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Implementation of the United States/Russian HEU Agreement: Current Transparency Status and Prospects

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ABSTRACT

The National Nuclear Security Administration's (NNSA) Highly Enriched Uranium (HEU) Transparency Implementation Program (TIP) monitors and provides assurance that Russian weapons-grade HEU is processed into low enriched uranium (LEU) under the transparency provisions of the 1993 United States (U.S.)-Russian HEU Purchase Agreement[i]. Meeting the Agreement's transparency provisions is not just a program requirement; it is a legal requirement. The HEU Purchase Agreement requires transparency measures to be established to provide assurance that the nonproliferation objectives of the Agreement are met.

The Transparency concept has evolved into a viable program that consists of complimentary elements that provide necessary assurances. The key elements include: 1) monitoring by technical experts; 2) independent measurements of enrichment and flow; 3) nuclear material accountability documents from Russian plants; and 4) comparison of transparency data with declared processing data. In the interest of protecting sensitive information, the monitoring is neither full time nor invasive. Thus, an element of trust is required regarding declared operations that are not observed.

U.S. transparency monitoring data and independent instrument measurements are compared with plant accountability records and other declared processing data to provide assurance that the nonproliferation objectives of the 1993 Agreement are being met. Similarly, Russian monitoring of U. S. storage and fuel fabrication operations provides assurance to the Russians that the derived LEU is being used in accordance with the Agreement. The successful implementation of the Transparency program enables the receipt of Russian origin LEU into the United States.

Implementation of the 1993 Agreement is proceeding on schedule, with the permanent elimination of over 8,700 warhead equivalents of HEU. The successful implementation of the Transparency program has taken place over the last 10 years and has provided the necessary nonproliferation assurances to the U. S. while developing an increasing level of trust and cooperation between the U. S. and Russian government agencies.

BACKGROUND

In 1993, the U. S. and Russia launched a new phase of nonproliferation by entering into an Agreement for the purchase by the U. S. of low enriched uranium (LEU) derived from highly enriched uranium (HEU) (≥ 90% U-235) recovered from retired Russian nuclear weapons. The goal of this Agreement was to convert the HEU from an equivalent of 20,000 Russian nuclear weapons into LEU that would then be purchased by the U. S. for use as fuel in commercial nuclear power reactors. This was a very ambitious goal given the former adversarial stance between the two nations. A further complicating factor involved legal restrictions on the part of the U. S. that restricted the importation of enriched uranium from Russia. It was essential to address these concerns in order to obtain the exemptions required on the part of the U. S. and to obtain access to Russian and U. S. nuclear facilities that were to perform the work. This required substantial effort to implement a regime in which the security and technology interests of each country were protected while mechanisms were put into place to provide assurance and build trust that the elements of the purchase agreement were indeed being implemented.

TRANSPARENCY OBJECTIVES

One of the key aspects of the 1993 Agreement is the requirement for transparency to ensure that the nonproliferation objectives of the Agreement are being met. This was a government-to-government Agreement, which addresses national nuclear nonproliferation objectives and formed a legal basis for commercial entities (Tenex and United States Enrichment Corporation (USEC)) to serve as the executive agents and conduct LEU transfers on a "business basis". As an additional condition, however, the U.S. required assurance that the nonproliferation objectives were indeed being met (i.e., LEU purchased was being converted from HEU recovered from weapons) in return for allowing the importation into the U. S. of a relatively large amount of Russian enriched uranium. This goal was to provide for both the protection of sensitive information while at the same time providing for transparency of the processing operations and material flow information that would provide the needed assurances in an atmosphere of openness and trust. Short notice random inspections and detailed record auditing are not part of this regime.

The implementing documents that established Transparency are the Memorandum of Understanding[ii] and the Protocol on Transparency Arrangements[iii] signed in 1994, and the implementing annexes that detail the access and monitoring rights of each party. Under Transparency, both the U. S. and Russia have: 1) declared the processing operations for HEU and LEU which fall under this Agreement; 2) have agreed to provide all material movement and accountability documentation; and 3) permit spot checking of process operations and independent measurements, as defined in the annexes, through on-site monitoring visits.

