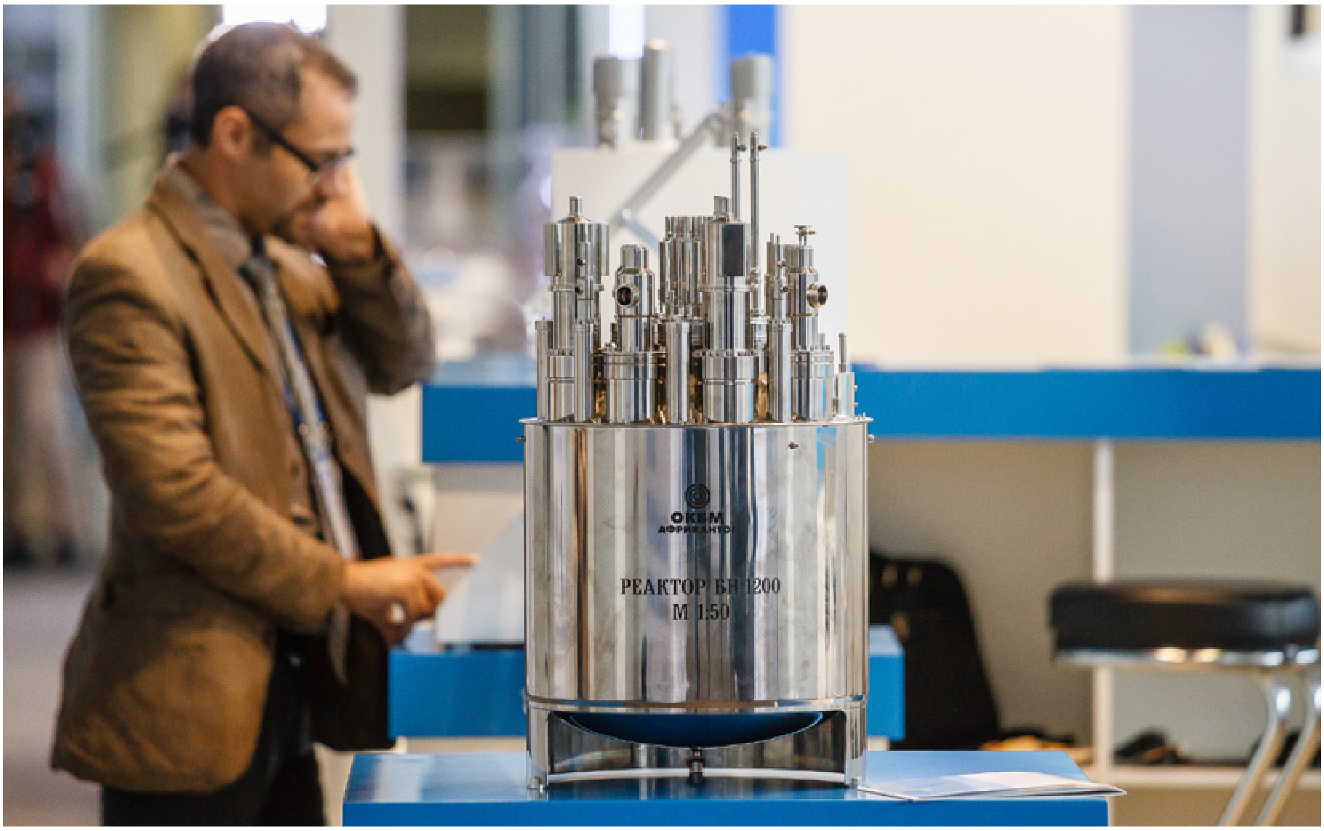
CONTENTS

Back to contents



First Among the Fast

In late April, Vienna hosted the International Conference on Fast Reactors and Related Fuel Cycles: Sustainable Clean Energy for the Future (FR22). Russia, the only country that has long been operating commercial fast reactors, was one of the key conference participants. The conference was held in a mixed format, with some of the events staged in Vienna and others online.

