Contents:

ROSATOM NEWS

SERVICE

Bulgarian Project

Rosatom has completed the feasibility study on the life extension of Kozloduy Unit 6.

On July 25 in Sofia, Bulgaria, the representatives of the Kozloduy nuclear power plant and a consortium of Russia's Rusatom Services and Bulgaria's Risk Engineering Ltd signed the final report of the feasibility study on extending the service life of Kozloduy Unit 6 to 60 years. The study demonstrated that all assemblies, systems and structures were in operating condition. Unit 6 is safe to operate until 2051, provided that routine maintenance and repairs are carried out at the facility, its long-term performance is properly managed, and all recommendations listed in the final report are followed.

"Together with our partners, we have done a tremendous job," Kirill Komarov, Rosatom's First Deputy CEO for Corporate Development and International Business said. "Successful completion of this project was made possible thanks to a very responsible attitude of Russian and Bulgarian engineers, cultural affinity and mutual trust."

According to Bulgarian Energy Minister Temenuzhka Petkova, the top priority of the Bulgarian government is to maintain the existing power generation and develop the nuclear power industry in full compliance with the international environmental and human health protection standards.

In 2017, Bulgaria granted a new 10-year extension operating license to Kozloduy Unit 5. The Bulgarian government regards the life extension of Unit 6 operating life as one of its main tasks. NL

ROSATOM NEWS

TRANSPORT

Pathway to the Arctic

Rosatom has established a directorate for the Northern Sea Route (NSR).

The new body will be responsible for the implementation of government policies and strategies on Northern Sea Route development, cooperation with Russia's regional authorities, and management of projects, including infrastructure ones. Its role will also include setting goals for subsidiary companies, controlling how key performance indicators are met, and performing public functions and services. The directorate will remain in charge of the nuclear icebreaker fleet and the related infrastructure.

For reference:

NSR is the shortest sea route from East and South-East Asia to Europe. Cargo transportation through NSR becomes more and more active. In 2017 10.7 mln. tonnes of cargo were transported via the NSR. The volume has increased by 42.6% when compared to 2016. It is anticipated that NSR will see stable growth of freight turnover in the future. Rosatom's nuclear icebreakers provide a year round convoy to accompany ships on the NSR. They pave the way for cargo ships in 2-meter thick ice. Nuclear icebreakers are much more eco-friendly when compared to diesel icebreakers. They help preserve fragile Arctic ecosystems.

NEWBUILD

Step by Step

Nuclear fuel loading started at the world's first floating nuclear power unit Akademik Lomonosov.

The operations to load fuel into the reactors of the floating power unit began on July 25 at Rosatomflot's coastal base in Murmansk, preceded by obtaining the permit from Russian regulatory body Rostechnadzor.

"This spring we successfully towed the floating power unit with no nuclear fuel on board from Saint Petersburg to Murmansk, and here we are almost through with the final operations," Rosenergoatom's Director of Directorate for the Construction and Operation of Floating Nuclear Thermal Power Plants Vitaly Trutnev said. "We have started one of the major procedures, in the course of which nuclear fuel will be loaded step by step into the first reactor and then into the second one."

ROSATOM NEWS

For reference:

The Akademik Lomonosov floating power unit is the first model in a series of towable low-capacity power units. The facility is outfitted with two KLT-40S reactors generating up to 70 MW of electricity and 50 Hcal/h of thermal energy. Such power units are easily transported and therefore convenient for operation in Russia's Far North and Far East as they can supply remote cities of 100,000 people and industrial facilities with energy. FNPPs are also suitable for use in island countries since they can function as desalination plants. At present, Rosatom is working on the second generation of FNPPs represented by improved floating power units of a smaller size based on two 50 MW RITM-200M reactors.

The next key operations to be performed by the end of the year are the first criticality and the initial stage of harbor acceptance tests. They will be performed after receiving relevant permits from Rostechnadzor.

The main condition for starting up the floating power unit in Murmansk is safety. Rosenergoatom's Deputy Director for FNPS Dmitry Alekseyenko says that Rosatomflot's base has the necessary infrastructure, staff and competencies to perform all of the aforementioned operations.

