COOPERATION BETWEEN THE RUSSIAN FEDERATION AND THE UNITED STATES TO ENHANCE THE EXISTING NUCLEAR-MATERIAL PROTECTION, CONTROL, AND ACCOUNTING SYSTEMS AT MAYAK PRODUCTION ASSOCIATION

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ABSTRACT

The Ministry of the Russian Federation for Atomic Energy (MINATOM) and the US Department of Energy (DOE) are engaged in joint, cooperative efforts to reduce the likelihood of nuclear proliferation by enhancing Material Protection, Control and Accounting (MPC&A) systems in both countries. Mayak Production Association (Mayak) is a major Russian nuclear enterprise within the nuclear complex that is operated by MINATOM.

This paper describes the nature, scope, and status of the joint, cooperative efforts to enhance existing MPC&A systems at Mayak. Current cooperative efforts are focused on enhancements to the existing MPC&A systems at two of the plants operated by Mayak that work with proliferation-sensitive nuclear materials.

This work was supported by the US Department of Energy Office of Nonproliferation and National Security, and by the US Department of Energy contracts at each laboratory.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.
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INTRODUCTION

In accordance with agreements between the Russian Federation and the United States concerning control, accounting, and physical protection of nuclear material, the Mayak Production Association (Mayak) is participating as a partner with MINATOM, DOE and several DOE national laboratories in the Joint US/Mayak Project Team (JUSMPT). The goal of the JUSMPT is to reduce the likelihood of nuclear proliferation by enhancing the existing MPC&A systems at Mayak. The MPC&A enhancements at Mayak are designed to reduce the threat of either an abrupt or protracted theft of uranium or plutonium in forms and quantities that can be most easily and directly used in an explosive device. The work of the JUSMPT is also focused on the establishment of a sustainable infrastructure that will provide continuing support for the technology-based enhancements.

Mayak operates a number of plants and facilities that produce, process, handle and/or store proliferation-sensitive nuclear materials. MINATOM has given permission for the JUSMPT to engage in cooperative efforts to enhance the existing MPC&A systems at four plants operated by Mayak. Based on the information that MINATOM has allowed Mayak to disclose, the JUSMPT has determined that two of these four plants do not present a significant proliferation risk, and thus the work of the JUSMPT is currently focused on two of the four plants suggested by MINATOM.

BACKGROUND

Mayak began operation in June 1948 for the purpose of producing plutonium and other nuclear materials for weapons. Mayak continues to operate a number of plants and facilities that work with proliferation-sensitive nuclear materials. Facilities located within two of these plants are the subjects of current MINATOM / DOE cooperative efforts to enhance the existing MPC&A systems at Mayak. These plants are:

1. The RT-1 Plant.

   In 1976 Mayak commissioned the RT-1 Plant for the purpose of reprocessing spent nuclear fuel from civilian reactors. One of the primary goals in the reprocessing of civilian spent nuclear fuel is the extraction and refinement of plutonium dioxide. The original plan was to use the plutonium dioxide as a feed stock in a closed nuclear fuel cycle that would have involved producing mixed-oxide fuels containing both uranium and plutonium for use as fuel in civilian power reactors. To date, this plan has not been put into operation. As a result, Mayak is now faced with the long-term problem of storing and safeguarding the plutonium dioxide, which is a proliferation-sensitive nuclear material.
The RT-1 Plant also reprocesses fuel from research reactors and Naval reactors. In these cases, Highly Enriched Uranium (HEU) is extracted and converted to an oxide. A significant quantity of the reprocessed HEU contains more than 50% $^{235}\text{U}$.

An international consortium is now considering the possibility of sponsoring a project that would result in shipping a sizable number of Russian Naval reactor cores to Mayak for reprocessing. If this comes to pass, considerably more HEU will be extracted at the RT-1 Plant.

Some of the HEU is sent to fuel fabrication plants to manufacture HEU fuel for research reactors. Some of the HEU is used to enrich Low Enriched Uranium (LEU) to bring it to the enrichment level needed for the production of fuel for civilian power reactors.

For long-term storage, the plutonium dioxide is packed in specially designed, hermetically sealed containers comprised of inner and outer containers made of stainless steel with a metal-ceramic filter in the lid. The storage facility for these containers is located within the RT-1 Plant boundary and consists of two buildings along with engineering facilities that ensure that the functions of receiving, handling, controlling and accounting are properly executed. The storage facility for the HEU is also located within the RT-1 Plant boundary. The HEU oxide extracted during reprocessing is stored within the boundaries of the RT-1 Plant.

2. Plant 1.

This plant contains the HEU Oxidation and HEU Purification facilities. These facilities are two of a number of MINATOM facilities in which the HEU obtained from the dismantling of nuclear weapons is processed and subsequently blending with LEU for sale to the United States as part of the HEU Purchase Program – another joint Russian / US nonproliferation program. The Plant 1 HEU Oxidation Facility receives the dismantled weapons components and converts these components to metal shavings that are then oxidized. The Plant 1 HEU Purification Facility processes the resulting HEU oxide to purify it.

Initial contacts with Mayak related to the DOE MPC&A program began with a visit in July 1994 by a Russian delegation, including representatives of Mayak, to a plutonium storage facility at the Hanford Site, located in Richland, Washington. On a reciprocal visit, a US delegation traveled to Ozersk in October 1994 and toured the RT-1 plant. In a June 1995 agreement between MINATOM and DOE, Mayak was selected to be one of the sites for expanded cooperation. This selection paved the way for the first meeting of the JUSMPT that was held at Ozersk in February 1996.

