CONTENTS

ROSATOM NEWS

More Projects

Russia and Argentina specified areas of nuclear cooperation between the countries.

A strategic document defining the scope of the Russian-Argentinean partnership in the civil nuclear sector was signed in Buenos Aires on December 1 on the margins of the G20 summit. Presidents Vladimir Putin and Mauricio Macri attended the signing ceremony. Rosatom's Director General Alexey Likhachev on Russia's part and Minister of Energy Javier Iguacel on Argentina's part signed the document. **"We are absolutely confident that this initiative will give a new impetus to our mutual cooperation,"** Alexey Likhachev said.

The parties will first consider different approaches to the construction of small and large capacity nuclear power plants in Argentina. They will also discuss an option of jointly operating a fleet of Russian-designed floating nuclear power plants to be built after successful commissioning of Akademik Lomonosov, the world's only floating nuclear power unit. The agreement also provides for potential projects in third countries, including nuclear research centers, staff training, and research programs.

Argentina also proposed that Rosatom join the country's national uranium project and share the in-situ leaching technology that is used by Rosatom to mine uranium.

The framework agreement on civil nuclear cooperation between the two countries was

signed on July 12, 2014 during Vladimir Putin's visit to Argentina. It provides for fundamental and applied research in peaceful uses of nuclear power; design, construction, operation and decommissioning of nuclear power plants and research reactors; nuclear waste management; production of radioactive isotopes, etc. The document establishing a legal framework for new projects came into force on November 23, 2018.

In 2015, Russia and Argentina signed a memorandum of understanding on the construction of a Russian-designed VVER-1200 reactor in this South American country. In addition, a memorandum of understanding on uranium exploration and mining was signed in January 2018. It proves that the cooperation between Russian and Argentina is gaining momentum.

Cooperation in Africa

Russia and Rwanda signed a cooperation agreement on peaceful uses of nuclear power.

Rwandan Minister of Infrastructure Claver Gatete and Rosatom's Director General Alexey Likhachev signed the agreement to cooperate in the civil nuclear energy sector on December 5 during the visit of Rwanda's delegation to Moscow.

The new document will be a starting point for a nuclear energy dialogue between Rwanda and Russia. It creates a legal framework enabling the countries to carry out specific

projects. **"We are glad to give our Rwandan colleagues access to more than 70 years of Russia's expertise in civil uses of nuclear energy. We hope that our cooperation in this field will contribute to Rwanda's economic growth and improve local living standards,"** Alexey Likhachev said.

The multitude of cooperation areas includes the construction of a nuclear science and technology center and a nuclear power plant in Rwanda. Russia will also help Rwanda develop its nuclear infrastructure to meet international nuclear industry standards and radiation safety requirements, maintain security of nuclear materials and radiation sources, and establish storage facilities for nuclear materials and radioactive waste. The framework agreement between the countries provides for joint fundamental and applied nuclear research and production of commercial isotopes for industry, medicine and agriculture. It also covers shipments of machinery and materials, organization of seminars and conferences, and training of technical and research staff for the industry. Working groups will be established to carry out specific projects and research initiatives.

The framework cooperation agreement is a logical continuation of the memorandum of understanding signed by Rosatom and

ROSATOM NEWS

the Ministry of Infrastructure of Rwanda on June 22 of this year in Moscow. Since then, representatives of Rwanda have visited a number of research centers and operational power plants in Russia, including the Joint Institute for Nuclear Research (JINR) and the Novovoronezh-II NPP.

Rwanda is interested in training its nuclear staff at JINR and joint research projects with this institute. **"I hope that our researchers will be helpful to the Russian research institute, gain invaluable experience there and share it locally,"** said Jeanne d'Arc Mujawamariya, Rwandan Ambassador Extraordinary and Plenipotentiary to Russia. According to her, Rwanda has had a similar experience with CERN, but wants to give students more opportunities with JINR. Constructing a nuclear plant is Rwanda's national project; this is why it was important for stakeholders to see the world's first Generation III+ reactor unit at Novovoronezh-II. NL

Mission Complete

Rosenergoatom (Rosatom's power generation division) became the world's third nuclear operator after ČEZ (Czech Republic) and EDF (France) to have completed the OSART program.

The Operating Safety Review Team (OSART) consisting of the IAEA's multidisciplinary experts arrived at Rosenergoatom on the invitation of the Russian government and Rosatom. It took the Russian nuclear operator three years to prepare for the mission, which lasted a little more than two weeks. The OSART mission visited Rosenergoatom's head office and Balakovo, Kola and Smolensk nuclear power plants. The sites were selected to feature three Russian reactor designs – VVER-1000, VVER-440 and RBMK-1000.

