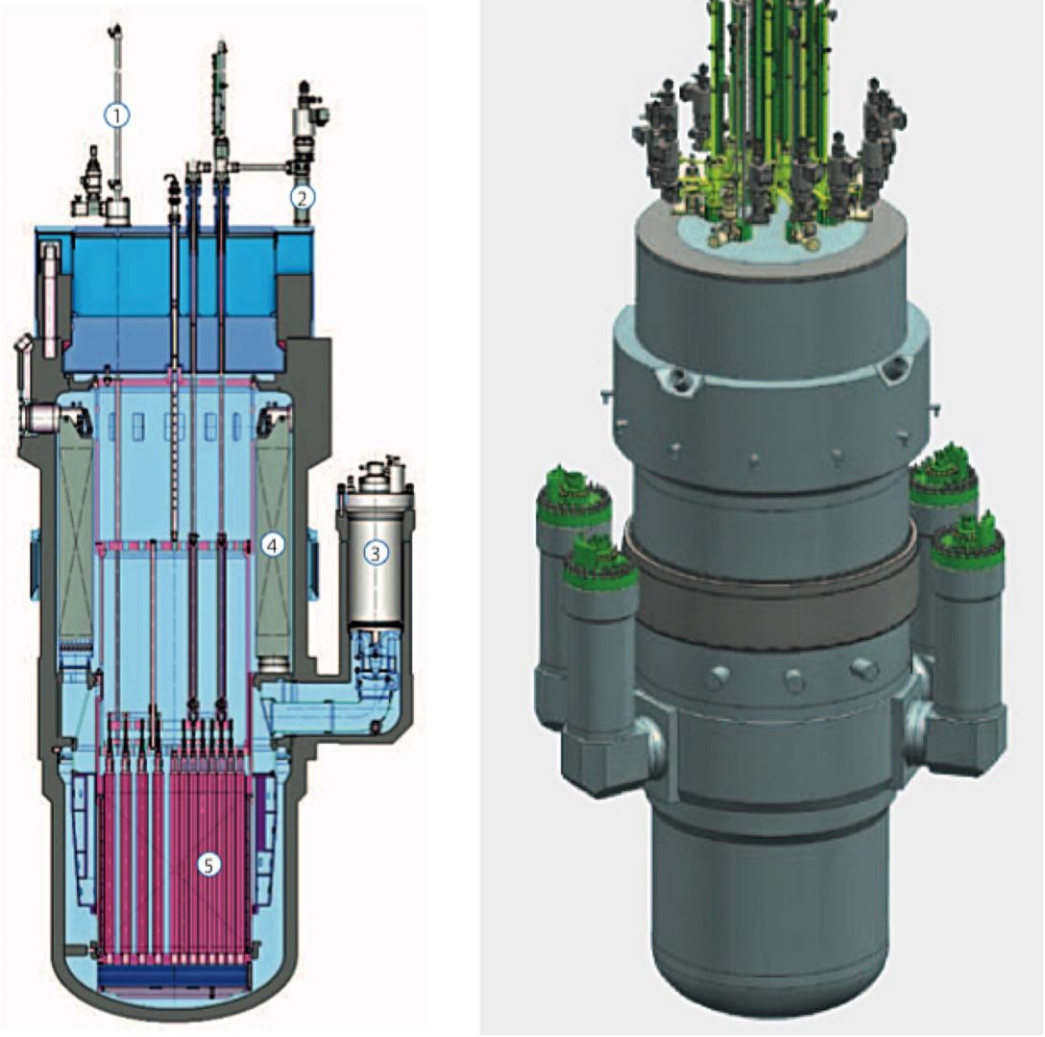


Model of the OPEB.
Source: РИА Новости / Алексей Даничев / Перейти в фотобанк

The OPEB will have two 175 MWt / 50 MWe RITM-200M integrated PWRs capable of delivering a total of 100 MWe.

