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Abstract

Six US Department of Energy Laboratories are carrying out a program of cooperation with the Russian Research Center Kurchatov Institute to improve nuclear material protection, control and accounting (MPC&A) at the Institute. In 1995 the primary emphasis of this program was the implementation of improved physical protection at a demonstration building at Kurchatov, and the upgrading of the computerized materials accounting system, measurement instrumentation, and physical inventory procedures for a critical assembly within this building. Work continues in 1996 at this building but now also has begun at the two Kurchatov buildings which constitute the Central Storage Facility. At this facility, there will be upgrades in the physical inventory taking procedures, a test and evaluation of gamma-ray isotopic measurements, and evaluations of nuclear material portal monitors and neutron-based measurement equipment. There will also be implementation of an improved computerized materials accounting system which will include bar code printing and reading equipment, development of a tamper indicating device program, and substantial improvements in physical protection. Finally, vulnerability assessments begun in 1995 are being extended to additional high priority facilities at Kurchatov.

Introduction

The US/Russian Laboratory-to-Laboratory Nuclear Materials Protection, Control and Accounting Program (hereafter the "Lab-to-Lab Program") is a program of cooperation between six US Department of Energy (DOE) Laboratories and the nuclear institutes and enterprises of the Russian Federation. The purpose of the program, which was started in 1994, is to reduce the risk of nuclear weapons proliferation by strengthening systems of nuclear materials protection, control and accounting (MPC&A) at Russian nuclear facilities (1).

This paper describes recent progress in MPC&A under the Lab-to-Lab Program at the Russian Research Center Kurchatov Institute in Moscow. Kurchatov Institute is a large research facility with almost ten thousand employees and research programs in solid state physics, fusion and plasma physics, and nuclear physics, as well as nuclear power and reactor safety.

Work in MPC&A under the Lab-to-Lab Program is supervised and coordinated by a Project Team consisting of staff from Kurchatov as well as from six US DOE Laboratories: Brookhaven National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratories. Each US Laboratory has assumed the responsibility to support MPC&A work at Kurchatov in particular areas. Brookhaven staff support upgrades in physical inventory taking and verification; Livermore staff facilitate evaluation of gamma-ray isotopic measurement techniques and implementation of vulnerability assessments; Los Alamos staff support development of an improved computerized materials accounting system, site-wide system studies and evaluations of nuclear material portal monitors and neutron-based measurement equipment; Oak Ridge staff provide assistance for the implementation of bar code printing and reading equipment; PNNL staff support the application of electronic scales and tamper indicating devices; and Sandia staff facilitate improvements in the physical protection system.

During the first year of the Lab-to-Lab program, the primary emphasis of the effort was directed toward improvements in Building 116 at Kurchatov (2). This paper describes recent MPC&A advances at the Central Storage Facility (CSF) which consists of Buildings 114 and 128 and which recently has become the focus of the Kurchatov program.

An important function of the CSF is the intermediate storage of all "fresh" nuclear material used by Kurchatov facilities. In addition CSF staff are responsible for almost all internal shipments and receipts of such material to and from Kurchatov facilities as well as for almost all external shipments and receipts to and from other nuclear sites, both Russian and outside of Russia. The nuclear material within the CSF is very heterogeneous and is in a variety of physical and chemical forms -- itemized and bulk form in solid state and solutions. The inventory of nuclear material includes uranium at various enrichments and plutonium in laboratory quantities.

Site-Wide System Study

During the past year, Los Alamos personnel have been working with Kurchatov staff to evaluate how MPC&A can be applied to the site as an integrated system. This has included identifying all nuclear facilities and material on the site to address the highest priority facilities. When complete, this evaluation will be used to plan further activities and to integrate physical protection with MC&A.

Vulnerability Assessment

Livermore has three contracts in place concerning safeguards effectiveness evaluation and planning at Kurchatov. Under the first contract a two week workshop was conducted at Kurchatov in May 1995. Reports have been completed which identify potential targets, document applicable security program requirements, and analyze vulnerabilities and potential upgrades at a particular facility. This contract was modified to allow the conduct of a three week workshop covering MC&A evaluation and vulnerability assessment at Kurchatov for Russian Navy personnel in February 1996. The second contract is with Eleron to conduct a vulnerability assessment of a Kurchatov facility. Similar reports as described above have been received from Eleron. The third contract is with Kurchatov for the conduct of vulnerability assessments of the next three highest priority facilities at Kurchatov.

