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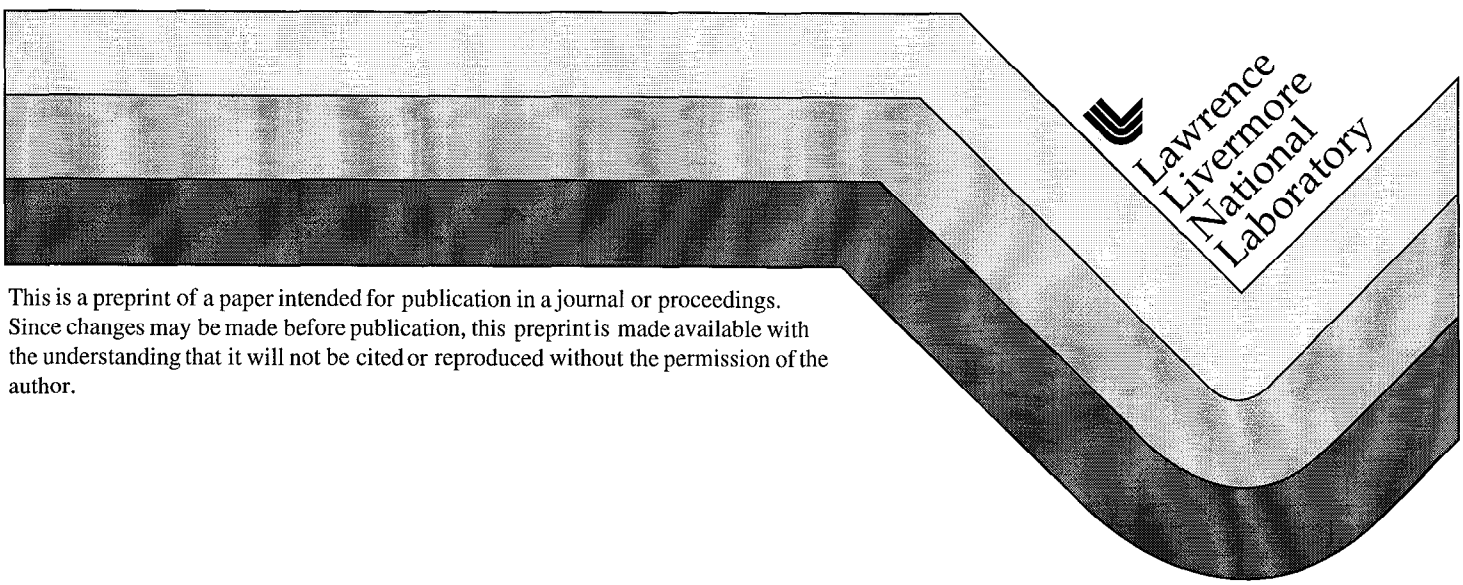

IMPLEMENTATION OF U.S. TRANSPARENCY MONITORING UNDER THE U.S./RUSSIAN HEU PURCHASE AGREEMENT

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Abstract:
During the past three years U.S. monitoring at Russian nuclear facilities, subject to the HEU Purchase Agreement, has evolved as MINATOM and DOE negotiators worked to improve transparency rights and as additional Russian facilities began processing HEU. The number of Russian nuclear facilities subject to U.S. monitoring has increased from two in 1996 to the current four. In that time, physical monitoring, which only permitted visual inspections and access to process forms is being supplemented by instrumentation which detects U-235 enrichment of material in containers and instrumentation which is used to confirm that blending of HEU into LEU at the blending facilities is taking place.

This paper summarizes the U.S. HEU Transparency monitoring activities performed in Russian facilities. It then summarizes the process used to certify the Blend Down Monitoring System (BDMS) that is currently in use at one of these facilities.

Background:
In February 1993, the Governments of the United States and the Russian Federation signed a bilateral Agreement for the purchase of low enriched uranium (LEU) derived from 500 metric tons (1,100,000 pounds) of highly enriched uranium (HEU) removed from Russian nuclear weapons. The conversion of HEU to LEU is currently being performed in four Russian nuclear processing facilities. The LEU is then shipped to the United States where it is converted into fuel to be used in nuclear power plants. In the United States, there are six facilities processing LEU subject to the HEU Purchase Agreement.