When opening the Conference, IAEA Director General Rafael Mariano Grossi said that the global community was preoccupied with the challenges of sustainable development, fighting climate change, and energy transition. Nuclear energy technologies and fast reactors in particular will help mankind address those challenges.

"Besides being low-carbon like all nuclear reactors, fast reactor systems tick key boxes when it comes to sustainability: they shrink the environmental footprint of the waste while extracting significantly more energy from the fuel. They can be a bridge to even safer and more efficient nuclear power, providing sustainable clean energy for generations," Mariano Grossi said.

Fast neutron reactors use plutonium-239 obtained from uranium-238 as fissile material. These reactors are much more efficient than conventional thermal neutron reactors because they use much less natural feedstock. What is more, fast reactors can process nuclear waste from thermal neutron reactors. The inclusion of uranium-238 into the nuclear fuel cycle increases the fuel potential 150-fold.

ROSATOM NEWS

Back to contents

Therefore, the nuclear generation scheme with fast reactors operating in a cluster with thermal reactors will ‘close’ the nuclear fuel cycle.

Fast reactors can use liquid metals (sodium, lead or a lead-bismuth eutectic) or gasses as coolants. Every leading country of the global nuclear club invests in the development of fast reactor technology. Their representatives spoke at the conference about the latest achievements in this field.

In 2011, China launched its sodium-cooled experimental fast reactor (CEFR), which was constructed in close partnership with Rosatom. At present, China is building two 600 MW sodium-cooled fast neutron CFR-600 reactors as part of its fast reactor demonstration project. Scheduled to go critical by 2025, the two reactors will have some of their systems and equipment manufactured by Rosatom. Speaking at the Conference, Mr. Yang Hongyi, a representative of the Chinese Institute of Atomic Energy, said that China planned to build a 1,000 MW commercial fast neutron reactor by 2030. The country also works on the design of a sodium-cooled small modular fast reactor with a power capacity of 1 to 3 MW and a 1 MW lead-bismuth cooled reactor.

France, the United States, South Korea, India and Japan also have national research programs in fast reactor technology.

In 2001, the Generation IV International Forum (GIF) was established as an international cooperation program bringing together 13 countries. GIF aims to promote joint research into promising nuclear technology, fast neutron reactors included, with research in this field broken down into the sodium-cooled (SFR), lead-cooled (LFR) and gas-cooled (GFR) fast reactor tracks.

During the four days of the Conference, its participants discussed nuclear fuel cycles of the future, economics, safety design and analysis, new structural materials for fast reactors, promotion of innovative projects, and much more.

“FR22 used to discuss only the fast reactor design, but now we dig into a much broader array of topics. This conceptual transformation signals a transition of the global nuclear community to a new stage of nuclear energy development,” Rosatom’s special envoy for international and R&D projects Vyacheslav Pershukov concluded.

Ahead of the game

With two sodium-cooled reactors, BN-600 and BN-800, operating at the Beloyarsk nuclear power plant, Russia remains the only country with a track record in commercial operation of fast neutron reactors. Rosatom’s representatives could rely on their hands-on experience when speaking at the conference about the proprietary commercial technology spanning all the way from fabrication of new fuel to construction of different fast reactors and reprocessing of spent nuclear fuel.

ROSATOM NEWS

Back to contents

Russia works currently on several designs of fast neutron reactors, including sodium, lead and lead-bismuth cooled reactors. The first two designs are developed as part of Rosatom's Proryv (Breakthrough) Project.

The detailed design of BN-1200, a sodium-cooled fast reactor to be constructed at Beloyarsk Unit 5, has been completed and is ready to be put into action. The decision to start the construction is expected to be made later this year. It is planned that the reactor will achieve its first criticality in the early 2030s. **"If compared with BN-800, the new design embraces a number of innovative solutions. They will make the cost of electricity produced by BN-1200 lower than that produced by conventional VVER-1200 reactors. We will also dispel the myth that fast neutron reactors make electricity more expensive,"** Vyacheslav Pershukov stressed.

