The U.S.-Russian Uranium Deal: Results and Lessons

In February 1993, Russia and the United States signed an agreement on the disposition of highly enriched uranium (HEU) extracted from Russian nuclear weapons. Under the terms of the deal, Russia undertook to down-blend 500 tons of HEU, enough to build 20,000 nuclear warheads, over a 20-year period. The two sides agreed that the resulting low-enriched uranium (LEU) would be used as fuel by nuclear power plants in the United States, hence the informal name of the program, “Megatons to Megawatts.”

In January 1994, Russia’s Techsnabexport (Tenex) and the United States Enrichment Corporation (USEC), the state-run companies authorized by their respective governments to implement the deal, signed the contract. In the U.S. case, that meant that USEC was a supplier of enriched uranium to private utilities. According to assessments made at the time, the value of the entire program was expected to reach about $12 billion.

Background
The idea of down-blending excess stockpiles of weapons HEU and using the resulting LEU as fuel for nuclear power plants was first proposed in 1991 by Thomas Neff, a senior researcher at the Massachusetts Institute of Technology’s Center for International Studies. The idea was received in the U.S. academic community with great enthusiasm and was supported by the Bush administration in view of the signing in July 1991 of the Soviet-U.S. Strategic Arms Reduction Treaty (START I), which mandated a reduction of the two countries’ nuclear weapons stockpiles by approximately 5,000 warheads apiece.

Given the difficult economic situation in the Soviet Union at the time, Moscow expressed interest in Neff’s proposal, which opened up the prospect of billions of U.S. dollars in hard currency earnings being generated as a by-product of implementing START I. The idea looked attractive to the Russian government, which hoped that some of that money could be used to support the Russian nuclear industry, which, like all other state enterprises, was suffering from a sharp reduction in government funding.

The HEU-LEU agreement differed in an important way from the 1992 Agreement on the Safe and Secure Transportation, Storage and Destruction of Weapons and the Prevention of Weapons Proliferation, which provided the legal framework for the so-called Nunn-Lugar program. Under the terms of the latter agreement, the United States was the donor and Russia was the recipient of U.S. financial and technical assistance, including money provided to help Russia implement the reductions specified in START I. In contrast, the HEU-LEU agreement was essentially a mutually advantageous commercial deal.

An important element of Neff’s concept was his proposal to down-blend HEU at Russian plants rather than in the United States. The goal of the proposal was to employ as many Russian facilities and people in the post-Soviet nuclear establishment as possible. The Russian side strongly supported this approach, as HEU down-blending on U.S. territory was unacceptable to Russia because the isotopic composition of this material was classified.

The main factor driving the U.S. side was the doubts by many Western experts about the safety and security of the huge Soviet nuclear arsenal after the collapse of the Soviet empire. In addition, a significant part of that arsenal was left on the territory of the newly independent republics of Belarus, Kazakhstan, and Ukraine. The economic and political situation in all three was even worse than in Russia.

Leading Russian scientists, including Yuri Osipov, president of the Russian Academy of Sciences, also gave their backing to the plan. Osipov discussed the proposal with the Russian minister of atomic energy, Viktor Mikhailov, who...
gave it his full support. After a series of meetings and informal exchanges between Russian and U.S. representatives, the two governments entered into formal negotiations in the summer of 1992. They also set up a joint working group to undertake a comparative analysis of the two sides’ proposals regarding the technology of down-blending HEU.

The Choice of Technology
HEU is produced by increasing the content of the fissile isotope uranium-235 from 0.7 percent in natural uranium to levels of 20 percent or more. In modern enrichment plants, enrichment involves running uranium in the form of the gas uranium hexafluoride through a gas centrifuge. At the plant, many thousands of them are installed, forming enrichment cascades.

Fuel for nuclear power plants typically has an enrichment level of about 4.5 percent, which means that it is LEU. In the global market, the enrichment level of the uranium for nuclear power plants is strictly limited to 5 percent. For weapons use, an enrichment level of 90 percent is desirable.

Stockpiles of HEU were accumulated in the Soviet Union and the United States during the Cold War era. The HEU-LEU agreement contemplated the reduction of the Russian HEU stockpile by 500 tons by down-blending it to LEU that could be used for nuclear power plant fuel.

However simple this looks, the question of down-blending was not a trivial one. Technologically, this could be done in different ways, and the choice of the blendstock and its form was one of the key elements of the process because it determined the final isotopic composition of the product.

One of the issues associated with blending was the possibility of accumulation in the LEU of the U-234 isotope, which is a kind of a poison for nuclear fuel. After detailed elaborations, the working group agreed with a proposal by Russian experts to use gas-phase dilution by mixing HEU hexafluoride with hexafluoride of slightly enriched uranium. The blendstock of slightly enriched uranium came from depleted uranium produced by uranium enrichment plants and later enriched to 1.5 percent. In this case, the resulting product satisfied the ASTM® requirements for power plant fuel isotopic composition, and the whole process also allowed Russian enrichment plants to continue to be busy with producing slightly enriched uranium.

LEU Production in Russia
The first 186-ton batch of LEU was produced in 1995 at the Urals Electrochemical Combine in the Sverdlovsk region from about 6 tons of HEU.

Another three Russian enrichment plants, which were run by the Ministry of Atomic Energy (the precursor to Rosatom, the Russian state atomic energy corporation), joined the program at a later stage: the Siberian Chemical Combine in the Tomsk region, the
component and 5.5 million separative work units (SWUs)—the enrichment services needed to make LEU out of natural uranium—per year. By the time the work under the agreement is completed later this year, Russia will have down-blended 500 tons of HEU and produced a total of 15,200 tons of LEU.