The U.S. Department of State, the U.S. Department of Energy (DOE) and Russian Federation Ministry of Atomic Energy (RF MINATOM) are responsible for negotiating rights which will provide confidence that the delivered LEU has come from HEU removed from Russian nuclear weapons and that the LEU is used for peaceful purposes. These rights allow U.S. and RF personnel to visit the processing facilities and observe critical processing steps to provide confidence that the non-proliferation objectives of the Purchase Agreement are achieved. DOE and MINATOM are also responsible for implementing the transparency measures that provide both parties with information necessary to confirm that the processing of HEU into nuclear fuel is occurring [1,2].

For DOE, there are three transparency objectives:
- that the HEU is extracted from nuclear weapons,
- that this same HEU is oxidized, and
- that the HEU is blended into LEU.

For MINATOM, the transparency objective is:

- that the LEU is fabricated into fuel for commercial nuclear power reactors.

Since the basic Agreements were negotiated and signed, both the U.S. and R.F. participants, have converted transparency concepts into a viable and evolutionary operation program. The evolutionary process of the Transparency Program originates with the basic Agreement documents containing general principles and concepts. The following process is used to generate specific transparency program structures and operating parameters.

Prior to formalizing transparency measures, monitors visit declared processing facilities during familiarization visits. These visits permit monitors to develop an understanding of pertinent facility operations that are used to develop a facility specific monitoring structure. Formal agreement on monitoring activities are reached during Transparency Review Committee (TRC) meetings [2,3,4,5].

Seven TRC meetings and associated supporting meetings have culminated into the current transparency regime. The resulting implementing Annexes, currently 16 documents, provides the framework to conduct monitoring operations at each facility. This process is functioning and successful.

U.S. monitors now visit the four Russian nuclear processing facilities on a regular basis. Special monitoring teams are permitted six visits per year per site to conduct transparency operations. We have also established a Permanent Presence Office (PPO) at the Ural Electrochemial Integrated Enterprise in Novouralsk and will celebrate it's third anniversary in August 1999. Monitors have developed a greater understanding of actual operations and a professional rapport between plant staff and monitoring teams. This expanded understanding and accumulation of transparency data plus changes in processing facilities and operations generates a need to modify negotiated Annexes to adjust transparency measures to reach non-proliferation objectives of the HEU Purchase Agreement. Figure1 diagrams this evolutionary process.

An example of this methodology is as follows. In April 1996, monitors to the Oxidation facility at the Siberian Chemical Enterprise (SChE) were permitted access to the oxidation glove box, the analytical laboratory, and the packaging and shipping areas. During the monitoring visits, monitors gained a better understanding of the actual process steps. While access to these areas provided DOE with information concerning the second transparency objective (that material was being oxidized), there was a need to adjust the monitoring protocol to better achieve these objectives.

At TRC-5 in December 1996 transparency monitoring rights were expanded to include access to the storage area where HEU weapons components were stored and permitted the use of hand-held portable non-destructive analysis instrumentation to confirm the presence or absence of HEU in closed containers. By February 1997, these rights were fully implemented.

Also, during TRC-5, both sides agreed that monitoring equipment could be installed at the location where HEU is combined with 1.5% enriched LEU blendstock to produce the final LEU product assay. This equipment would provide enrichment and flow information for the HEU, the LEU blendstock, and the LEU product as well as tracking the HEU through the blending process. Since this BDMS instrumentation required the use of radioactive sources, approval by various Russian regulatory authorities was required prior to installation and operation of the equipment.

This paper discusses the current status of the transparency implementation measures and the regulatory procedure used to install the flow and enrichment instrumentation at the blending area of a Russian processing facility.

The Transparency Process:
The processing of uranium subject to the HEU Agreement, involves a total of 10 processing plants in the United States and the Russian Federation, shown in Figure 2. In the RF, there are currently a total of four facilities performing five processing activities. At the Mayak Production Association (MPA) in Ozersk and the SChE Oxidation facility in Seversk, HEU weapons components in sealed containers are received. The HEU metal is machined into chips, oxidized and then purified. The purified oxide is then shipped to one of two facilities where the purified oxide is fluorinated. These facilities are the ElectroChemical Plant in Zelenogorsk and the Conversion Plant at SChE . Upon being fluorinated, some of the HEU hexafluoride from SChE is shipped to the Urals Electrochemical Integrated Enterprise in Novouralsk where it is blended down to LEU. The remaining $HEUF_6$ is blended at SChE and ECP. This process is depicted in Figure 3.