Implementation of transparency has been a major undertaking, and has been underway since 1995. When deliveries began in 1995, all of the transparency details involving access, allowed measurements, and information to be provided had not yet been resolved

and unanticipated problems or questions have arisen in the interim. These have been resolved during regular sessions of the Transparency Review Committee (TRC), the most recent of which was held in Geneva during April of this year.

Participating Facilities and Goals

Four Russian facilities perform the processing of the HEU recovered from Russian weapons and it's conversion/down blending into LEU (< 5% U-235). Two of the facilities – The Siberian Chemical Enterprise (SChE) at Seversk and the Mayak Production Association (MPA) at Ozersk – receive the recovered weapons components and convert them to a purified uranium oxide suitable for subsequent processing. Since the blending process uses a gas blending of the volatile UF6, conversion of the oxide to UF6 is necessary. Both the ElectroChemical Plant (ECP) at Zelenogorsk and the Siberian Chemical Enterprises (SChE) performs this conversion. Down blending of HEU into LEU and transfer of the blended product to the 30B shipping containers is performed by the Urals Electrochemical Integrated Enterprise (UEIE) at Novouralsk, SChE, and ECP. The final LEU product is then transferred to Saint Petersburg for shipment to the U. S. Title to the LEU material changes from Tenex to USEC when the 30B cylinders are loaded on the ship at St. Petersburg.

In the U. S., the LEU is delivered to USEC and shipped to the USEC uranium enrichment plant in Paducah, Kentucky. From 1995 through 2002, LEU was received at Portsmouth, GDP. Five U.S. nuclear fuel fabricators that process LEU into fuel for commercial nuclear reactors are also subject to the HEU Purchase Agreement. These include: Global Nuclear Fuel - Americas, Framatome-Lynchburg, Framatome-Richland, Westinghouse Nuclear Fuel Fabrication Facility, and Westinghouse-Hematite (operations were shutdown in 2001).

U. S. fuel manufacturers provide natural uranium to USEC equivalent to the quantity needed to produce the LEU purchased. This natural feed stock is then returned to Russia as part of the 1993 Agreement and the 1999 Feed Agreement[iv]. Since such feedstock, in principle, could be used to enrich new HEU, transparency rights have been established for monitoring the natural component feed stored in Russia.

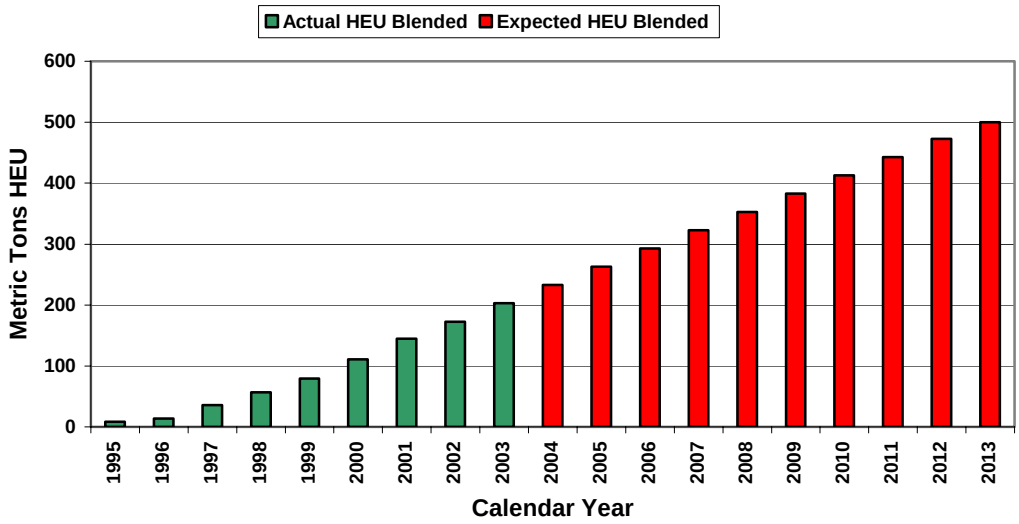
The overall goal of the 1993 Agreement is to convert 500 MT of HEU from an equivalent of 20,000 dismantled Russian nuclear weapons to LEU suitable for use in U. S. reactors by 2013. From 1995 to 1999, the conversion and processing rates increased until the 30 MT per year rate was achieved in 2000 and sustained at this rate.

