The 1993 United States – Russian Federation Highly Enriched Uranium Purchase Agreement: Overview, Implementation, and Results
Overview: The HEU Purchase Agreement

- Transformed 500 metric tons of highly enriched uranium (HEU) from dismantled Russian nuclear weapons into fuel generating 10% of U.S. electricity
- Clear demonstration of shared U.S.-Russian commitment to progress under Article VI
- A groundbreaking technical and commercial partnership
- Arguably the world’s most successful nuclear nonproliferation endeavor

Secretary of Energy Ernest Moniz and Rosatom Director General Sergey Kirienko commemorate the 2013 completion of LEU deliveries under the Agreement
Signed in 1993, the Agreement provided for the disposition of HEU from dismantled Russian warheads made excess by bilateral arms control agreements. The United States committed to purchase low enriched uranium (LEU) derived from 500 MT Russian weapon-origin HEU over a twenty-year period. 30 MT 90% $^{235}\text{U}$ converted into LEU annually; implementation through commercial executive agents. Cooperation on a grand scale: the equivalent of approximately 20,000 nuclear weapons transformed into commercial fuel generating 7 billion megawatts electricity.
The Transparency Challenge

The Agreement mandated that “the parties shall establish transparency measures to ensure the objectives of this Agreement are met, including provision for nuclear material accounting and control and access. . .”

- The first time that bilateral arms control entered the fissile material processing facility
- Unprecedented technical challenges and sensitivities
- Sides balanced the need to evaluate the veracity of declarations against the need to protect national security and commercial interests
- Successfully translated Agreement’s broad transparency mandate into specific shop floor monitoring steps
- Groundbreaking use of radiation detection equipment (RDE) for transparency in HEU process areas
Results of U.S. Transparency Monitoring

- Over 20 years, the unprecedented became routine. From 1993-2013:
  - 385 U.S. monitoring visits to Russian HEU processing facilities
  - Over 41,000 measurements to confirm the enrichment of HEU in sealed containers
  - 500 MT HEU converted to over 14,000 MT LEU subject to transparency monitoring
- Shared monitoring experience can inform future Article VI progress
  - Agreement’s monitoring regime provides analogues and precedents for many verification challenges
  - Lessons learned for managed access, RDE use, tags and seals, data exchanges, etc.

Final U.S. monitoring visit to the Siberian Group of Chemical Enterprises, 2013
**U.S. HEU Minimization**

- 374 MT of U.S. HEU declared excess to use in nuclear weapons
- At the end of CY 2014, more than 146 MT HEU downblended to LEU
  - Additional 20 MT to be downblended in the coming years
- Over 50 MT of excess U.S. HEU downblended to LEU under IAEA monitoring

Packaging LEU metal downblended from U.S. HEU Metal
The HEU-to-LEU Conversion Process

1. Weapons dismantlement
   - Start of transparency

2. HEU component receipt

3. HEU oxidation

4. Conversion to LEU

5. HEU fluorination

6. HEU purification

7. LEU transfer for shipment

8. LEU fuel fabrication

9. Nuclear power plant use
   - End of transparency
Russia: HEU weapon components to LEU hexafluoride

Russia processed HEU subject to transparency at four sites:

Mayak Production Association
Siberian Group of Chemical Enterprises
Electrochemical Plant
Ural Electrochemical Integrated Enterprise
Two U.S. facilities received weapons-origin LEU from Russia:
Paducah Gaseous Diffusion Plant
Portsmouth Gaseous Diffusion Plant

Five U.S. sites fabricated LEU into nuclear fuel under the Agreement:
Areva-Richland
Areva-Lynchburg
Global Nuclear Fuel
Westinghouse
ABB-Combustion Engineering
Implementing Transparency: Facility Access

- **In the Russian Federation**
  - Up to six annual monitoring U.S. visits to each of the four Russian HEU processing facilities
  - Permanent U.S. monitoring office at Ural Electrochemical Integrated Plant
- **In the United States**
  - Up to six annual Russian visits to each of the U.S. gaseous diffusion plants
  - Up to two annual Russian visits to each U.S. nuclear fuel fabricator
  - Permanent Russian monitoring office at the Portsmouth Gaseous Diffusion Plant
U.S. Monitoring Objectives

• Evaluate consistency among facility documentation, U.S. expert observations, and measurements from U.S. RDE
• Develop confidence that all LEU delivered under the Agreement was derived from Russian weapons-origin HEU

Monitoring Tools

• Detailed Declarations of material shipping, sampling, and processing
• Expert Observations of significant material processing steps
• Independent Measurements on uranium in process and storage

HEU metal oxidation at the Mayak Production Association
Document Exchanges

• Sides exchanged detailed accounting and process documentation of all material subject to transparency
• The U.S. received and reviewed over 300,000 pages of Russian process declarations
• The United States provided over 35,000 pages documenting the peaceful use of Russian-origin LEU in U.S. facilities

Preparing purified HEU oxide shipping documentation, Mayak Production Association
Observations

- U.S. experts observed plant operations and major material transformations firsthand

Reading an LEU cylinder serial number in a transfer autoclave at the Urals Electrochemical Integrated Plant

Recording blend point pressure values at the Electrochemical Plant
Measurements

- The Blend Down Monitoring System (BDMS) performed continuous, unattended HEU flow and enrichment measurements.
- Over 10,000 days operating in Russian blending facilities.
- U.S. non-destructive assay (NDA) equipment confirmed enrichment of HEU in process and storage.
- Performed 41,000 measurements of HEU metal, oxide, and hexafluoride in sealed containers.

NDA of an HEU component, Mayak Production Association

Adjusting BDMS detector settings, Urals Electrochemical Integrated Plant
Final LEU Delivery

• The final shipment of LEU under the Agreement was delivered to the U.S. executive agent on November 14, 2013 in Saint Petersburg, Russia
• This delivery marked the culmination of a remarkable twenty year partnership in nuclear commerce, nonproliferation, and arms control
Russian weapons-origin LEU in U.S. Commercial Reactors

101 reactors in the United States have received LEU delivered under the Agreement