Simultaneously, Rosatom is building a lead-cooled fast reactor named BREST-OD-300. First concrete for it was poured last year; achieving first criticality is scheduled for 2026. This reactor will meet the so-called 'inherent safety' criteria. It means safety will be ensured through the natural laws and properties of structural materials. BREST is constructed in the pilot demonstration center (PDEC) in Seversk, Tomsk Region. Apart from the reactor, PDEC will feature a two-module facility for fuel fabrication and reprocessing. Construction of the fabrication module has been finished; installation of the equipment is underway; commissioning is scheduled for 2023. The fuel reprocessing module is currently under development; its construction is expected to begin in 2026. In 2030, PDEC will be completed and ready for operation. "PDEC will feature a fully-fledged closed nuclear fuel cycle, with only 10% of uranium-238 needed as input (it will be extracted from uranium tailings) and minimum uranium waste as output — its radioactivity will be comparable to that of natural uranium, and we will thus achieve radioactive equilibrium," Vyacheslav Pershukov concluded.

The work is underway to develop an engineering design of a more powerful lead-cooled reactor, BR-1200. Implementation of this design will begin after the commissioning of BREST.

Russian companies also work on the concept of a small modular fast reactor SVBR-100 that will be cooled with a lead-bismuth eutectic alloy. Development of the lead-bismuth technology started in the Soviet Union as long ago as the 1950s: marine reactors with this coolant were in operation for many years. Georgiy Torshinsky, an advisor to CEO of AKME Engineering and Director of Leipunsky Institute of Physics and Power Engineering (part of Rosatom), explained advantages of this technology at FR22. He mentioned its increased safety and potentially high efficiency of lead-bismuth as a coolant.

Space Rotations Under Control

In April, MOKB Mars announced that it finished the manufacture of onboard instruments for the second Arktika-M weather satellite. The company belongs to Rosatom and engages in space programs.

Arktika-M is the second satellite of a new high elliptical orbit (HEO) satellite constellation. The first one was launched in February 2021. The images of Earth it takes are regularly shown in weather broadcasts on Russian television. What makes the new constellation special is an inclination of its high elliptical orbit, enabling the satellites to cover the entire Arctic.

MOKB Mars designs and manufactures control units and takes part in functional tests. The algorithms deployed in the CUs control the rotation of the satellite around the center of mass and determine its modes of operation.

The engineers have adapted the onboard control system for a new gyroscope and are taking part in the incoming tests and installation of the apparatus onto the satellite. The next step will be comprehensive ground testing of the assembled satellite.

The second Arktika-M will be launched in late 2023. With two satellites in orbit, the Hydrometeorological Center of Russia will receive consistent information about the Russian Arctic territories and seas of the Arctic Ocean. This information will improve the accuracy of short-term weather forecasts and help scientists better understand the global climate warming processes. The weather satellites will also relay signals of the Cospas-Sarsat search and rescue system.

It is planned to launch a total of three satellites by 2025. Data from the Arktika-M constellation supplemented by data from Elektro-L satellites will ensure a quasi-continuous coverage (coverage through short time intervals) of real-time weather conditions all over the globe.