Under the terms of the HEU-LEU agreement, the United States has the right to monitor the HEU down-blending process. In practice, that translates into quantitative monitoring of the flow of uranium hexafluoride in three pipes: two pipes for the HEU and the blendstock inflows and one pipe for the outflow of the LEU produced. U.S. personnel also recorded the U-235 enrichment level in each of these pipes.

In the early years of the agreement, the monitoring was conducted by U.S. inspectors who visited the Russian facilities involved in the program. Later on, however, the United States developed and installed a remote monitoring system at the down-blending facilities, thus eliminating the need for regular visits.

The Problem of Natural Uranium

The natural-uranium component of LEU was an important part of the deal. Essentially, it represents the amount of natural uranium (with 0.7 percent U-235 content) that would have been required to produce a given amount of LEU through natural enrichment rather than by down-blending HEU.

When LEU arrives in the United States under the HEU deal, two market products are delivered for payment: the SWUs and natural uranium feed, the raw material from which LEU was produced. In transactions on the uranium market, these two commodities are usually traded separately and have their individual prices.

According to the terms of the deal, there were two separate lines in the Tenex-USEC contract for the price of the natural component and the price of SWUs. These were based on the market prices at the time and later were periodically reviewed and adjusted by the parties.

Initially, under the terms of the deal, the United States agreed to pay in full for the SWUs and the uranium component required for the production of the down-blended material. This situation remained until April 1996, when the U.S. Congress passed a bill privatizing USEC. The bill introduced strict quotas on sales of the natural-uranium component on the U.S. market. Essentially, it made it impossible for USEC to pay for that natural-uranium component under the HEU-LEU agreement.

The problem was exacerbated by the fact that Russia and the United States had not signed an agreement for peaceful nuclear cooperation. The absence of that document complicated the return to Russia of the natural-uranium component, which no longer could be sold in the United States.

Moscow and Washington were forced to begin lengthy negotiations to find a mutually acceptable solution. The complications were such that LEU deliveries were interrupted for more than six months and the whole program was on the brink of complete collapse.

The two sides finally found a way out of the deadlock in March 1999. The Russian Ministry of Atomic Energy and the U.S. Department of Energy signed an agreement in Washington on the transfer of the natural-uranium component to Russia. They agreed that USEC would return to Russia an equivalent of the natural-uranium component and pay only for the SWU content. In the same agreement, Washington made an exception to its nuclear export law by allowing the natural uranium associated with the HEU deal to return to Russia even though the United States did not have a nuclear cooperation agreement with that country.

At the same time, Tenex and a group of Western companies (Areva, Cameco, and Nukem) signed an option for the purchase between 2002 and 2013 of the Russian natural-uranium component that was being accumulated on U.S. territory. This arrangement allowed the deal to proceed, and LEU deliveries restarted in August 1999.

Prospects for Post-2013 Sales

In the United States, some politicians and independent observers had been arguing for proposals to induce Russia to continue the HEU-LEU operation after 2013, citing arms control and nonproliferation benefits. Until recently, there also were economic reasons because of a shortage of domestic enrichment capacity in the United States.

Russia, however, has no intention of extending the HEU-LEU agreement. Senior Rosatom executives have made clear on more than one occasion, insisting that the remaining Russian excess HEU stockpiles would be needed for Russia’s nuclear energy industry.

Considerable uncertainty existed over continued Russian supplies of uranium products to the United States after the HEU deal was finished, taking into account the restrictions imposed in conjunction with the suspension of the anti-dumping investigation agreement...

After the breakup of the Soviet Union, Russia and several other former Soviet republics sold many uranium products in the U.S. market at artificially low prices, a practice known as dumping. In response, Washington imposed a high anti-dumping tariff, essentially closing the door to the U.S. market for Russian nuclear suppliers. That door was partially reopened by the 1992 agreement, which created an exemption for the LEU shipments supplied under the HEU-LEU agreement via USEC. It was all but impossible, however, for Russia to provide natural uranium or enriched uranium that was not part of the HEU-LEU agreement, as those exports were not covered by the exemption.

In an effort to resolve that problem, which would have become much more serious for the United States after the supplies under the HEU-LEU had ended, Rosatom and the Commerce Department in February 2008 signed an amendment to the 1992 agreement, allowing the Russian nuclear industry to supply up to 20 percent of the U.S. market demand for uranium products between 2014 and 2020. Under the amendment, Tenex is to sign contracts directly with U.S. nuclear power plant operators, bypassing USEC. As of last January, the Russian portfolio of contracts signed under this arrangement was worth about $6 billion.

**Criticisms of the Agreement**

In the late 1990s, some Russian media outlets launched a campaign of sharp criticism against the HEU-LEU agreement. They quoted analysts as saying that the terms of the deal were daylight robbery because the price Russia was getting for the 500 tons of HEU being down-blended to LEU was an order of magnitude lower than it should have been. Critics also argued that the agreement undermined Russian national security because it reduced the country’s strategic stockpiles of HEU.

That rhetoric culminated in 1999 during a special hearing launched by the Russian State Duma Committee on Geopolitics. The Duma members who presided over the hearing invited representatives of the atomic energy, foreign affairs, and defense ministries to testify. In his opening remarks, the committee’s chairman, Alexey Mitrofanov, then a member of the nationalist political party LDPR, essentially repeated the arguments outlined above. He said that the Duma should discuss the question of Russian withdrawal from the agreement because the deal ran counter to Russian national interests.

One of the authors of this article, Vladimir Rybachenkov, was invited to the Duma meeting as the Foreign Ministry representative. He attended the hearing and rebutted criticisms by saying that selling 500 tons of weapons-grade
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