Physical Protection

The physical protection system design for Kurchatov Institute, jointly developed by Sandia and Kurchatov personnel, consists of four main components: physical barriers, entry control systems, alarm assessment system, and interior and exterior sensors. The majority of equipment is of Russian design and manufacture and is being supplied and installed under a subcontract to Eleron. Recent work for the buildings of the Central Storage Facility has included site preparation, the installation of several sensors and a video alarm system, as well as the installation of a communication and display system.

Site preparation at the CSF required considerable clean-up of the grounds. Trees were trimmed, and brush, discarded objects, debris and existing fences were removed. This created a "clear zone" around the buildings and facilitated follow-on work such as the installation of perimeter sensors and fences. The clear zone, an element of the design, maximizes the effectiveness of barrier and detection sensors and of the cameras that monitor the grounds encircling the facility. System design also entails the installation of window barriers, reinforced steel doors, vehicle and personnel gates, and power supply and signal cabling to and from the buildings.

Several types of sensors in place at the CSF provide detection of unauthorized activity as well as a routine monitoring capability. Intrusion detectors installed at potential access points alert security personnel if a secured door, window, or other access point is compromised. Fencing and other sensors secure the clear zone surrounding the building. Consequently, security personnel are made aware of unauthorized movement within the confines of the facility.

All sensors are integrated electronically to an alarm communication and display system by which video and alarm displays in another building inform security personnel of the nature and status of an event. Sensors designed for the detection of specific types of activities monitor both the interior and exterior of the facility. Closed-circuit television cameras monitor the perimeter of the facility viewing the clear zone as well as certain areas within the buildings.

Los Alamos personnel are working with Kurchatov staff in a program to test and evaluate hand-held and portal monitors of both Russian and US manufacture. The purpose of this program is to determine which improvements should be implemented for the many different monitoring tasks at Kurchatov. Preliminary results suggest that detectors using Geiger-Mueller tubes are appropriate for contamination monitoring, but that detectors based on scintillators are required to detect modest amounts of nuclear material.

Computerized Material Accounting

Since 1994, Kurchatov personnel have been developing a computerized nuclear material accounting system that would address the specific needs of the Institute and other Russian nuclear facilities. The first component of this system was established in Building 116, was demonstrated in December 1994, and has been used in a physical inventory taking at the Nartsis facility in February 1996 as well as for other activities.

Current work at Kurchatov is addressing the broader question of a design for an improved site-wide computerized accounting system for all Institute facilities which use nuclear material. The US Lab-to-Lab project has established a standard set of software tools for the participating Russian institutes. As a result of interactions with Los Alamos personnel, Kurchatov has chosen to develop its site-wide system using a real-time client/server architecture based on networked personal computers with Windows NT as the operating system. The core of the proposed system will be two servers located in Building 114 of the CSF; these will be linked by fiber optics to clients, bar code readers, electronic scales and other equipment in other buildings throughout the Institute. During the past year Kurchatov has developed an advanced computerized material accounting system using Windows NT, SQL Server, and Visual Basic. Kurchatov, as well as other Russian institutes within the Lab-to-Lab project, also are evaluating the COREMAS material accounting system which has been developed by Los Alamos and which uses the same software tools.

The Kurchatov site-wide accounting system must be certified to handle classified data, so the initial Los Alamos order for computers for this system was placed with KAMI STC of Moscow, an organization fully qualified to provide the required certification. This order provides a server for Building 114 and several clients for Buildings 114 and 128; KAMI has certified and delivered these computers to Kurchatov, where they are now being linked together to provide the first demonstration of a computerized accounting system at the Central Storage Facility and to support physical inventory taking at the CSF.

Physical Inventory Taking

A major goal of improvements in material control and accounting is the performance of a physical inventory taking (PIT) of the nuclear material at a nuclear facility. A PIT includes ensuring that all items on inventory are included in the facility records and that the content of the items (or at least a suitable random sample thereof) corresponds to the recorded values. A PIT is a substantial undertaking for a facility with a large number of nuclear material items.

Kurchatov, in consultation with Brookhaven, is developing a plan for a PIT at the CSF that takes into account item identification, item counting, random sampling, measurements, a measurement control program including the use of standards, statistical evaluation, computerized material accounting, and required measurement equipment and hardware. Because of the quantity and number of forms of nuclear material involved, the plan is to be organized in phases so that over time, increasing fractions of the inventory are accounted for by means and procedures considered by the plan.

Experience has been gained by participation of CSF personnel in design and development of PIT and physical inventory verification (PIV) procedures for the Nartsis critical assembly. Using these procedures, Kurchatov personnel conducted a second PIT at Nartsis. These procedures included use of the Canberra Inspector portable gamma spectrometer provided by the Lab-to-Lab program as well as a prototype system for

computerized material accounting. These activities have contributed to modification of the preliminary plan and to the development of an improved plan for PIT at the CSF.

