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TRANSPARENCY: Tracking Uranium under the U.S. / Russian HEU Purchase Agreement

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INTRODUCTION

By the end of August, 2005, the Russia Federation delivered to the United States (U.S.) more than 7,000 metric tons (MT) of low enriched uranium (LEU) containing approximately 46 million SWU and 75,000 MT of natural uranium. This uranium was blended down from weapons-grade (nominally enriched to 90% ^{235}U) highly enriched uranium (HEU) under the 1993 HEU Purchase Agreement that provides for the blend down of 500 MT HEU into LEU for use as fuel in commercial nuclear reactors. The HEU Transparency Program, under the National Nuclear Security Administration (NNSA), monitored the conversion and blending of the more than 250 MT HEU used to produce this LEU. The HEU represents more than half of the 500 MT HEU scheduled to be blended down through the year 2013 and is equivalent to the elimination of more than 10,000 nuclear devices.

The HEU Transparency Program has made considerable progress in its mission to develop and implement transparency measures necessary to assure that Russian HEU extracted from dismantled Russian nuclear weapons is blended down into LEU for delivery to the United States. U.S. monitor observations include the inventory of in-process containers, observation of plant operations, nondestructive assay measurements to determine ^{235}U enrichment, as well as the examination of Material Control and Accountability (MC&A) documents.

During 2005, HEU Transparency Program personnel will conduct 24 Special Monitoring Visits (SMVs) to four Russian uranium processing plants, in addition to staffing a Transparency Monitoring Office (TMO) at one Russian site.

BACKGROUND

In February 1993, the governments of the United States and the Russian Federation signed a bilateral agreement for the purchase of LEU derived from 500 MT HEU removed from Russian nuclear weapons. The HEU Purchase Agreement provides each government the right to assure that transparency objectives of the Agreement are met, including provisions for nuclear material accounting, control, and access. It is on a government-to-government basis that transparency monitoring is performed. The sale and purchase of the resultant LEU is a separate commercial contract that is, however, dependent on the assurance that the transparency objectives are being attained.

The NNSA, the U.S. Department of State, and the Russian Federal Atomic Energy Agency (Rosatom) are responsible for negotiating transparency-monitoring rights. These

rights assist the United States and the Russian Federation in determining that the delivered LEU was derived from HEU removed from Russian nuclear weapons and that the LEU is used for peaceful purposes. U.S. and Russian personnel (called monitors) exercise these rights during their visits to the processing facilities to observe critical processing steps. In this fashion, the processing of HEU to LEU is made transparent. The NNSA and Rosatom are also responsible for implementing those transparency measures that provide both parties with information necessary to confirm that the processing of HEU into nuclear fuel is occurring.

There are three transparency objectives that NNSA seeks to accomplish under the HEU Purchase Agreement. These objectives are to assure that:

- the HEU is extracted from nuclear weapons,
- this same HEU is oxidized, and
- the declared quantity of HEU is blended into LEU.

Rosatom's objective is to assure that the LEU is fabricated into fuel for commercial nuclear power reactors. Monitoring rights for Rosatom end at the U.S. fuel fabrication facilities and do not include any rights to monitor at the commercial nuclear reactor facilities where the LEU is used.

The HEU processing in Russia currently includes the following four Rosatom facilities. The Mayak Production Association (MPA) in Ozersk and the Siberian Chemical Enterprise (SChE) in Seversk who both receive weapon components and process the HEU metal into purified HEU oxide for use in other facilities. SChE and the Electro Chemical Plant (ECP) in Zelenogorsk, then process the HEU oxide into uranium hexafluoride. These two plants, plus the Ural Electrochemical Integrated Plant (UEIP) in Novouralsk, blend down the HEU hexafluoride into LEU, in the assay specified by the U.S. Enrichment Corporation (USEC). The LEU product is shipped to the USEC gaseous diffusion plant in Paducah, Kentucky, for subsequent sale and shipment to U.S. commercial reactor fuel fabrication facilities. All of these facilities are involved in transparency operations under the HEU Purchase Agreement.