U.S. monitors visit each of these facilities up to six times per year for a total of five days each visit. In addition, U.S. monitors maintain a permanent office at the UEIE facility, where they are permitted daily access. As a result of these monitoring activities, monitors obtain information which is used to determine the extent to which the three transparency objectives are being achieved. The information obtained as a result of these activities is archived, analyzed and evaluated as part of an information management structure.

Information Management/Data Accumulation:
Data accumulation forms the input basis for the evaluation of monitoring objectives. There are four major tools used by monitors: observations, use of NDA instruments, use of BDMS flow and enrichment monitoring instrumentation at the blend point, and Material Controlled and Accountability (MC&A) documentation review.

Expert Observations:
At each of the four Russian processing facilities, U.S. monitors are allowed to visit agreed upon process areas and observe the operations underway at that location. Names of 100 Monitors, selected from a pool of some 150 technical experts, are submitted to MINATOM. Monitors fall into one of five categories of expertise: uranium metal processing, uranium hexafluoride, portable NDA equipment, fixed BDMS equipment experts, and MC&A.

In addition to observing processing operations, monitors also select and track containers of uranium through various process steps. Monitors receive MC&A forms from which they can compare observations with data on the MC&A forms and record transparency data on approved forms for detailed review, analysis, and historical reference back in U.S. facilities.

Portable NDA Instruments:
Two sets of portable NDA instruments consisting of a Sodium Iodide detector, Canberra Inspektors, and laptop computer systems were provided to each RF facility (Figure 4).

These instruments are kept under secure tags and seals at each of the facilities and used only at the request and in the presence of U.S. monitors. The instrumentation is used to confirm the presence of HEU in weapons component containers and upon removal of the component from the unique shipping container, U.S. monitors use the NDA instrument to confirm that no HEU remains in the container. The portable NDA units are used to determined U-235 enrichment of metal chips which are the result of the machining of the HEU metal component prior to introducing the metal chips into the oxidation glove box. Monitors observe the oxidation process and then use the NDA to determine U-235 enrichment of the resultant oxide. Monitors can also determine U-235 enrichment prior to and upon removal of the HEU from the purification process. They also use the NDA on the purified oxide being prepared for shipment to the fluorination facilities.

At the fluorination facilities, monitors can determine U-235 enrichment upon receipt (if they are present when the material is delivered), and upon removal from the fluorinators and prior to introduction into the blending facility where the HEU is blended with 1.5% blendstock to final LEU product. The portable NDA data provides direct and independent confirmation of HEU material in the overall process.

Blend Down Monitoring System (BDMS):
Both U.S. and RF representatives agreed that a system that was capable of confirming that HEU was being blended in the blendpoint piping would be of mutual benefit for transparency. It was proposed that such a system should also provide information regarding the U-235 enrichment in each of the three legs of the blending tee (HEU, 1.5% LEU blendstock, and LEU product as well as the fissile mass flow rate [7,8]. This decision was the basis for change to the Annexes agreed to at TRC-5 in December 1996.

The initial agreement envisioned a system that could be installed directly onto the existing piping, without requiring any cutting into the pipes. Such a requirement made it necessary for the system to use radioactive sources. It was also agreed that UEIE would be the first of the three blending facilities for which the BDMS would be installed. As a result, several Russian regulatory agencies became involved in the approval and certification process [9]. The lead RF regulatory agency was Gosatomnadozor (GAN).

As part of the certification process, and in order to provide the Russian side with assurance that the BDMS was safe for use in nuclear facilities, the BDMS was installed at the Paducah Gaseous Diffusion Plant in April 1998 and shown to a MINATOM/GAN delegation in June 1988 (figure 5). As a result, final approval for installation of the BDMS at the blendpoint in UEIE was obtained in December 1998. The equipment was installed at UEIE in January 1999. Additional equipment is packaged and awaiting RF approval to ship and install a set of BDMS instruments at the ECP blending facility. Since blending at SChE was included in the transparency program in 1998, BDMS instruments need to be fabricated for installation at that facility.

Information Management/Data Analysis:
The second step in the information management process involves the analysis of the information accumulated as a direct result of monitoring activities. There are two major focus areas: Data Quality and Trip Instructions.

Data Quality:
Data, in the form of MC&A documentation, is provided to U.S. monitors in one of two ways. Process data is given to the U.S. monitors for their review, during each visit. Monitors inventory the forms. At the conclusion of a monitoring visit, these forms are shipped to MINATOM for classification review and release. In an agreement reached during the November 1997 TRC6 meeting, these forms are then sent to DOE within two months after the monitoring visit. The second set of MC&A forms involves information deemed by MINATOM to contain commercial proprietary data. U.S. monitors receive these forms in the facility they are monitoring and are allowed to hand-copy pertinent information contained on them.