Once the fuel is loaded, the reactors started up, and the tests finished, Akademik Lomonosov will proceed to Pevek (located on the Chukotka peninsula in the Russian Far East). At the moment, construction is underway in the city to create the infrastructure (including a set of buildings, hydraulic structures, and an onshore site) for ensuring safe anchorage of the power unit, and seamless power supply. The vessel is expected to reach the destination this year. NL

Novovoronezh-II Unit 2: Cold and Hot Trials Started

Second phase of commissioning procedures began at Unit 2 of Novovoronezh-II NPP. It will last for 100 days, the nuclear plant's operator Rosenergoatom reports.

"We have already carried out pressure tests of the primary and secondary circuits for the pressure of 3.2 and 2.0 MPa and confirmed the integrity of these circuits. Now, we are to switch on reactor coolant pumps and carry out necessary integrity and strength tests. We must confirm that all mechanisms work routinely and later come to stages which relate to obtaining a Rostechnadzor's license for loading nuclear fuel in the reactor," Novovoronezh-II NPP director Vladimir Povarov explained.

ROSATOM NEWS

For reference:

The Generation III+ VVER-1200 reactor is constructed at Novovoronezh-II NPP Unit 2 site. It is the reference project for Rooppur NPP, built in Bangladesh. The unit provides for the highest level of operational safety and fully meets all post-Fukushima requirements. Its main feature is a combination of active and passive safety systems, which do not require the NPP personnel's intervention.

Cold and hot trials are an important phase of a nuclear unit commissioning. It involves the performance testing of equipment. Trials of the overpressure protection system of the primary and secondary circuits are carried out, performance tests of reactor coolant pumps are conducted, and the reactor plant protection systems are tested. This is a last large-scale technological operation at the power unit before first criticality.

The second phase of commissioning is divided into two parts. The "cold" trials come first. This stage will take 35 days. They are followed by "hot" trials. At this stage the start-up, adjustment and operation specialists will try four reactor coolant pumps at hot parameters (preset pressure of 16.0 MPa and coolant temperature of 280 °C) for 100 hours. NL

INNOVATION

3D Collaboration

RusAT and the All-Russian Institute of Aviation Materials will join efforts to design additive manufacturing equipment and materials.

Rusatom Additive Technologies (RusAT), Rosatom's integrator for 3D printing technologies, and the All-Russian Institute of Aviation Materials (VIAM) signed an agreement on cooperation. The parties will collaborate on developing additive manufacturing equipment to set up end-to-end production of components based on uniform standards.

The agreement provides for cooperation in several key areas. One of them is adaptation of metal powders developed by VIAM for manufacturing aviation and nuclear components at RusAT's facilities. Another

area of cooperation is materials engineering support required for developing software and production tools that affect the properties of materials used in 3D printers.

The parties have established the Scientific Board, a body to coordinate projects related to additive manufacturing equipment and technologies, and component manufacturing throughout the period of the agreement. The Board's members will be appointed within the three months after the date of the agreement.

For reference:

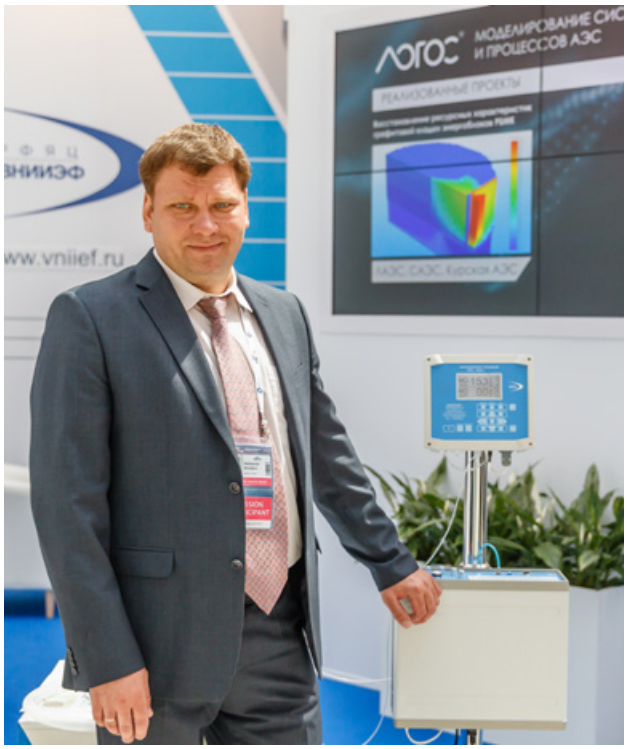
RusAT is a manufacturer of 3D printers and their components, as well as materials and metal powders for 3D printing. The company also develops integrated software solutions for additive manufacturing, provides printing services and helps integrate AM technologies into production processes. RusAT plans to start serial production of its second-generation industrial 3D printer and put it on the market in the short term.
VIAM is the country's biggest state enterprise specializing in development of aerospace materials.

MEDICINE

Breathing for Life

Rosatom created Tianox, a medical device synthesizing medication from air.

The device allows for performing nitric oxide (NO) inhalation therapy to treat pulmonary hypertension, which may occur



as a surgery complication or result from underdevelopment of the lungs in premature infants. The unparalleled technology was developed by the nuclear engineers at the Russian Federal Nuclear Center. The institution has already reserved the rights to sell the device.

At present, nitric oxide for NO-therapy is purchased in pressure vessels, which are placed beside surgical beds. The gas is costly and has an average shelf life of two months, after which it becomes poisonous. Tianox can produce NO immediately next to the patient. The key element of the device is a generator housing a discharge chamber to synthesize nitric oxide, which dilates blood vessels, from the surrounding air. The gas is measured out and fed into a patient's lungs through a flexible hose.

The doctor can use a switch to adjust the dosage to specific treatment methods. Before the gas hits the breathing mask, it is sampled

and analyzed by the system. During the procedure, Tianox automatically measures the concentration, blows the measuring duct and even cleans itself. If anything goes wrong, the device shuts off.

The mass introduction of Tianox will help save a lot of lives as it will be of great use at cardiac surgery centers, in anesthesiology, resuscitation and intensive care departments, and perinatal centers. Alexander Chuchalin, one of Russia's leading pulmonologists, believes that the use of Tianox in medical practice will increase the average lifespan of Russians by two and a half years.

The Russian Federal Nuclear Center has already carried out laboratory tests on the device and prepared the technical documents. Tianox has also been under clinical trial at the Russian National Institute for Research, Development and Testing of Medical Equipment of the Federal Agency for Surveillance in Healthcare (Roszdravnadzor — Russian healthcare regulator). "Our device has successfully undergone electromagnetic compatibility tests and proved itself compliant with GOST (Russia and CIS technical standards) safety and effectiveness standards for medicine," said Alexander Shirshin, Senior Researcher at the Russian Federal Nuclear Center and a member of Tianox developer team. "At the moment, we are filing an application to Roszdravnadzor to register the device as a medical product."

Once the relevant certificate is issued, the nuclear center will introduce its product to the market. The sales of Tianox are most likely to begin at the end of 2018 or in the beginning of 2019.

Reactors for Medicine

The South African Nuclear Energy Corporation (NECSA) and Rusatom Healthcare, the healthcare division of "Rosatom", agreed to partner in the construction of innovative reactors on the territory of South Africa. The agreement on cooperation in the sphere of non-power related uses of nuclear technology was signed on the sidelines of the BRICS Summit in Johannesburg on July 26.

The main area of cooperation identified in the document is that of nuclear medicine and particularly cancer treatment in Africa and abroad. Rusatom Healthcare and NECSA intend to build two solution reactors in the Republic of South Africa. The reactors will be used for medical isotope production. The parties also plan to construct a commercial cyclotron in South Africa to further increase the production capacity of nuclear medicine in the region. A cyclotron is another cost-effective method of producing various radiopharmaceuticals.