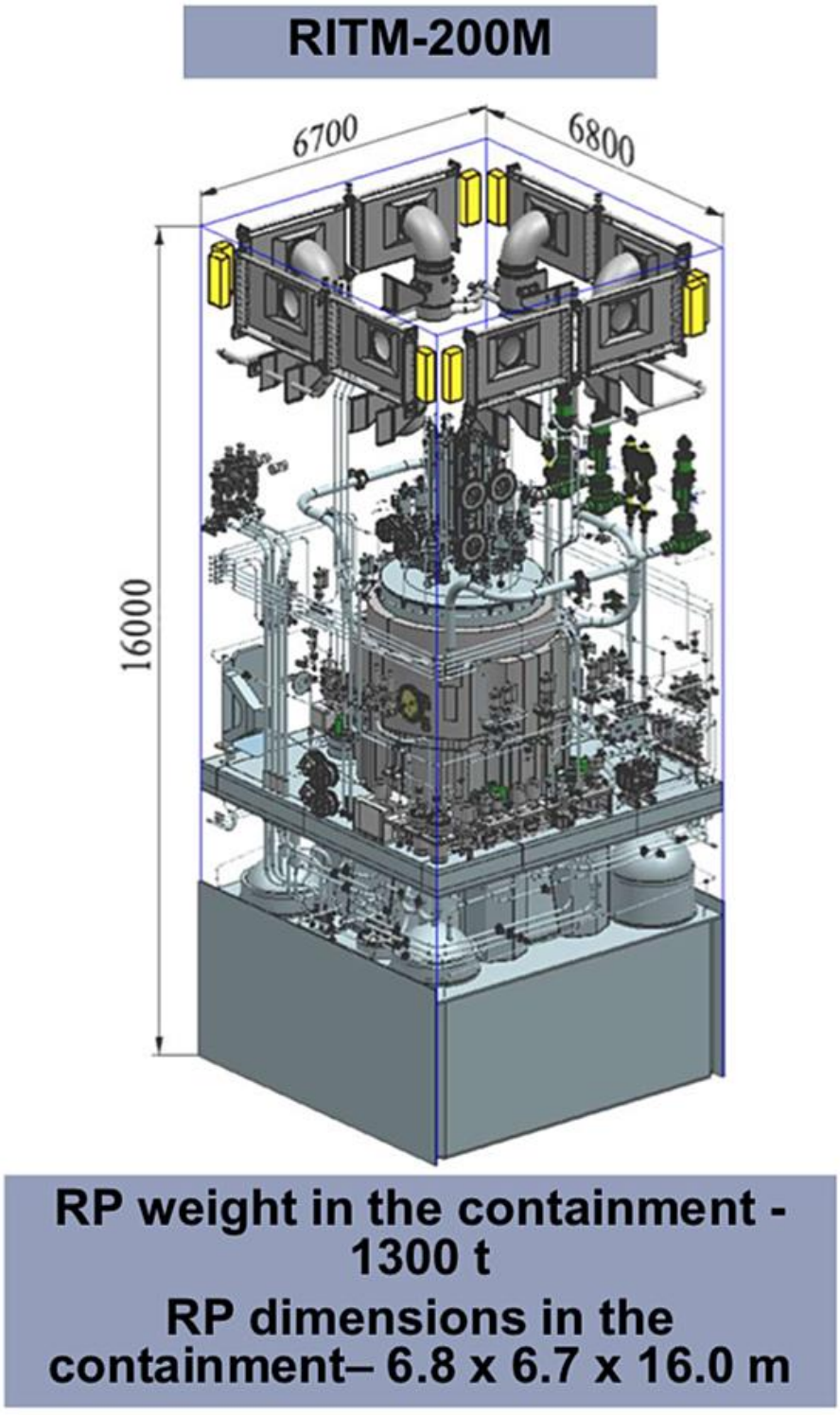
3. Reactor design

The OKBM Afrikantov RITM-200M reactor is similar to the RITM-200 reactors already in service on Russia's new generation of Project 22220 LK-60Ya universal icebreakers, but is optimized for non-propulsion applications on a floating nuclear power plant. (http://www.okbm.nnov.ru/en/).



RITM-200 cross-section (left) & RITM-200M external view (right). Legend: (1) safety rods, (2) control rods, (3) canned motor main circulation pump, (4) steam generator modules, and (5) reactor core. Source, both graphics: OKBM Afrikantov

Aboard an FNPP, each RITM-200M will be housed in an individual compact containment, as shown in the following diagram.



Source: OKBM Afrikantov / Atomenergomash (April 2017)

The RITM-200M reactor has a 10 year refueling interval. The reactors are designed for a 160,000 hour / 20-year operating cycle between "factory repairs" in a shipyard. During a 20-year operating cycle, the reactors will have to be refueled dockside one time. Unlike *Akademik Lomonosov*, there will be no spent fuel handling equipment or a spent fuel storage compartment aboard an OPEB. Therefore, these resources will have to be provided in a shoreside facility or a separate refueling vessel that comes alongside when needed to perform a refueling.

At the end the 20-year operating cycle, the reactors will be shut down and the OPEB will be towed back to a qualified shipyard for "factory repairs," which would include scheduled maintenance, repairs, reactor refueling, and radioactive waste removal. At the conclusion of this shipyard period, the OPEB will be ready for its next 20-year operating cycle and it will be towed to its next assigned port.

Service life of the RITM-200M reactors is expected to be 480,000 hours / 60 years in 3 operating cycles separated by two "factory repair" periods at 20 year intervals. Based on the successful service life extension programs implemented for Russia's oldest nuclear-powered icebreakers, it may be possible to extend the service life of the reactors beyond 60 years.