The HEU Transparency Program is responsible for assuring that the transparency provisions under the HEU Purchase Agreement are developed and implemented. The HEU Transparency Program conducts its actions through seven U.S. Department of Energy (DOE) site or operations offices, an NNSA Service Center, and eight DOE laboratory or facility locations throughout the United States. The program also interfaces with an array of U.S. Government and private industry participants in the nuclear fuel industry, as well as Russian officials located in five cities within the Russian Federation.

Since 2001, the HEU Transparency Program has conducted four monitoring trips to UEIP to confirm that the natural uranium feed material returned to Russia is stored and used in accordance with the March 1999 Feed Agreement. This natural uranium material is the equivalent quantity of material associated with the HEU to LEU converted and delivered to USEC.

MONITORING ACTIVITIES

The HEU Transparency Program has developed a number of transparency measures that are in place and operational at the four Russian uranium processing facilities. At any given time, 100 monitors are approved for SMV and TMO assignments. HEU Transparency Program monitors are technical experts in their fields and represent the United States during their visits to the Russian processing facilities. Here they interact with their Russian facility counterparts to understand and monitor processing operations. Through periodic SMV and TMO assignments, a mutual understanding of the operations is established and transparency data are gathered consistent with the objectives of the HEU Purchase Agreement.

The Program annually conducts up to 24 SMV trips to the four Russian facilities. Five to ten Program monitors visit a Russian facility over a five-day period. From 1996 through December 2005, the Program will have conducted 184 SMV trips totaling approximately 6300 monitor-days. Monitor activities include the inventory of in-process containers, observing HEU process operations, and review of Russian material control and accounting documentation.

Monitors also conduct non-destructive assay (NDA) measurements on HEU containers to determine whether the HEU is weapons-grade enrichment. These measurements use portable equipment that was first introduced into the Russian plants in 1997. The units use low-resolution sodium iodide detectors to measure the count rate of the 186-keV gamma ray emitted by ^{235}U to determine the enrichment. The original equipment was based on the Canberra Inspector multi-channel analyzer (MCA). We have recently upgraded the equipment at the four Russian plants. The new units use a smaller MCA produced by the AMPTEK Company and have been designed to be more robust and user-friendly for the monitoring operations.

Typically the HEU Transparency Program monitors performed more than 3,000 measurements annually using portable NDA equipment. This equipment has proven a reliable method to assure that containers observed by monitors contain HEU and also provides an independent confirmation of empty HEU containers.

The TMO, established in 1996 at UEIP, provides the Program with daily plant access to monitor plant processing operations. The TMO approach requires U.S. personnel to live near the processing facility where the monitors are allowed daily access and provides additional assurance that the nonproliferation goals of the program are being achieved.

The U.S. DOE has developed, tested and demonstrated equipment that continuously monitors the blending operation. This Blend Down Monitoring System (BDMS) measures the flow and enrichment of the UF_6 gas in the HEU, blend stock, and LEU-product pipes at the blend point. The enrichment of the UF_6 is determined by measuring the rate of the 186-keV gamma rays from ^{235}U . This result is combined with a measurement of the UF_6 density. The density is determined by measuring the intensity of a gamma ray from an external transmission source (either 122-keV from ^{57}Co or 60-keV from ^{241}Am). The flow monitoring equipment uses a shuttered ^{252}Cf source to produce

fissions in the ^{235}U atoms in the UF_6 gas. The shutter is opened and closed for ten second intervals. Scintillation detectors down stream of the Cf source detect the gamma rays from the fission fragments that are entrained in the flowing gas. The gas velocity is determined by the correlation of the detector signals and the shutter position. In addition, the shutter for the HEU line is kept closed for alternating 10 minute intervals. This second time structure can then be observed in the detector response of the LEU-product detectors allowing the system to actually trace the ^{235}U atoms from the HEU line into the LEU-product. This provides additional confidence that HEU is being irreversibly converted to LEU.

The Program installed BDMS equipment on the blending pipes at UEIP in 1999 and at ECP in 2003. These installations used a design that was developed in 1997 and utilize commercially available hardware from that time. In October of 2004 the program installed a more modern version of this system at SChE. With this installation 100% of the blending for the HEU-LEU Purchase program is continuously monitored.