"Both parties have a great deal of expertise

ROSATOM NEWS

For reference:

NECSA is recognized as a world leader in the production or nuclear medicine and exports these lifesaving radiopharmaceuticals to over 60 countries on a daily basis, with an annual turnover of in excess of a billion Rand (around 75 mln USD).
Solution reactors consist of an enriched uranium salt dissolved in water and acid and contained in shielded tank or vessel. Approximately 30 solution reactors have been built world-wide and operated over many years since the beginning of modern nuclear programmes in the 1940s and 1950s. Most of these reactors are no longer in service. However, in the 1990s a renewed interest in solution reactors for the production of medical isotopes has prompted several countries, including China, the Russian Federation and the United States of America.

in this sector and we believe that a combined effort will open up new markets and hasten new technological advancements in the sector. Nuclear medicine is rapidly expanding globally and plays a vitally important role in the early detection of cancers and other non-communicable diseases," Director General of Rusatom Healthcare Denis Cherednichenko said.

"We have long been planning a massive expansion of our nuclear medicine operations and look forward to exploring these opportunities with our Russian counterparts", Chairman of NECSA Kelvin Kemm replied.

According to the CEO of NECSA Phumzile Tshelane, nuclear medicine is the most effective method of early cancer detection. And the earlier cancer is deiagnosed, the more likely it is to respond positively to treatment, which generally results in a greater probability of recovery.

"Nuclear medicine not only saves lives, but also generates a large revenue for South Africa. NECSA is looking forward to increased production and the maximization of profits for the country," Phumzile Tshelane noted.

AWARD

ASE Won the FIDIC Award

The International Federation of Consulting Engineers (FIDIC) presented its annual Award of Merit to ASE (Rosatom Engineering Division) having recognized ASE's success in construction a spent fuel storage facility (SFSF) at the Ignalina NPP.

The SFSF was built by Nukem Technologies GmbH — the German subsidiary of ASE. "The project was managed by using the FIDIC contract tools that allowed its efficiency and transparency during the project implementation and involving the majority of participants," ASE explained.

ROSATOM NEWS

Ignalina NPP spent fuel storage facility is a part of the nuclear plant decommissioning project, financed by the European Bank of Reconstruction and Development (EBRD).

The FIDIC Awards 2018 ceremony will be held in Berlin (Germany) on September 9–10, 2018 during the international FIDIC infrastructure conference. The conference will elect the "Best project of the year" from the short list of companies that have received the Award of Merit.

For reference:

ASE (the Engineering Division of Rosatom State Corporation) was established by uniting the leading companies of the industry: EC "ASE", JSC; "Atomstroyexport", JSC; "Atomenergoproekt", JSC and "Atomproect", JSC. ASE is one of the global leaders in nuclear power engineering holding 31% of the global NPP construction market. Its representative offices, branches and front offices are operating within the territories of 15 countries. Almost 80% of the order portfolio is composed of overseas projects.
The International Federation of Consulting Engineers (FIDIC - acronym for its French name Fédération Internationale Des Ingénieurs-Conseils) is an international standards organization for the consulting engineering.

TRENDS

“Floating NPPs Will Turn into a Real Business”

ANTON MOSKVIN, *Vice President for Marketing and Business Development, Rusatom Overseas*

Before I start describing the world’s first floating nuclear power plant, I would like to outline the future of the world we will probably live in. No doubt that it will be a world of electric cars — per IEA estimates between 40 and 70 million of them will be on the roads by 2025. Power grids will transfer electricity in diverse energy systems with growing domination of renewable energy sources.

According to forecasts by 2050 renewables will be set to generate half of all global energy production, with coal production shrinking to just 11% to meet our environmental targets. And we will definitely need a substantial energy storage capacity to balance the supply and demand for power and transfer electricity from the place of its production to the place of consumption. And of course, we will have to invest a lot — both money and effort — in bringing the energy infrastructure and energy industry to the next level meeting the demand of the new energy paradigm.