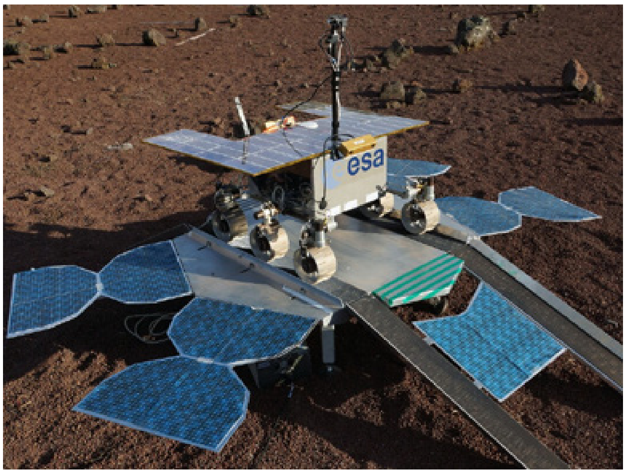
After the launch, MOKB Mars will provide maintenance services for the satellites throughout their service life. **"Sometimes it becomes necessary to control the operation of onboard systems and software from the ground. The most common situation is when solar flares cause interference with electronics,"** Vladimir Sokolov, Chief Research Officer at MOKB Mars, explains.

Upper rocket stages

MOKB Mars also develops control systems for Briz-M orbit insertion upper stages used on Proton-M heavy-lift launch vehicles. The

ROSATOM NEWS

Back to contents



apparatus developed at MOKB Mars was installed on Express-AMU3 and Express-AMU7 telecom satellites launched last December.

Engineers adapt control systems for each launch, taking current conditions into account. For instance, they adapted the Briz-M control systems for six alternative flight missions of the Russian-European ExoMars program. The first mission, ExoMars 2016, controlled by the systems developed and manufactured at MOKB Mars was launched successfully and reached the Mars orbit. The European Space Agency, however, refused to participate in the program for political reasons, so the launch of a new mission scheduled for September 2022 was postponed.

The primary scientific goal of the ExoMars missions is to search for signs of past life on Mars. To achieve this goal, scientists need to study the water and geochemical environments on the surface and in the soil, find and investigate sources and specifics of methane and other gasses on the Red Planet.

The Briz-M booster is also planned to be used on Angara-A5 launch rockets. Since 1999, Briz-M has been used in more than 100 launches of heavy-lift vehicles into geostationary, transfer and high elliptical orbits and an escape trajectory to Mars.

New engines

Rosatom is involved in the development of rocket engines for space exploration.

One of its subsidiaries, Troitsk Institute for Innovation and Fusion Research (TRINITI, a research center for plasma physics, controlled nuclear fusion, laser physics and technology, extreme conditions physics, etc.), develops a magnetoplasmadynamic (MPD) thruster. **"The quasi-stationary plasma propulsion engine has produced a hydrogen plasma impulse of over 100 km/sec in the single pulse mode. This allows us to reach the target performance on a prototype engine when switching over to the multiple pulse mode and have a propulsion power of 300 kW with an efficiency factor of 55%,"** MPD Program Head Konstantin Gurov said. The prototype is expected to be ready in 2024. Plasma propulsion engines with improved performance are needed not only for deep space exploration, but also for maneuvering and orbit changes by spacecraft.

Back to contents

The Research and Development Institute of Power Engineering (NIKIET, part of Rosatom and a major Russian research center for reactor technology) develops nuclear propulsion units for Russian lunar missions. The designs under consideration include electric jet engines powered by nuclear reactors with direct or turbine-based energy conversion. The nuclear reactor units can also be used to build a lunar power station to supply electricity to the lunar base.

Mars Moscow Experimental Design Bureau (MOKB Mars, part of Rosatom) develops and manufactures onboard systems and automatic navigation and control units for unmanned air and spacecraft, as well as ground controllers to test and prepare spacecraft for launch.

...and much more

The All-Russian Scientific Research Institute of Experimental Physics (VNIIEF, part of Rosatom and a research and development center for high temperature plasma, lasers, inertial confinement fusion, particle accelerators, etc.) develops and manufactures space telescopes. For instance, VNIIEF has developed an ART-XC telescope installed on the Spektr-RG space observatory. It was launched to orbit in 2019 with the goal of creating a complete X-ray map of the Universe. The observatory won a prestigious international Marcel Grossmann Award.