In the 35 years of its existence, OSART missions visited nearly 200 nuclear plants. Not long ago, IAEA experts started reviewing safety performance of nuclear operators, and Russia got on board. OSART missions are not new to the Russian nuclear corporation as they have visited Leningrad, Balakovo, Rostov, Smolensk, Kola and Novovoronezh nuclear power plants on separate occasions. **"The decision to invite OSART speaks for the readiness to continuously improve operational safety,"** says Dian Zahradka, IAEA Senior Safety Officer and OSART deputy leader. **"After we received a request for the mission, we made a team of 12 experts from the UK, Germany, Canada, China, Slovakia, Slovenia, France, South Africa, and Japan. Their total industry experience is 343 years."**

The scope of the OSART review at Rosenergoatom covered nine areas: leadership and management for safety, independent nuclear oversight, staff training and qualification, communications, maintenance, technical support, operational experience feedback, procurement, accident

ROSATOM NEWS

management, and emergency preparedness. As for the safety assessment of individual nuclear plants, these criteria were applied selectively. The OSART mission was divided into three groups to visit different sites. Experts analyzed documents, interviewed employees and watched how nuclear plants operate, managers motivate and control the staff, employees meet safety requirements, etc. **"It was important for us to see how the nuclear operator and plants interact in improving safety,"** Dian Zahradka said. **"Another goal of this mission was to exchange information with our Russian colleagues, accumulate knowledge, and build partnerships. This approach contributes to improving safety performance at host organizations and sites where our experts work."**

"The mission was a success. The IAEA confirms that Rosenergoatom fully complies with safety standards. We identified a couple of good practices that can be useful in other countries. These practices will improve nuclear safety both nationally and internationally," said Peter Tarren, Team Leader and Head of the IAEA's Operational Safety Section. The good practices identified are the system of communications at Kola NPP and the procurement system at Balakovo NPP.

A draft report was submitted to Rosenergoatom. Its final version will incorporate feedback from the company's management and will be sent to the Russian government in three months. The report will also be published on the IAEA's official website. Approximately 18 months after the OSART mission, a follow-up visit will take place. **"It is a unique opportunity for us to have our operations reviewed by IAEA experts,"** Rosenergoatom's Director General Andrey Petrov commented on the mission. **"Before this, there were only two OSART corporate missions conducted in the world, one in CEZ, the Czech nuclear operating organization, and the other one in EDF in France. The implementation of the suggestions made by the OSART team will help us further improve the level of NPP operational safety, and the identified good practices will contribute to improving the level of nuclear safety around the world."**

Quality Assured

Upper-level components of the automated control systems for India's Kudankulam NPP passed quality control tests before shipment.

Upper-level software and hardware components of the automated control systems for Kudankulam Units 3 and 4 passed quality testing at Rosatom's subsidiary in Nizhny Novgorod (Russia) and were found compliant with technical specifications.

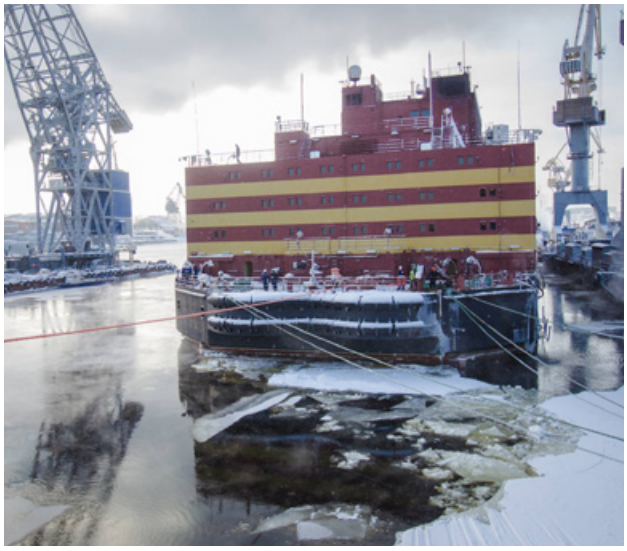
"Preliminary tests began in May 2018. We kept the entire process in check

ROSATOM NEWS

and followed technical requirements to meet project specifications. Commercial production will begin early next year on the basis of existing prototype. The tests will make it much easier to produce control systems for Kudankulam Units 5 and 6 because they will have the same design," said Evgeny Zolotaryov, Manager of the Kudankulam Control System Project at RASU (a Rosatom Group integrator for automated control systems).