But what do we have at present? Unreliable, insufficient access to energy is still among the top-5 development constraints for any business, i. e. there are more than one billion people without access to electricity all over the world. Solving this this problem is not an easy thing to do, as building efficient and

reliable energy systems might be too costly, risky or complicated for many countries and here is where action has to be taken by experienced industry players to provide support and assistance needed.

We in Rosatom believe that there is a solution to this issue, and it can change the landscape dramatically — a solution that will let us bring power to where it is needed most without any heavy burdens normally associated with capacity new build and plant operation.

These new solutions shall provide for plug and play project implementation as well as multiple options for supplier-customer relationships, they shall be easily connected to any grid and integrated with other clean power sources to build a sustainable energy system. Last but not least, it is crucial for us to offer our customers the solutions that are cost-effective, i. e. solutions with an acceptable price per kilowatt-hour.

Many existing market solutions do meet most of these requirements, however still have certain limitations. Thus, some baseload power sources proving for stable electricity supply are compromised by instability of fuel supply and impossibility to forecast fuel prices. These solutions cannot eliminate greenhouse gas emissions either. On the other hand intermittent power sources can be cost-effective enough but the grid and the electricity supply would be unstable.

Thus, we have come to understand that only nuclear can be a stable source of power with easily predictable prices and minimal dependence on fuel costs. And nuclear plants do not emit greenhouse gases. So, we have decided to combine advantages of nuclear power as a green energy source with the concept of transportability. We needed a power source that will be cost-effective, clean, stable and could be fast delivered to the customer. This is how the idea of a floating nuclear power plant has crystallized.

The floating nuclear power plant (FNPP) will be able to supply base load power for 60 years. Its advantages are as follows:

- Effective cost management due to fixed generation costs throughout its entire service life
- Potential for integration with renewable energy sources
- Multiple applications, including power generation, heat supply and water desalination
- Transportability — an FNNP can be operated offshore in remote areas
- Just like all the technical solutions that we introduce to the market, our FNPP has advanced safety and security systems.

The essence of our FNPP business model lies in its lifecycle that we are planning to implement. We will use a fleet of floating nuclear power plants. This will almost instantly provide customers with access to electricity.

As you see, the FNPP business model is different from that of large-scale nuclear power plants. However, it does little justice to each solution to pit them one against the other. We strongly believe that nuclear power is a reliable and stable baseload source, however, it can manifest itself in a number of technical solutions, depending on local specificities, for example, geographic ones. We plan to construct several FNPPs in advance and have them instantly available. Some of them will be prefabricated and ready for final assembling. Customers would not be

TRENDS

forced to sign decade-long power purchase agreements (PPAs), the plant delivery terms would be much more flexible in comparison to any land-based power plant — we are sure that FNPPs will make the access to the advantages of nuclear power much easier.

We are open to equity partnerships. Customers may become co-owners of a nuclear power plant. This might drive shipbuilders to form global partnerships. Being a nuclear technology vendor, Rosatom can be very flexible in forming partnerships to produce the vessel part of floating NPPs. We are looking forward to a future where FNPPs play a major role in bringing the advantages of nuclear power to customers.

For reference:

The Akademik Lomonosov floating nuclear power plant (FNPP) is equipped with two marine reactor units KLT-40S with electrical capacity of 70MW and thermal capacity of about 170 MW per hour. With 300 crew members, it weighs 20,000 tons and has a 40-year service life that can be extended. Akademik Lomonosov has a 12-year fuel cycle and uses 20% enriched uranium. At the end of July 2018 fuel loading operation was started at Akademik Lomonosov FNPP. According to current plans, world's first FNNP to be towed to Pevek (Chukotka region of Russia) and to start electricity production there in 2019.
The next generation floating power plant is based on a RITM-200M reactor design. It will also generate heat and electricity and desalinate water, but it will be 25 meters shorter and 5 meters narrower than Akademik Lomonosov. The draught of this upgraded FNPP is therefore reduced by 9,000 tons. By contrast, its installed capacity is increased by nearly 30%, from 77 MW to 100MW. The refueling cycle is extended from 3 to 10 years. Having a 60-year design life, the upgraded FNPP can be either towed or used as a self-propelled ship.