Upon the return of monitors from their visit, the data obtained is reviewed for completeness. Missing data and/or dates as well as any transcription errors or other questions concerning the data are noted and provided to future monitoring teams for adjustment and clarification.

Trip Instructions and Pre-trip Training:
The results of the data analysis and any questions resulting from the analysis are incorporated into trip instructions provided to the next team visiting that facility. These instructions also include findings discussed at the visit debrief. Prior to their visit, the team meets in the U.S. to discuss the trip instructions, goals for that visit, and historical information on the facility.

Information Management/Data Evaluation:
The final step in this Information management process involves the evaluation of all information obtained as a result of monitoring visits and the analysis of this and other information by U.S. technical experts. The process includes the use of process experts who assist in the evaluation of the data contained in the database. It also involves the continuing internal or self-evaluation of transparency operations and results. Reports and conclusions are used to adjust activities and to recommend any modifications of Annexes for future negotiations.

Conclusion:
A systematic approach to obtaining, analyzing and evaluating the information obtained as a result of monitoring activities in support of the HEU Transparency Program has been developed and implemented. This iterative approach provides rapid feedback from one trip to the next and assists both U.S. monitors and Russian facility personnel in performing the agreed upon monitoring activities. The incorporation of the BDMS equipment will further enhance our ability to state with confidence that HEU is being blended and non-proliferation objectives are being achieved.

HEU Purchase Agreement and associated transparency operations have achieved very impressive results to date. Through 1998, 60 metric tonnes (MT) of weapons grade HEU has been converted into LEU product. The resultant LEU-product has been delivered to the U.S. Enrichment Corp. Conversion and blending in Russia has expanded from 6 MT per year to 30 MT per year. (See Figure 6). U.S. monitoring efforts have kept pace with these increased processing rates and inclusion of additional facilities into the program. In 1999, we project about 275 person weeks of monitoring activity will be conducted.

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FIGURE 1: Evolution of Transparency Implementation