The February 1996 meeting of the JUSMPT provided the opportunity for the US members of the JUSMPT to tour the RT-1 Plant and gain first hand insights into the existing MPC&A
systems at the RT-1 Plant. During this meeting, Mayak personnel pointed out that the RT-1 Plant had been in use for more than 20 years and that the existing MPC&A systems could benefit from design, equipment and methodology enhancements. This meeting resulted in the identification of short-term, medium-term and long-term enhancements to the existing MPC&A systems at the RT-1 Plant.

In early 1999, Mayak prepared and submitted reports that characterized the HEU Oxidation and HEU Purification facilities located in Plant 1. In May 1999 Mayak, with the permission of MINATOM, hosted a meeting of the JUSMPT during which the JUSMPT toured both the HEU Oxidation and HEU Purification facilities. During these meetings and tours, short-term, medium-term and long-term enhancements to the existing MPC&A systems at the two Plant 1 facilities were identified.

WORK IN PROGRESS

The top level work-breakdown structure at the end of this report shows the work of the JUSMPT broken down into seven major areas. The majority of JUSMPT activities take place under work areas A, D and G. No work is underway in work areas B and C because these plants (the Isotope Production Reactor Plant and the Isotope Production Plant) appear to present a low proliferation risk based on information released by MINATOM and Mayak. Work area E is inactive while the JUSMPT awaits permission from the headquarters of the MVD Internal Troops and MINATOM to work cooperatively with the MVD at Mayak. At the present time, work area F (inter-plant transportation) falls largely under the umbrella of another MPC&A project team with only minimal review by the JUSMPT. While work area G accounts for a considerable portion of the total work of the JUSMPT, activities in this work area will not be discussed in this paper. In the remainder of this paper we will describe the activities in work areas A and D.

As shown in the diagram at the end of this report, work at the RT-1 Plant is currently divided into 11 work packages:

1. The initial reports characterizing the existing MPC&A systems associated with the production and storage of plutonium dioxide at RT-1 Plant were completed in mid 1996. In early 1999 Mayak received permission from Minatom to include in the work of the JUSMPT those facilities at the RT-1 Plant used to obtain HEU from the reprocessing operations. Reports describing the existing MPC&A systems associated with the HEU facilities at the RT-1 Plant are currently being prepared by Mayak for submission to the JUSMPT.

2. Upgrades to the existing badging and access control system for the RT-1 Plant are currently being negotiated.

3. Upgrades to the RT-1 Plant security perimeter. A section of the existing security perimeter around the RT-1 plant that had been damaged by a rising water table has been repaired. Nuclear-material and metal-detection monitors have been installed at all
frequently used pedestrian portals. The first phase of upgrades to the existing security communication system has been completed and a second phase is underway.

4. Upgrades to the HEU facilities are being planned and negotiated.

5. Upgrades in the reprocessing buildings are focused on improving the accuracy and timeliness of nuclear-material-balance calculations. Improvements are being made in measurement instruments, measurement methodologies and computerization of data gathering and computations.

6. Upgrades to the interim storage vault at the end of the plutonium processing line include hardening the vault walls and doors, building an access delay cage, improving intrusion detection and assessment, supplying improved scales, a bar code welding station and a computer for entering accounting data.

7. Upgrades to the long-term, plutonium-dioxide storage buildings include addition of access delay blocks as pictured at the end of this report, improvements in intrusion detection and assessment systems, welding of bar code labels onto the canisters, and improvements in tamper indication systems. A Physical Inventory Taking (PIT) laboratory has been established that includes non-destructive analysis (NDA) instruments to be used during future inventories to confirm the previous inventory records relating to the contents of the canisters, and to help detect unauthorized diversion of plutonium dioxide.

8. An improved alarm display and control system and video monitoring system are being installed in the central alarm station.

9. A computerized accounting system is being developed and installed that will network a number of workstations and instrument-data collection systems so that a computerized inventory of the plutonium and uranium can be maintained from the input to the reprocessing line, throughout the processing and including the long-term storage buildings. The PIT laboratory will also be a node on this network.

10. The current long-term storage buildings will be completely filled in the next few years. The JUSMPT is engaged in the design of a new storage facility that will incorporate advanced MPC&A concepts.

11. Improvements to intra-plant transportation are now being discussed.

Work at Plant 1 is still in the discussion stage. Minatom has currently suspended further approval for work at this plant and negotiations are underway to re-establish permission for this work.

CONCLUSION

Because of the quantity and nature of the nuclear materials involved, the work outlined in this paper represents a significant milestone in the ongoing program of cooperation between the Russian Federation and the United States on issues related to nuclear non-proliferation. Successful completion of this work will place a considerable quantity of proliferation-sensitive nuclear material under significantly improved protection, control and accountability. Furthermore, successful completion of this initial work may create the conditions for
expansion of our collaboration to include other Mayak plants and facilities that produce, process, handle and/or store proliferation-sensitive nuclear materials.

A civilian, spent-nuclear-fuel reprocessing plant (RT-1) is the first Mayak facility to receive MPC&A enhancements. An extremely large quantity of plutonium dioxide is stored at the RT-1 plant.

Nuclear material detection portal have been installed at the RT-1 Plant to detect an attempt to carry stolen nuclear material out of the plant.

Canisters are loaded with plutonium dioxide and sealed for storage in a temporary storage vault at the end of the reprocessing line.

The canisters of plutonium dioxide are transported from the temporary storage vault at the end of the reprocessing line to the long-term storage buildings.
The Physical Inventory Taking (PIT) laboratory before shipment to Russia. The PIT laboratory has now arrived at the RT-1 Plant at Mayak where it will be used during periodic inventories to make non-destructive-analysis measurements on the canisters of plutonium dioxide in an effort to detect theft of material.

Steel-clad, steel-reinforced, concrete blocks that are being placed on top of canisters of plutonium dioxide in storage in order to increase the time required for a thief to gain access to the canisters.