The Kudankulam NPP construction project is key to civil nuclear cooperation between Russia and India. The nuclear plant is being built in the state of Tamil Nadu (South India) and will consist of six nuclear power units with VVER-1000 reactors. The project was commissioned by the Nuclear Power Corporation of India Limited (NPCIL). Construction started in 2002 under the supervision of Rosatom's subsidiary ASE. Units 1 and 2 of Kudankulam NPP are already connected to the grid. In 2017, the first concrete was poured at Units 3 and 4, which are scheduled for commissioning in 2023 and 2024 respectively. Preparations are underway at Units 5 and 6, with the first concrete expected to be poured in 2019 and 2020.

On October 5, a document on further civil nuclear cooperation between Russia and India was signed on the margins of the 19th Russian-Indian Summit held in New Delhi. The parties declared their intention to build six Russian-designed power units at a new site in India, expand cooperation in third countries, and join efforts in other promising nuclear fields apart from power reactor construction. Russia will offer India a Generation 3+ VVER reactor design and plans to increase local content in machinery and equipment for the new power plant.



FPU Generated First Electricity

One of the reactor units on board the Akademik Lomonosov floating nuclear power unit (FPU) started generating electric power.

The reactor on the starboard side of the FPU now anchored in Murmansk reached 10% of its rated power capacity. It means that one of the reactors generated its first electricity.

This is an initial, but very important step in the comprehensive equipment testing process to check the unit's functionality. **"The testing process is divided into several stages. First, tests are carried out at the maximum of 10% of the reactor's rated output, followed by gradual power ascension to 110% of the output for final tests,"** said Pavel Ipatov, Director for Special Projects and Initiatives at Rosenergoatom (Rosatom's power generation division). Reactor equipment, automatic controls, safety systems and other hardware to enable safe power ascension to the next level are all tested at every stage.

ROSATOM NEWS

Before the reactor unit switched to the power generating mode, all necessary preparations were made to ensure safe and reliable operation. The staff was properly instructed, operation manuals written, fuel supplied, fire safety, radiation monitoring, control, protection and ventilation systems checked, and radioactive waste storage facilities prepared.

In the near future, both reactors of the FPU will be tested at full capacity to verify their performance parameters and ability to operate for the entire service life. Auxiliary systems of the facility will also be checked for compliance with specifications.

The comprehensive testing process at the FPU began on November 25 and will last until the spring of 2019. Its primary goal is to make sure Akademic Lomonosov unit is ready for commercial operation.

The FPU is an unparalleled low-power movable nuclear facility built by Rosatom. It is designed to operate in Russia's Far North and Far East, supplying power to large industrial sites, ports and cities. In the autumn of 2019, the floating power unit will be towed to the port of Pevek (Chukotka Peninsula) to operate as part of a floating nuclear power plant (FNPP) that will replace the retiring capacity of the onshore Bilibino nuclear power plant and Chaun thermal power plant.

The FNPP is designed to withstand extreme impacts, such as a tsunami or other natural disasters. The station is equipped with two KLT-40S nuclear reactors that can generate up to 70 MW of power and 50 Gcal/h of heat in standard working conditions, which is enough to meet the needs of a city with the population of 100,000. Floating power units are also suitable for island countries since they can function as desalination plants.

At present, Rosatom is working to create the second generation of floating power plants that will be smaller than the current version. They will be equipped with two RITM-200M reactors with a capacity of 50 MW each. NL

To the beginning of the section.

TRENDS

Rosatom: A Year in Review

2018 is coming to a close, which means it's time look back and asses the results of our work. We have analyzed Rosatom's core activities and identified the year's key milestones.

CONSTRUCTION

Rosatom has asserted its position as a leading global exporter of large-capacity nuclear power plants in 2018. The Russian nuclear corporation started construction of three nuclear power units and commissioned three more.

— On-site construction operations started at two of Rosatom's overseas projects, Akkuyu Unit 1 (Turkey) and Rooppur Unit 2 (Bangladesh). As of mid-December 2018, new construction was launched at four sites around the world. Taking into account the foundation concreting at Kursk II Unit 1 (Russia), VVER-1200 reactors accounted for 75% of new construction globally. Limited works permit recieved for Akkuyu NPP Unit 2.

— Russia's last VVER-1000 reactor was put into operation at Rostov NPP Unit 4. A similar reactor was brought online

at Tianwan NPP in China. Unit 1 of Leningrad II was the third VVER reactor commissioned within a year. It is a VVER-1200 reactor.

— The innovative reactor of the world's only floating nuclear power unit, Akademic Lomonosov, generated its first electricity in 2018. It is now being prepared for transportation to its destination port of Pevek.

NUCLEAR OPERATION

Much progress has been made in extending the service life of operational power units.