VNIIEF also participates in the development of the Spektr-UF observatory nicknamed "the Russian Hubble." It is designed for astrophysical research in the ultraviolet and visible ranges of the electromagnetic spectrum and detection of 10 keV to 10 MeV gamma rays.

VNIIEF develops a spectrograph module for the detection of ultraviolet radiation from stars and star imaging, and works on space laser communication systems that will transmit signals for distances up to 45,000 km, from the ground to low-earth orbit (LEO) satellites. The laser-based communication systems enable transmission of a hundredfold more information than by other means; their signals can hardly be intercepted, and no permits need to be obtained to use these communication channels. The first experiments are scheduled for 2024.

To the beginning of the section

Nervous System for Nuclear Plants

In April, the Research Institute for Instrumentation Engineering (SNIIP), Rosatom's core metrology company, celebrated its 70th anniversary. It is a subsidiary of Rusatom Automated Control Systems (RASU), Rosatom's division for I&C systems and electrical engineering responsible for the design and supply of the 'brain' and 'nerves' — instrumentation, control and monitoring systems — for nuclear power plants in Russia and abroad.

About RASU

Established in 2015, RASU provides a full range of services covering the entire lifecycle of instrumentation and control (I&C) systems used in the nuclear industry and other sectors.

The last year was successful for the company as revenue and orders for new products grew 26% and 30%, respectively. In 2021, RASU upgraded IT system of Rostov Unit 1 and supplied balance-of-plant I&C systems for two units of Kursk II in Russia. In the same year, RASU made the first shipments of I&C components for the Rooppur NPP in Bangladesh and Akkuyu in Turkey. Protection relays and electrical equipment for the I&C system were shipped to India for Kudankulam Unit 3.

RASU is proud of having contributed to the equipment of the Belarusian NPP. This is the first Russian-designed nuclear power plant built abroad, which was fitted out with the Russian I&C system. Consisting of about 20 subsystems, it is based on PORTAL (a Russian acronym for 'licensed software for distributed automation systems') supervisory control and data acquisition (SCADA) software package, which was in development since early 2000s. It collects, processes and archives data, makes calculations, enables instrumentation and control functions, and synchronizes data bases. PORTAL provides the plant personnel with complete, real-time and reliable information about the condition and performance of the equipment. The first version of PORTAL was installed at Leningrad II. The Belarusian NPP received an upgraded version of the software, with administration processes automated and self-diagnostic tools upgraded.

PORTAL serves as a basis for a high-level block system, which is a supervisory control hub for all I&C subsystems.

RASU also supplied a fully Russian-designed safety system TPTS-SB compliant with all the post-Fukushima safety requirements developed by the IAEA. The key of them is diversification: safety channels should be built on different hardware and software and designed on different principles so that a same-type error would not cause a failure of all the systems of a nuclear plant. In 2020, TPTS-SB received an international certificate of compliance with all the applicable standards. In June 2021, the patent for the safety system was recognized by the European Union. This system will be installed at Rooppur, as well as at El Dabaa.

Electrical engineering is another line of business RASU engages in. For example, the company has certified its low-voltage switchgear (LVS) to international standards. A line of LVS enclosures has been designed and is now produced in Russia. One may

think that making an enclosure is simple but it should be remembered, though, that the function of LVS is to control power supply to the equipment, and loss of power to the circulating pumps was a cause of the Fukushima disaster. This is why much attention is paid to the LVS enclosures: they should be resistant to earthquakes; pull-out modules should withstand no less than 400 push-pull cycles; equipment should continue working even at tropical temperatures, and cabinet doors should remain closed even at the short-circuit current of 100 kA — and all this should not come at a price for customers.

About SNIIP

As a key subsidiary of RASU, the Research Institute for Instrumentation Engineering (SNIIP) is responsible for the end-to-end design of complex automated systems for radiation control, radiation monitoring and personal dosimetry.

