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Rosatom makes progress in implementing fourth-generation nuclear reactor technology

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Russia's state nuclear corporation Rosatom continues its successful research and development efforts to validate innovative nuclear fuels for next-generation fast neutron reactors. Two core designs with different types of uranium-plutonium nuclear fuel are being developed for the BN-1200 reactor: MOX fuel, and SNUP fuel.

New SNUP and MOX fuel assemblies, produced at the Siberian Chemical Combine are scheduled for testing at the Beloyarsk NPP reactors. Core loading is planned for 2025. These tests will allow scientists to evaluate the fuel at its maximum design parameters, study its operational performance, and prepare it for licensing.

The BN-1200 is expected to become the world's first serially produced fast neutron reactor. It represents the next evolutionary step in Russia's sodium-cooled fast reactor line, following the BN-600 and BN-800

reactors at the Beloyarsk NPP. The BN-1200 will also be constructed at the Beloyarsk NPP site, with construction scheduled to begin in 2027.

“The BN-1200 reactor is designed to accommodate either of the two fuel types—SNUP or MOX. We already have extensive experience with MOX fuel production and operation, while high-density SNUP fuel offers additional advantages that could be valuable in the future,” said Alexander Ugryumov, Senior Vice President for Science and Technology at TVEL.

Generation IV Nuclear Energy Systems, as defined by the IAEA, employ advanced technologies designed to maximize fuel efficiency, enhance safety, improve energy output, and minimize nuclear waste. Russia is a global leader in Generation IV technology, with preliminary work on the BN-1200M reactor underway at the Beloyarsk NPP and the world’s first lead-cooled reactor with a closed nuclear fuel cycle (BREST-OD-300) under construction in the Tomsk region.

Fast neutron reactors offer significant advantages over traditional thermal reactors, which utilise only about 1% of the uranium, leaving the remaining 99% as waste. Fast reactors can efficiently use secondary products of the fuel cycle, such as plutonium, and "burn" highly radioactive transuranic elements, producing more fuel than they consume.

MOX fuel is made from plutonium oxide, derived from reprocessed spent nuclear fuel, and depleted uranium oxide, a byproduct of uranium enrichment. In 2024, experimental MOX assemblies began operation in the BN-800 reactor.

SNUP fuel (mixed uranium-plutonium nitride) uses uranium and plutonium in nitride form instead of the traditional uranium dioxide.

While not yet commercially deployed, it is being developed for fast reactors with sodium or lead coolants. Its high density allows for compact reactor designs and better fuel efficiency. Experimental SNUP fuel assemblies have been undergoing testing in the BN-600 reactor since 2014, achieving progressively higher burnup levels.

Rosatom’s Balanced Nuclear Fuel Cycle is designed to reduce the volume and activity of radioactive waste by implementing a closed-cycle approach. This strategy improves safety, minimizes environmental risks, and facilitates the recycling of valuable nuclear materials. It supports sustainable energy models by reducing waste and reintroducing nuclear materials into the cycle.