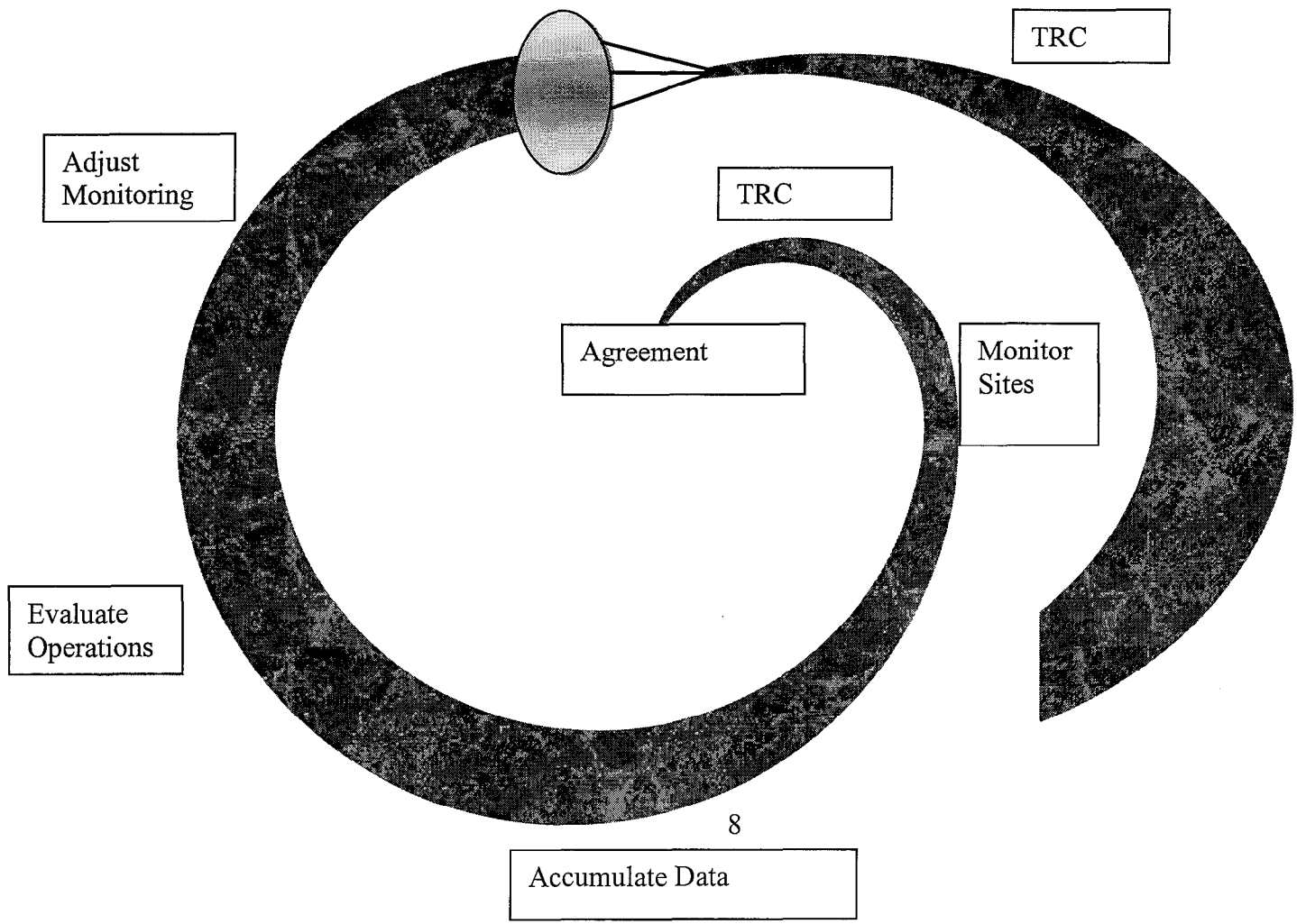


FIGURE 2: U.S. and Russian Facilities