— The reactor pressure vessel was successfully annealed at Balakovo Unit 1. It is the only nuclear island component that cannot be replaced. Service life extension by annealing is therefore the only option to safely and efficiently increase an NPPs lifecycle. Neutron flux makes steel more brittle and less strong, and annealing helps restore its original properties. Previously, Rosatom engineers annealed only VVER-440 pressure vessels. The VVER-1000 vessel was annealed for the first time ever. Western-designed vessels can also be annealed using this technology.

— Rosatom finalized its feasibility study for the life extension of Kozloduy Unit 6 (Bulgaria) until 2051. This unit has a VVER-1000 reactor.

FUEL

Generation 3 fuel loading continued at operating VVER-1000 reactors; development of optimized fuel assemblies for VVER-440 reactors is in its final phase.

Third-generation fuel, TVSA-12 and TVSA-T. mod.2, loading into operational reactors. These fuel assemblies make VVER-1000 reactors more cost-efficient in operation. The fuel of this design is currently used at Temelin (Czech Republic) and Kozloduy (Bulgaria) NPPs. It is expected to keep transitioning foreign VVER-1000 units running on modified UTVS fuel toward the more modern TVS-2M.

— Rosatom is close to finishing the development of a new fuel design for VVER-440 reactors. These fuel assemblies are of interest for the Loviisa (Finland) and the Paks (Hungary) NPPs. New fuel longevity tests were completed in December.

MECHANICAL ENGINEERING

— Atomenergomash, Rosatom's mechanical engineering division, produced and shipped two reactors for the RITM-200 power unit to be installed on the Ural nuclear icebreaker.

— Production of major components for large-capacity nuclear power plants runs as scheduled.

INFORMATION TECHNOLOGY

The major achievements in this area are related to automated control systems for nuclear power plants.

— Rosatom completed acceptance tests of upper-level hardware and software

components of the automated control systems for Kudankulam Units 3 and 4. Similar systems will be installed at Units 5 and 6 of this Indian plant.

— Rosatom began developing an automated control system for four units at the Akkuyu nuclear power plant.

INTERNATIONAL AGREEMENTS

Breakthrough agreements with China and Uzbekistan were signed this year as well.

— The number of contracts with China has grown. Rosatom signed an agreement to build two reactor units on a new site near Xudabao and two more units at Tianwan in addition to the other four. The VVER-1200 design will be used on both sites.

The Russian nuclear corporation will deliver machinery and fuel for China's first medium-capacity fast neutron reactor CFR600.

Rosatom will supply radionuclide heater units (RHUs), which will be used in radioisotope thermoelectric generators (RITEGs) for the Chinese Lunar Exploration Program.

— Rosatom signed an action plan to build six reactor units on a new site in India.

— Rosatom won a contract to construct two VVER-1200 reactors in Uzbekistan. The first unit is planned to be commissioned by the end of 2028. Engineering surveys of the potential site began.

— A strategic document was signed to define the scope of civil nuclear cooperation with Argentina, including small and large capacity nuclear power plants, floating nuclear power plants, staff training and other areas. NL

To the beginning of the section.

GALLERY

SEASON'S GREETINGS!

This is the final issue of Rosatom Newsletter in 2018. On behalf of our whole team, please accept our kindest wishes for the coming year.

And while you wait for the New Year to come, take a look at the pictures of snow-covered Russian nuclear power plants to feel more of the winter holiday spirit right away.

BALAKOVO NPP

BILIBINO NPP

GALLERY

KOLA NPP

BELOYARSK NPP

BANGLADESH

First Billion for the Economy

Investments in the construction of Rooppur NPP exceeded USD 1 billion in 2018, according to Bangladeshi sources.

As of early December, the Government of Bangladesh approved allocation of USD 1.2 billion to finance construction and procure machinery for the nuclear plant.

The primary source of funding for the first nuclear power plant in Bangladesh is a loan granted by the Russian Federation. It covers 90% of the project's estimated costs. The remaining 10% is to be financed by Bangladesh. The funding for the project will come in several tranches, each to be approved by the Bangladesh Ministry of Finance.

For reference:

The Rooppur Nuclear Power Plant will be based on two Russian-designed VVER-1200 reactors with a capacity of 1,200 MW each. The plant is constructed 160 km away from Dhaka, the capital city of Bangladesh, in accordance with the general contract signed on December 25, 2015 with ASE (Rosatom's engineering division) acting as the project's general contractor. The VVER-1200-based design selected for the country's first nuclear power plant has been successfully implemented at Unit 1 of Novovoronezh II. The Generation III+ design meets all international safety requirements.

Bangladesh officials state that the construction of two power units at Rooppur is on schedule. NL