The March 1999 Natural Uranium Feed Component Agreement between DOE and Rosatom permits the transfer to Russia of the uranium feed component associated with the LEU delivered to the United States. As part of the Agreement, Rosatom agreed to stockpile up to 22,000 MT of the returning uranium. Under the Assurances Agreement, DOE has the right to conduct one annual inventory of cylinders containing uranium in storage in Russia and HEU Transparency Program monitors have conducted annual verification visits from 2001 to 2004. During the visits to the storage yard at UEIP, monitors checked the serial numbers of these cylinders and compared them with the information declared by Rosatom. All visits confirmed the quantities of uranium feed cylinders declared by Rosatom.

As the monitoring data are gathered and analyzed, the results are compared with Russian declared process rates and nuclear material accountability documents for consistency. U.S. technical analysts access the data to generate technical assessment and processing reports. These reports contribute to an assessment of whether or not the nonproliferation objectives of the HEU Purchase Agreement are being achieved.

The Program also assists Russian monitors during their visits to facilities in the United States to assure that LEU is being converted into reactor fuel elements. The fifth and latest Russian monitoring visit to the United States was in October 2005, when seven Russian monitors traveled to the uranium enrichment plant located at Paducah, Kentucky. During their two-week visit, HEU Transparency Program representatives also coordinated and accompanied the Russian monitoring team to two nuclear fuel fabrication plants located in Richland, Washington and Wilmington, North Carolina.

PROGRAM ACCOMPLISHMENTS

With almost ten years of experience in developing and implementing transparency measures, the HEU Transparency Program has attained a unique leadership role. Since 1995, the Program has conducted SMV and TMO trips approaching 11,000 monitor-days

at the Russian processing plants, and has established and demonstrated a workable transparency regime in the Russian Federation and the United States. We have achieved mutual respect for national security interests while developing professional relationships to achieve national goals. As a result of this monitoring activity, the Program provides the assurance that weapons-grade HEU is being processed and blended into reactor-grade LEU for use as fuel in commercial nuclear reactors, thus ensuring continued deliveries of LEU to the United States and assuring that stated nonproliferation objectives associated with this Program and the bilateral Agreement are being achieved.

From the initial delivery of LEU in 1995 through August, 2005, the HEU Transparency Program has monitored the conversion of over 250 metric tons of HEU that was converted to LEU for shipment to the United States. This quantity of HEU represents enough material for approximately 10,000 nuclear devices.

The TMO provides access to the UEIP in the closed city of Novouralsk, and allows the Program to monitor the majority of blending operations occurring within Russia. The UEIP has down blended over 50 percent of HEU to LEU material, and the TMO has been staffed almost continuously since opening at UEIP in August 1996. During 2005, ten monitors will be assigned, most for two-month terms, to the TMO.

The BDMS continuously monitors the HEU blending operations at the Russian facilities and provides the HEU Transparency Program with information that HEU is being down blended to LEU in accordance with the terms of the HEU Purchase Agreement. The BDMS was installed in 1999 at UEIP, 2003 at ECP, and 2004 at SChE. This system allows the Program to monitor 100 percent of the blending operations.

HEU Transparency Program monitors have conducted four annual verification visits to UEIP to confirm quantities of uranium feed cylinders declared by Rosatom as part of the 1999 Natural Uranium Feed Component Agreement. All visits confirmed the quantities of uranium feed cylinders declared by Rosatom.

MONITORING PLANS

Future HEU Transparency Program efforts in the Russian Federation are aimed towards implementing transparency measures in a cost-effective, non-intrusive manner. We will continue to conduct transparency monitoring activities in Russia and the United States to assure that nonproliferation objectives are met and that LEU shipments continue unabated. In addition, we will continue to monitor and verify the return of natural uranium to Russia, as appropriate. Finally, we will promote the positive results achieved by the HEU Transparency Program operations to support additional initiatives that are developed in the future for the further disposition of weapons-grade material.