Current Status

The 1993 Purchase Agreement has proceeded on three fronts since it's beginning in 1994: 1) recovery, conversion, and blending of approximately 217 MT HEU to date, 2) development and implementation of the monitoring protocols as defined in the Annexes, and 3) development of working relationships and trust between U. S. and Russian workers and monitors.

The annual progress in the conversion of HEU is shown in Figure 1, while the progress in permanently eliminating warhead-equivalents is shown in Figure 2. As can be seen, once

Figure 1
Historical Quantity of Cumulative HEU Blended



startup was accomplished, this has been a very consistent and successful program. The significance of this program in real terms is that already over 8,700 nuclear weapon equivalents have been permanently eliminated, correspondingly, the 30 MT of HEU amounts to 875 MT of LEU, which contains sufficient energy to provide approximately 10% of U. S. electrical power requirements each year.

Figure 2
Weapon Equivalents Remaining

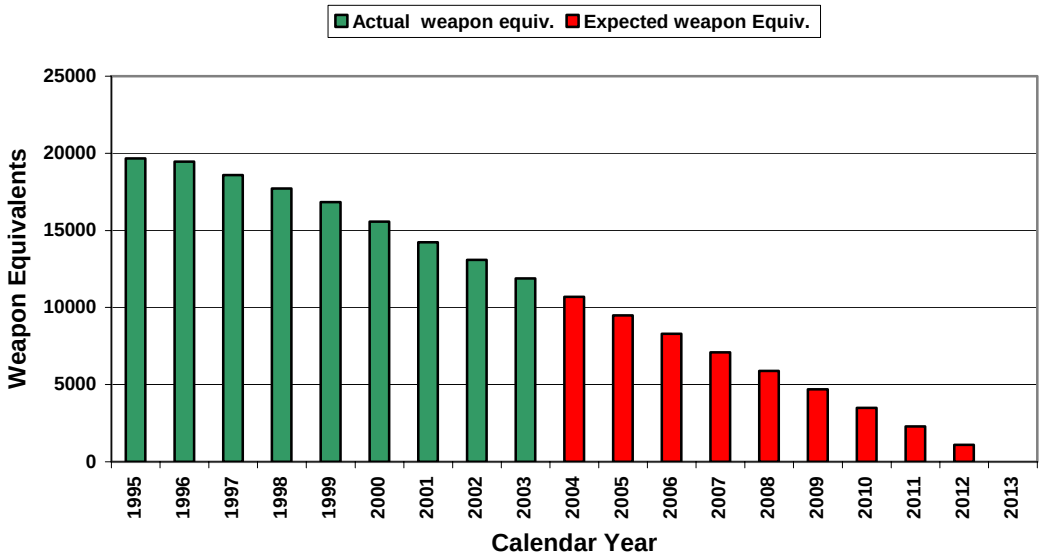
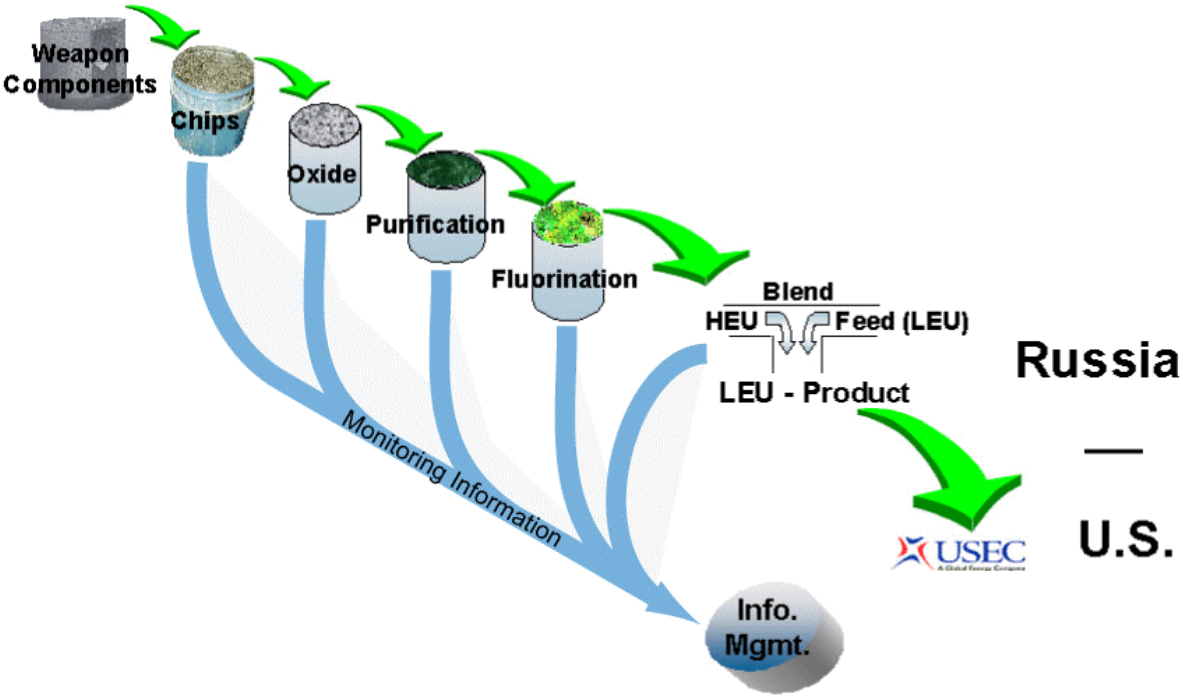


Figure 3 shows schematically the stages of conversion and processing operations that U. S. technical monitors observe at the Russian plants.

Figure 3
Transparency Monitoring in Russian Facilities



U. S. monitors observe Russian operations and collect data during six special monitoring visits each year to each of the four Russian plants and at the U. S. Transparency Monitoring Office at UEIE. This data is treated as sensitive information, and therefore, stored on a secure computer network within the U. S. Technical specialists in the U. S. compare these data and observations with the declared processing operations that provide confidence in declared processing activities.

The U. S. is also allowed to perform two key measurements: 1) non-destructive analysis (NDA) of in-process uranium materials using U. S. NDA instruments; and 2) measurement of the flow and enrichment of all UF6 streams in the blending process using the blend down monitor system (BDMS) equipment designed, built, and provided by the U. S. and then installed in the three Russian blending facilities.

The NDA system directly measures the enrichment of the in-process uranium utilizing the enrichment meter principle. During this past year, over 3,000 NDA measurements were performed covering all stages of operation. A statistical analysis was conducted during this past year by U. S. scientists to understand how many NDA measurements would be required for assurance purposes. The number and variety of measurements performed do indeed provide very strong assurance that HEU is indeed being processed.