Bar Code Technology

To improve the speed and accuracy of physical inventory taking operations, Kurchatov Institute has decided to use bar code symbols. Bar code printing and reading equipment for the Institute is being provided by Oak Ridge National Laboratory. When this equipment is integrated into the Kurchatov computerized accounting system, personnel will be able to conduct physical inventories of their material in less time and with fewer human errors. To improve data entry operations, the Institute will install bar code scanners on each client computer in their new MC&A system to allow users to rapidly input data with fewer key stroke errors. To track near real-time material movements at the Institute, a network of fixed transaction manager terminals will be installed. These transaction terminals extend the MC&A system into material storage areas for logging material transfers without exposing a more expensive computer to the risk of contamination or tampering. Portable data collection terminals will be used for routine item inventory operations. These portable terminals can hold information on hundreds of items before downloading the information periodically to the main system.

The first facility at Kurchatov to be equipped with bar code equipment is the Central Storage Facility. The equipment at this facility was installed earlier this year and is operational. Kurchatov Institute personnel demonstrated the use of bar code technology in physical inventory taking during May 1996. Although the hardware has performed as expected, the integration of the bar code equipment with the computerized material accounting system and the lack of portable terminals capable of Cyrillic alphabet display have been identified by Kurchatov as problems.

Scales and Weight Measurements

The effort to improve scales and weight measurements at the Institute is a collaboration between Kurchatov and Pacific Northwest National Laboratory (PNNL). The primary intention of this work is to upgrade the materials accounting system at Kurchatov to incorporate high-resolution digital scale technology that is electronically linked to a central database. Electronic scales and balances will be installed in both research and storage facilities and in many cases will replace the mechanical balances currently in use. This effort is designed to develop a state-of-the-art system for making and managing weight measurements which will be directly connected to a computerized material accounting system. The data management system also will include quality control procedures to ensure the integrity of both individual measurements and the entire system. And it will provide for the acquisition of working standards and the development of protocols for calibrating scales and other devices in the measurement chain.

Tamper Indicating Devices

The tamper indicating device (TID) work at Kurchatov is sponsored by PNNL. A TID workshop was held at the Institute in November 1995. This workshop provided an introduction and overview of TID program development, and discussed the various elements of a TID program. The workshop also covered the history, technologies for specific applications, program administration, application and removal, verification, inspection and response activities, and training program development for these devices. Kurchatov representatives presented site-specific information on problems and issues and presented potential solutions to develop and implement a TID program.

In the coming year Kurchatov personnel will work with PNNL staff to develop a TID program plan. The program will include: 1) specific goals for enhanced MPC&A via TIDs, 2) administrative requirements for the TID lifecycle, including procurement, accountability, use, and destruction, 3) identification of specific materials and locations where TIDs will be utilized and the types of TIDs approved for each use, and 4) the identification of the specific procedures necessary to implement the TID program. The Institute will develop procedures to address these administrative requirements and provide training to appropriate staff. Finally, the completed program will be demonstrated to the U.S. Project Team.

Radiation Measurements

Livermore has completed a contract with Kurchatov to test and evaluate gamma-ray isotopic measurements of enrichment on fresh fuel used in the Nartsis and Astra assemblies in Building 106. This work showed that nuclear materials at these two facilities could be measured by nondestructive, gamma-ray measurement methods. Gamma-ray spectrometry equipment was provided to Kurchatov under this contract and was used in the Physical Inventory Taking at Nartsis. Additional equipment is to be provided to Kurchatov under a new contract to measure the isotopics of nuclear materials stored in the Central Storage Facility.

Los Alamos has provided an Active Well Coincidence Counter (AWCC) to Kurchatov for the purpose of measuring the properties of nuclear material in a variety of physical and chemical forms. After testing, evaluation, and training of Kurchatov personnel in the use of this instrument, the first application of the AWCC will be for physical inventory taking at the Central Storage Facility. The AWCC will then be maintained at the CSF to verify future shipments of material both to and from the facility.

Conclusion

The Lab-to-Lab program has supported a broad range of work involving cooperation between US DOE Laboratories and Kurchatov Institute. In less than two years this program has led to important advances in MPC&A for nuclear materials at three buildings at the Institute. Later this year Kurchatov personnel will conduct an integrated demonstration of equipment, software, and procedures for MPC&A at the Central Storage Facility; the goal will be to provide a realistic simulation of the practical application of MPC&A systems for government organizations and other Russian facilities. With the establishment of a sound foundation for the application of these advances to other Kurchatov buildings which house nuclear facilities and material, work on such extensions will begin later in 1996.

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