As mentioned above, on April 19, SNIIP turned 70. Then Central Design Bureau No. 1, the institute was founded in 1952 to design instrumentation systems and devices for the fast-developing nuclear industry. The systems and instruments developed at CBD 1 were installed at the world's first nuclear power plant in Obninsk, Lenin nuclear icebreaker and Leninsky Komsomol nuclear submarine.

SNIIP has also designed instrumentation systems for space exploration programs. For example, the institute developed scientific apparatus for Sputnik 5 spacecraft that carried two dogs, Belka and Strelka, on board. Later, SNIIP developed Matroshka-R, a tissue-equivalent human phantom. It is a sphere made of a substance most closely imitating human tissues in terms of their composition and properties. The sphere has dosimeters installed at different depths corresponding to those of different organs in the human body. The sensors measure the radiation exposure and effect on the tissues. This is important because astronauts are not protected from radiation by the atmosphere, so health risks are much higher. Matroshka-R 'lives' on the International Space Station.

The solutions developed by SNIIP are used at Rostov, Kalinin, Beloyarsk NPPs and Novovoronezh II NPP, at the Tianwan, Akkuyu, and Rooppur NPPs, at the Akademik Lomonosov FPU and nuclear icebreakers.

SNIIP has a backlog of orders until 2030 for different SCADA systems.

To the beginning of the section

Nuclear Pharma's Grand Plans

Nuclear medicine is in the spotlight of Rosatom's attention as a life-saving non-power application of nuclear technology. This business dimension within Rosatom is supervised by Rusatom Healthcare and is divided into three segments — isotopes and radiopharmaceuticals, medical equipment, and nuclear medicine and radionuclide therapy centers. The company sees a growing demand in each of the three segments and expects to begin or increase product exports.

Isotopes and radiopharmaceuticals

Rosatom is a Top-5 global producer of isotope products. At least 30% of the isotope producing reactors worldwide are situated in Russia. Five Rosatom companies — Karpov Institute of Physical Chemistry (NIFHI), Institute of Reactor Materials, Research Institute of Atomic Reactors (RIAR), Mayak, and RosEnergoAtom — are directly involved in the production of isotopes. Rusatom Healthcare's subsidiary Izotop serves as an integrator responsible for the promotion, marketing, sales and shipments of isotope products.

Izotop supplies dozens of isotopes for different purposes, ranging from conventional radiopharmaceuticals, such as molybdenum-99/technetium-99m, iodine-131 and samarium-153, to innovative products. Rosatom was one of the first companies in the world to enter into commercial production of ytterbium-176 and lutetium-176 (starting materials for lutetium-177), having developed and adopted several fabrication processes for Lu-177. It is considered the most effective radioisotope for targeted radionuclide therapy of inoperable tumors and metastatic lesions. Over 95% of starting materials for Lu-177 is produced in Russia, and Rosatom alone accounts for at least 30% of the fabricated isotope.

Neither Rosatom nor its customers have terminated any of the signed contracts. Rosatom has retained its customer base in more than 50 countries and expanded geographic coverage by adding Oman, Saudi Arabia and Uruguay to the list.

While continuing to supply its customers with the well-known products, Rosatom plans to expand its market offer. For this purpose, Rusatom Healthcare intends to produce isotopes with cyclotrons and build a GMP-compliant isotope production facility.

It will be based at the premises of NIFHI in Obninsk, Russia. Construction documents for the facility have been signed off by the regulator, so the plan for the current year is to begin construction works and complete the erection of protective fencing, underground works, concrete bedding, water and thermal insulation, foundation, and underground utilities. Commercial operation is expected to start as soon as 2025. Costs of the project are estimated at RUB 9 billion; production capacity will stand at 89,000 Ci per annum. It is assumed that the isotope production facility will fabricate a wide range of radiopharmaceuticals, including those most commonly used (containing iodine-131, samarium-153 and molybdenum-99), in compliance with the GMP standards. It will also present a number of promising radiopharmaceuticals containing lutetium-177, actinium-225 and radium-223. With sales from the new plant, Rosatom intends to increase its share in the radiopharmaceuticals market.