The BDMS measures HEU, blend stock (1.5% U-235), and product flow (<5.0% U-235) to provide information that can be compared with Russian blending declarations and actual deliveries of LEU to the U. S. In addition, the BDMS measures the enrichment of the HEU, blend stock, and LEU to verify that the correct materials are being blended as declared. The system also provides "traceability" measures that assure the HEU is in the product stream. To date, operational BDMS systems have been installed at UEIE and at ECP. Currently, these systems monitor approximately 75% of the HEU that is being blended each year. A third BDMS system has been built, and is currently being prepared for installation at SChE this fall. When operational, the U.S. will have direct monitoring of 100 percent of all HEU blending. In May of this year, Russian installers and operators received installation and operations training on this new unit at the Oak Ridge National Laboratory.

Beginning in 2000, the Russian Federal Agency for Atomic Agency (successor to MinAtom) began providing an annual declaration of all usage and storage of natural feed in Russia that has been shipped from the U. S. The U. S. sends a team to Russia each year to monitor this inventory. The last feed monitoring trip to UEIE (where the feed is stored) was during August 2003. Another trip is scheduled for August 2004.

Data and information is obtained during the transparency monitoring operations conducted by the U. S. and from Russian processing and accountability records. This data is given a quality review and then entered into an automated system for archiving and future reference. A secure computer protects sensitive Russian processing data and is secured in the U.S. Experienced technical personnel perform quality reviews for completeness and clarity of data, especially correlation of monitor observations and inventories with Russian processing and material flow data; prior to data comparisons. The combination of U.S. monitor observations and measurements coupled with Russian processing declarations and records provide assurance to the U. S. that the nonproliferation objectives of the 1993 Agreement are being met.

The second part of transparency involves providing assurance to Russia that the LEU delivered under this program is being fabricated into fuel and used for power production as declared by the U. S. As with the U. S. monitoring activities in Russia, Russian teams visit U. S. facilities to take inventory and to observe declared processing operations. The U. S. provides complete declarations and documentation to the Russian Federal Agency for Atomic Energy of all material flows and ultimate end use of all LEU delivered under this program.

On October 1, 2003, Russia initiated its fourth successful visit in the United States when eight representatives from the Russian facilities entered the uranium enrichment plant located at Paducah, Kentucky. Since the Paducah plant had replaced the Portsmouth plant as the receipt and shipment facility for material from Russia, the Russian team conducted a familiarization visit to the Paducah plant. The Russian delegation also monitored two nuclear fuel fabrication plants located in Wilmington, North Carolina and Lynchburg, Virginia. During these visits, inventories of delivered LEU were made and process operations and plant records were reviewed.

The visit to the Paducah plant provided the necessary background and framework to successfully negotiate a new monitoring annex covering the Paducah site. This was accomplished at the 11th meeting of the TRC, which was held in Geneva during April 2004.

CONCLUSION

HEU-TIP is a viable transparency program that enables implementation of the HEU Purchase Agreement. It is a robust and mature program supported by five DOE field offices and seven major DOE national laboratories. We are proud of what we have achieved over the past ten years and we will continue to strive for more cost-effective and unobtrusive monitoring. Our program's success is the direct result of the mutual trust and assurances developed between our two countries through our common nonproliferation and security objectives. It is also a testament to the dedication, professionalism, and technical expertise of each and every member of the transparency program in the United States and Russia.

For further information on this program, please visit the following web sites: http://heu.llnl.gov or http://www.nnsa.doe.gov/na-20/heu_trans.shtml.

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[i] Agreement between the Government of the United States of America and the Government of the Russian Federation concerning the Disposition of Highly Enriched Uranium extracted from nuclear weapons. (February 1993)

[ii] Memorandum of Understanding between the government of the United States of America and the government of the Russian Federation relating to transparency and additional arrangements concerning the Agreement between the Government of the United States of America and Government of the Russian Federation concerning the disposition of highly enriched uranium extracted from nuclear weapons. (September 1993)

[iii] Protocol on HEU Transparency Arrangements in furtherance of the Memorandum of Understanding of September 1, 2003. (March 1994)

[iv] Agreement Between the U.S. DOE and MinAtom Concerning the Transfer of Source Material to the Russian Federation (March 1999)