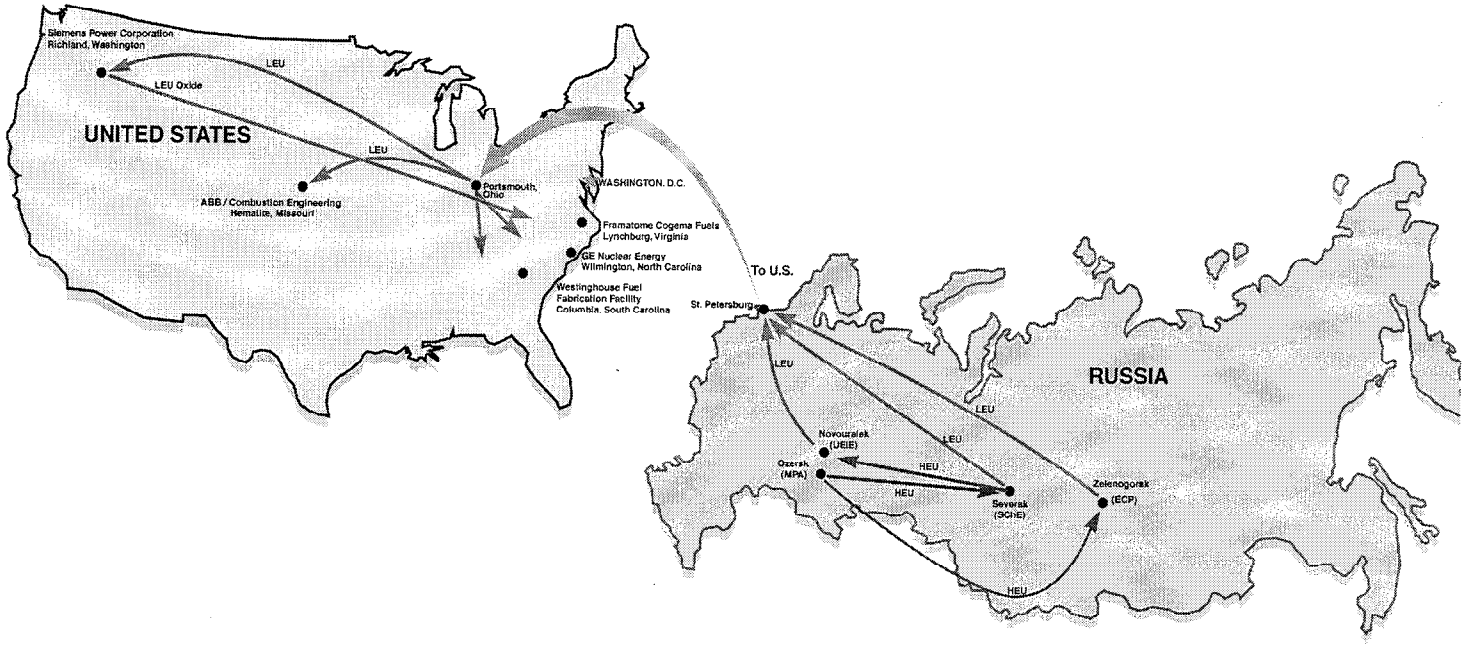


Figure 3: Transparency Process