For now, Russia accounts for less than 5% of the market while the US holds 40–50%, the EU 20–25%, and Japan 10%. As production at the new facility begins, Russia's share is expected to increase to 10–30% depending on the product type and a level of competition in certain products. **"Our plan is to meet 100% demand in the domestic market for radiopharmaceuticals, increase deliveries to our customers in the Middle East and Asia and, when it becomes relevant in geopolitical terms, begin deliveries to Europe and the USA,"** CEO of Rusatom Healthcare Igor Obrubov shared his plans.

Another goal of Rusatom Healthcare in the radiopharmaceuticals segment is to scale up cyclotron-based production of radioisotopes.

Back to contents

Radionuclides produced with cyclotrons differ from those produced in nuclear reactors. Reactors account for about 80% of the total output, while cyclotrons produce the remaining 20%, which are mostly ultra short-lived isotopes, such as fluorine-18, carbon-11 and iodine-123. At Rosatom, the centers of cyclotron-based production are V. Khlopin Radium Institute and the Center for High-Technology Diagnostics. The latter obtained a permit for the production of fludeoxyglucose in March 2022. Cyclotron-produced radiopharmaceuticals are essential for highly-accurate diagnostics, which serves as a basis for target therapy.

Short life of cyclotron-produced isotopes is a major limitation to their use. For example, fluorine-18 used in positron emission tomography has a half-life of 109 minutes. That means it should be used right where it is produced. In case of carbon-11 with a half-life of 20 minutes and oxygen-15 (2 minutes), time limitations are even stricter.

Having analyzed all the factors, market depth included, Rusatom Healthcare came to a decision to establish medical centers that will provide diagnostic and therapeutic services with the use of radiopharmaceuticals.

Market estimates

According to WNA, over 40 million procedures involving the use of radioisotopes are performed every year worldwide. The largest consumer is the USA with a 50% market share, followed by Europe (25%).

The size of the medical isotope market is little more than USD 5 billion, according to Izotop's estimates. The market will double by 2030, with target therapy products leading the growth.

International market research company 360 Research Reports gives a higher estimate: the nuclear medicine market will soar from around USD 6.2 billion in 2021 to over USD 10 billion as soon as 2028, growing by an annual average of 7.4% in 2022–2028.

Polaris Market Research is even more optimistic: the nuclear medicine market will grow 9.0% per annum until 2028 to reach the size of over USD 12.17 billion.

Medical centers

Rusatom Healthcare has made agreements with two existing oncology clinics in the Russian cities of Lipetsk and Ufa to establish radionuclide therapy centers that meet all safety standards, right down to the installation of a dedicated sewerage system. Plans were finalized, and the company proceeded with construction. The centers are expected to open their doors in 2023–2024.

Rusatom Healthcare has plans in the future to build dedicated hospitals that will use both radiopharmaceuticals and radiation technology for diagnostics and treatment. The company is looking for customers for the construction of such hospitals in Russia and abroad. According to some estimates, one nuclear hospital is needed for every 10 million people. There is a clear shortage of nuclear hospitals in the world, so the company sees demand for them and is willing to offer help to any country showing interest in nuclear medicine. **"This is where we are fully in the global healthcare trend: many medical centers — no matter how specialized they are — want to bring every case to a closure. They strive to provide the**

broadest range of medical services so that every patient can be diagnosed properly and then receive treatment and follow-up medical care under a single brand name," Igor Obrubov says.

Equipment for nuclear medicine

No nuclear hospital can operate without proper medical equipment. Rusatom Healthcare has entered the market with a novel device; another one is upcoming.