4. OPEB development plans

In November 2020, Rosatom director for development and international business, Kirill Komarov, reported that there was demand for FNPPs along the entire length of Russia's Northern Sea Route, where a large number of projects are being planned.

This was reinforced in May 2021, when Russia's President Vladimir Putin endorsed a plan to deploy OPEBs to supply a new power line at Cape Nagloynyn, Chaunskaya Bay, to support the development of the Baimskaya copper project in Chukotka. The development plan calls for 350 MWe of new generation. The two alternatives remaining in contention in early 2021 were a floating LNG-powered generator proposed by Novatek and a fleet five OPEB-class FNPPs with longer service life but higher cost proposed by Rosatom. Rosatom claims it can deliver the first two OPEB units by early 2027, and two more in

the fourth quarter of 2028. The fifth unit will be used as a reserve unit to replace one of the other units during its “factory repairs” period in a shipyard. Baimskaya currently is supplied from Pevek, where the *Akademik Lomonosov* is based.

Rendering of an OPEB in a protective mooring. Source: Rosatom

In December 2020, the official Russian news service reported that numerous foreign countries have expressed interested in acquiring an OPEB. Bellona reported that “Rosatom has long claimed that unspecified governments in North Africa, the Middle East and Southeast Asia are interested in acquiring floating nuclear plants.”

Rendering of an OPEB at a tropical site. Source: Strana_Rosatom

Aisberg claims that the OPEB announced in January 2021 can operate in tropical and subtropical climates, with seawater temperatures up to 40°C (104°F) and outside air temperatures up to 47°C (117°F).

5. For more information

- V. M. Belyaev, et al., “Technology Development and Design Approaches Including Economics of Small and Medium Sized Reactors,” OKBM Afrikantov / Atomenergomash presentation at the IAEA’s First Meeting of the Technical Working Group for Small and Medium-sized of Modular Reactors (TWG-SMR), Vienna, 23-26 April 2017: https://nucleus.iaea.org/sites/htgr-kb/twg-smr/Documents/TWG-1_2018/18A_RUSSIA_ROSATOM_Veshnyakov_TWG_SMR_240418.pdf
- Peter Lobner, “Manufacturing the Reactor Vessel for an RITM-200 PWR for Russia’s new LK-60 Class of Polar Icebreakers,” The Lyncean Group of San Diego, 29 August 2017: https://lynceans.org/all-posts/manufacturing-the-reactor-vessel-for-an-ritm-200-pwr-for-russias-new-lk-60-class-of-polar-icebreakers/
- “Floating NPPs, a Solution for Electricity Demand in Hot Countries?” European Nuclear Society: https://www.euronuclear.org/news/floating-npps-future-solutions/
- “Advances in Small Modular Reactor Technology Developments - A Supplement to: IAEA Advanced Reactors Information System (ARIS) 2020 Edition,” pp. 115 – 118, “RITM-200M (JSC “Afrikantov OKBM”, Russian Federation),” International Atomic Energy Commission, 2020: https://aris.iaea.org/Publications/SMR_Book_2020.pdf
- Video: “ENS webinar: "Rosatom SMR solutions: floating nuclear power plants and beyond" (22:17 minutes), European Nuclear Society, 7 May 2020: https://www.youtube.com/watch?v=RT8q9McmhBM&t=53s
- Charles Digges, “Rosatom redesigning floating nuclear plant for foreign customers, media reports say,” Bellona, 14 December 2020: https://bellona.org/news/nuclear-issues/2020-12-rosatom-redesigning-floating-nuclear-plant-for-foreign-customers-media-reports-say
- “Russia plans new generation of FNPPs,” Nuclear Engineering International, 6 January 2021:

https://www.neimagazine.com/news/newsrussia-plans-new-generation-of-fnpps-8442344

- Atle Staalsen, “State developers plan flotilla of floating reactors on Russian East Arctic coast,” The Barents Observer, 26 February 2021: https://thebarentsobserver.com/en/nuclear-safety/2021/02/state-developers-plan-flotilla-floating-reactors-russian-east-arctic-coast
- Charles Digges, “Russian nuclear officials offer new promises to build ‘optimized’ floating nuclear plants,” Bellona, 20 April 2021: https://bellona.org/news/nuclear-issues/2021-04-russian-nuclear-officials-offer-new-promises-to-build-optimized-floating-nuclear-plants
- Charles Digges, “Russia eyes building five more floating nuclear plants: report,” Bellona, 4 May 2021: https://bellona.org/news/nuclear-issues/2021-05-russia-to-build-5-more-floating-nuclear-plants-report
- “RITM Reactor Plants for Nuclear-Powered Icebreakers and Optimized Floating Power Units,” JSC Afrikantov OKBM: http://www.okbm.nnov.ru/upload/iblock/8f9/8f9af11596fd20b7f12723ac0845afa6.pdf