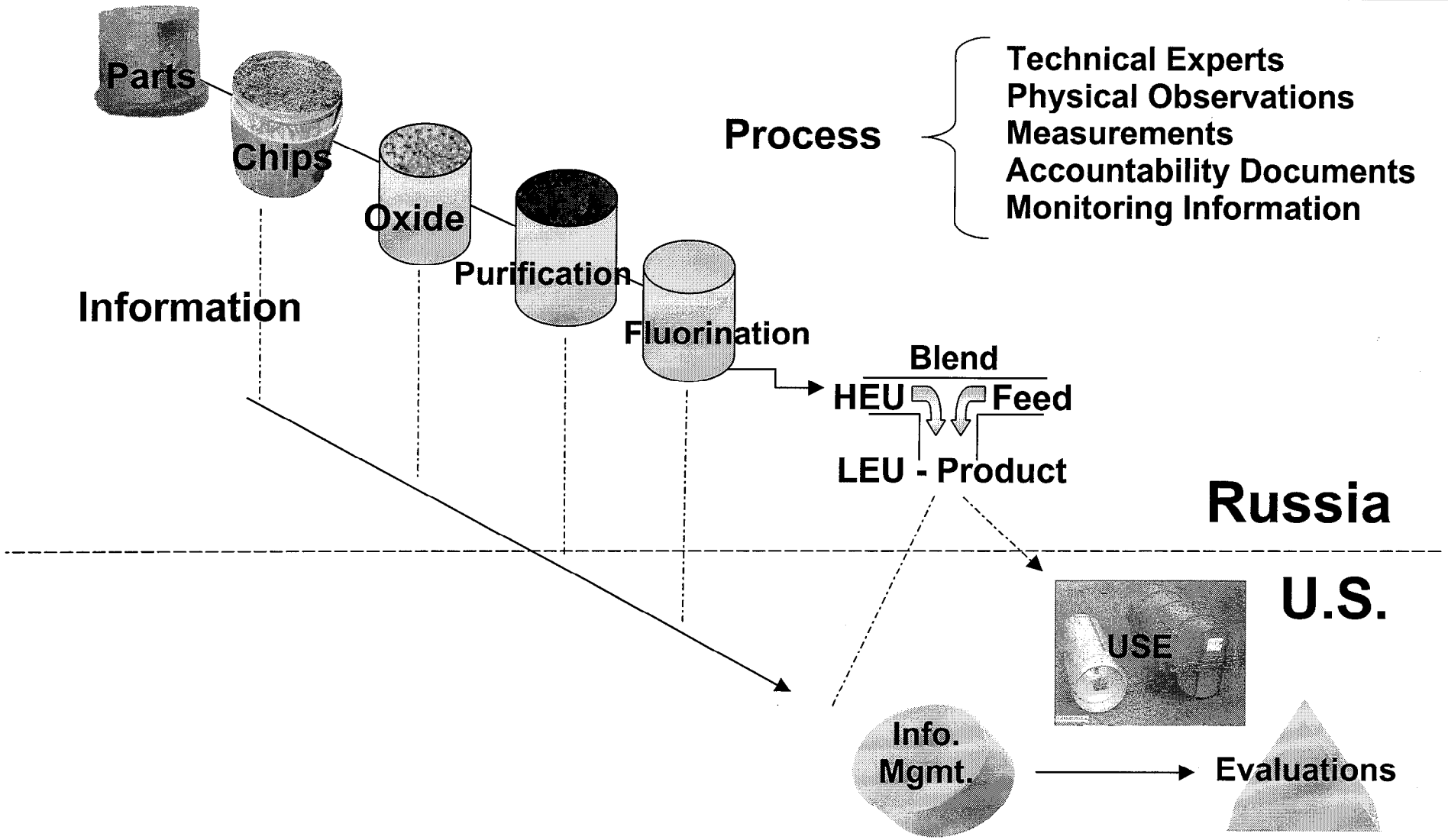
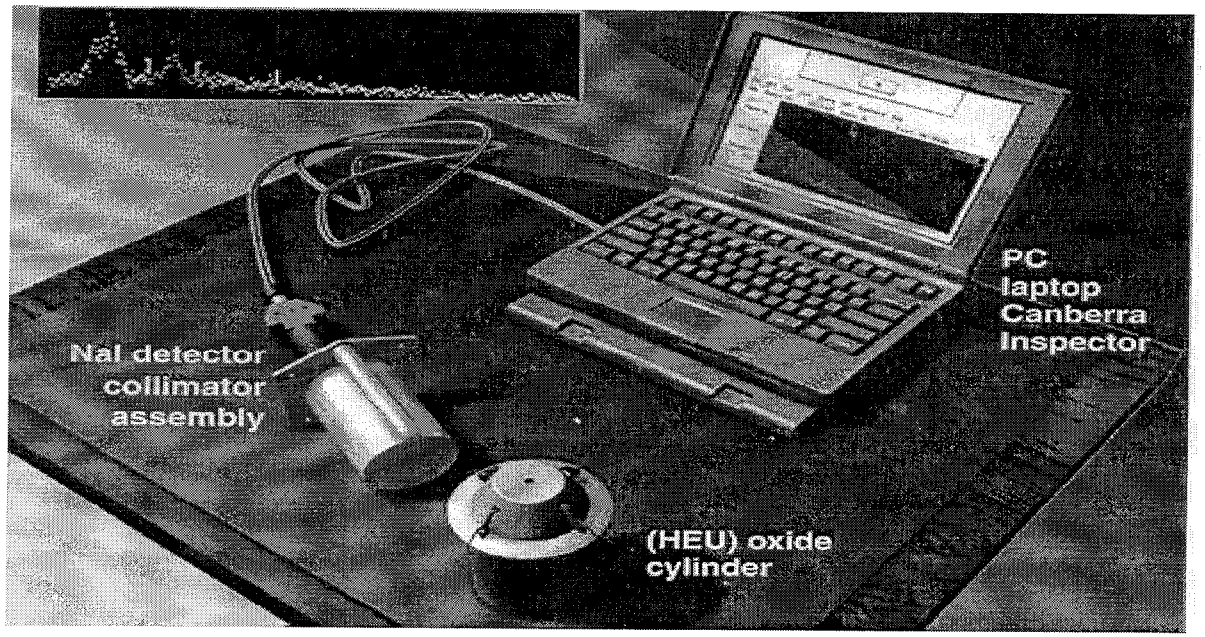