Late last December, Rosatom obtained a registration certificate for Brachium, a gamma unit for internal radiotherapy (brachytherapy). It has the following principle of action: a source of ionizing radiation is placed on an applicator, which is supplied together with the source, and inserted into the body as close to the tumor as possible. Thanks to the highest precision of application with increments as little as 1 mm, radiation affects mostly cancer tissues while exposure of healthy tissues remains very limited. Brachium treats tumors in the nose, pharynx, esophagus, bronchi, lungs, breast and prostate. Personnel safety was not forgotten either: a tungsten layer in the container for used radiation sources prevents exposure of the staff. The latest AI-powered software ensures individual treatment planning, accurate dose calculation, data recording, and patient condition monitoring. The first batch of Brachiums has already been sold out.

Later this year, Rusatom Healthcare expects to obtain a registration certificate for Onyx, an external beam radiation therapy unit. It has a particle accelerator with energies of 2.5 to 6 Me V. Lower energies are used for diagnostic purposes (the unit includes a CT scanner), while higher energies are used in treatment procedures. Precision is of paramount importance for external beam therapy, so Onyx is extremely adjustable — the doctor can easily change the position of the table and acceleration tube to target tumors as accurately as possible. If a tumor is located in the lung, then a breath synchronization system comes into play. It can stop the accelerator if the patient begins to cough or takes a too deep breath. This function is not present in every external beam therapy unit of other manufacturers. Onyx is also fitted with a collimator. It is a device consisting of 120 thin tungsten strips that have a width of 0.5–1 cm and are designed to configure the beam so as to match the tumor geometry.

What is more, the company plans to pilot a new generation of experimental toroidal linear accelerators that use irradiation techniques. Development of Russian magnetic resonance scanners is also underway. Serial production of Russian-designed MR scanners is expected to begin as soon as 2026.

With sanctions imposed on Russia, the overarching goal is to provide Russian doctors and their patients with top-quality services. As Igor Obrubov assured, Rusatom Healthcare will fully meet domestic demand for equipment and radiopharmaceuticals and ensure national technology security in nuclear medicine even if international companies leave the Russian market. The next step is to enter export markets of "friendly" countries and, if the situation allows, other jurisdictions.

In global trend

The use of nuclear technology –radiopharmaceuticals and irradiation techniques — is a key trend in the global healthcare industry, which is also supported by the IAEA. The Agency procures equipment for developing countries (such as Paraguay or Namibia) and helps develop clinical training programs (Latin America is the most recent case) and establish international ties. For example, memorandums of understanding were signed by ten Arab countries in the IAEA headquarters, with nuclear medicine defined as one of the priority cooperation areas. The IAEA also supports its member states in the development, production and quality assurance of alpha-emitting pharmaceuticals, particularly those containing actinium-225.

> According to the Russian Government Resolution dated March 5, 2022, the list of foreign countries and territories that have committed unfriendly actions against Russia, its companies and citizens include Australia, Albania, Andorra, the United Kingdom, including Jersey, Anguilla, the British Virgin Islands, Gibraltar, EU Member States, Iceland, Canada, Lichtenstein, Micronesia, Monaco, New Zealand, Norway, South Korea, San Marino, North Macedonia, Singapore, the USA, Ukraine, Montenegro, Switzerland.

There are two reasons why nuclear technology is developing. First, radiopharmaceuticals are relatively easy-to-use in diagnostics and effective in treatment, particularly that of difficult cases. Second, cancer incidence is growing because, among other causes, the possibilities of diagnostics and treatment were limited during the COVID pandemic. Since many patients have been diagnosed too late, doctors are now facing a sharp rise in the incidence of cancer. In the first half of 2021, Russian oncologists saw a surge in patients first diagnosed with malignant tumors.

In this situation, Rosatom's activities in radiopharmaceuticals, diagnostic and therapeutic equipment and nuclear medicine centers will give many patients a chance to recover and live a full life. It is not a secret that 90% of cancer cases can be treated successfully if diagnosed early.

To the beginning of the section