FIGURE 4: NDA Pictures



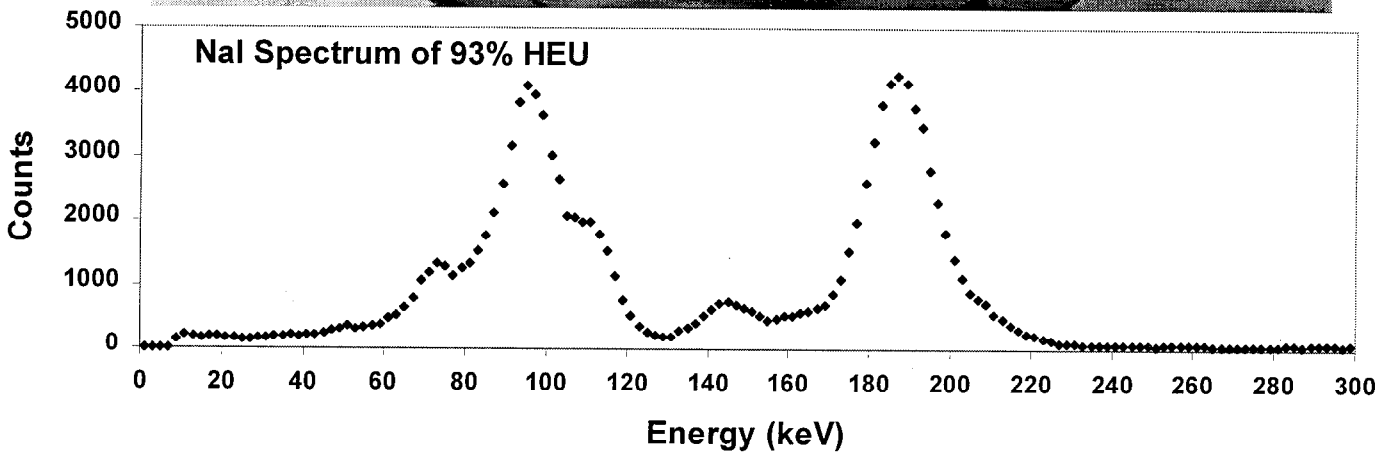


FIGURE 5: BDMS Photo At Paducah

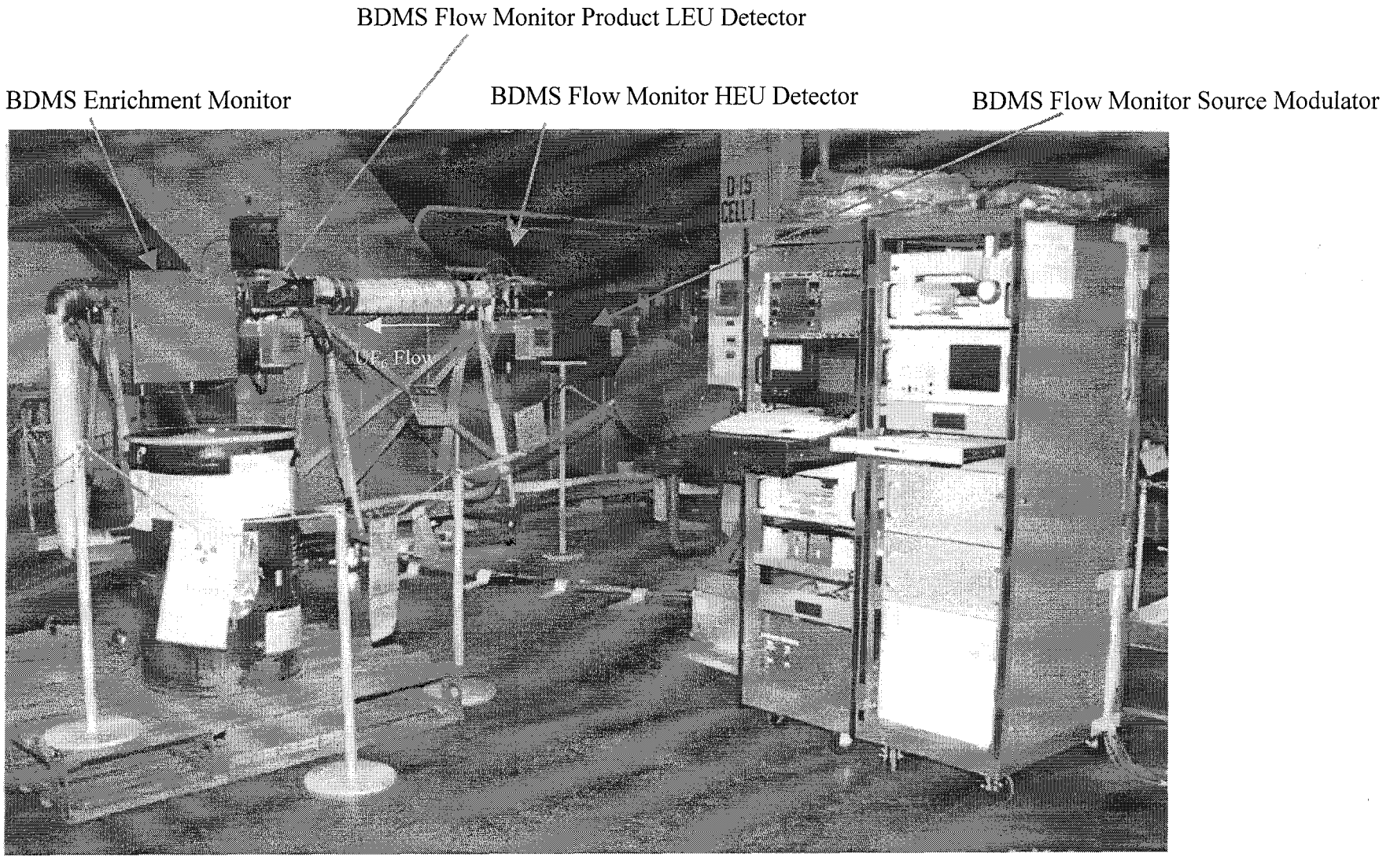


FIGURE 6: Monitoring Resources Expanding with HEU Processing