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MPC&A Upgrades at the Institute of Theoretical and Experimental Physics (ITEP)

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Abstract

Materials Protection, Control and Accounting (MPC&A) equipment upgrades are complete at the Institute of Theoretical and Experimental Physics (ITEP), a site that has significant quantities of weapons-potential nuclear materials. Cooperative work was initiated at this Moscow facility as a part of the U.S.-Russian program to upgrade MPC&A systems.

An initial site visit and assessment were conducted in September 1996 to establish communication between ITEP, the U.S. Department of Energy (DOE), and participating U.S. National Laboratories. Subsequently, an agreement was reached to develop two master plans for MPC&A upgrades. Los Alamos National Laboratory (LANL) and Oak Ridge National Laboratory (ORNL) assisted in developing a plan for Material Control and Accounting (MC&A) upgrades, and Sandia National Laboratories[1] (SNL) assisted in developing a plan for Physical Protection System (PPS) upgrades. The MC&A plan included MC&A training, a mass measurement program, nondestructive assay instrumentation, item identification (bar coding), physical inventory taking, portal and hand-held nuclear material monitors, and a nuclear materials accounting system. The PPS plan included basic PPS design training, Central Alarm Station (CAS) relocation and equipment upgrades, a site and critical-building access control system, intrusion detection, alarm assessment, and guard force communications.

DISCLAIMER

Introduction

In recognition of the global importance of nuclear nonproliferation, the Department of Energy's (DOE) Materials Protection, Control and Accounting (MPC&A) program was created to protect weapons-usable nuclear materials in the Former Soviet Union. Cooperative work was initiated at the Institute of Theoretical and Experimental Physics (ITEP) as part of the U.S.-Russia program to upgrade MPC&A systems. The program has three principal objectives:

1. Secure all weapons-usable nuclear materials in forms other than nuclear weapons by entering into agreements of cooperation with government ministries and individual sites.
2. Implement systematic and rapid MPC&A upgrades.
3. Ensure future nuclear materials security by encouraging the development of a safeguards culture and indigenous site-level capabilities, and by strengthening national-level systems for MPC&A.

ITEP was the first Russian Federation nuclear facility, included in the DOE MPC&A program, at which the systematic and rapid upgrades have been completed. This paper describes the completed MPC&A upgrades intended to protect the significant quantities of fissile nuclear material at ITEP.

Background

ITEP became a part of the U.S.-Russian cooperation in MPC&A at the July 1996 meeting of the Gore-Chernomyrdin Commission (GCC). A DOE technical team subsequently visited the site to establish the basis for future cooperation. ITEP is the Russian institute responsible for developing heavy water reactor technology, among other development activities. It has a fissile material storage facility and a zero-power reactor called "MAKET." ITEP was the third nuclear energy research institute to be established in the Soviet Union and commissioned the first heavy water reactor in 1948.

The heavy water research reactor at ITEP was originally fueled with natural uranium; the fuel enrichment was increased to 20% and finally to 90%. The reactor had been operating 36 years before the Chernobyl accident. Though the reactor was technically sound, it was closed in the aftermath of Chernobyl and finally decommissioned. The MAKET reactor was the prototype for a new sub-critical reactor known as the Electro-Nuclear Neutron Generator. The Electro-Nuclear Neutron Generator reactor will generate high-flux neutrons for basic and applied research and is expected to be operational in the future.

The MAKET reactor and the Electro-Nuclear Neutron Generator use the same type of fuel as the shutdown reactor used. Individual fuel elements are hollow aluminum cylinders containing aluminum/uranium dioxide clad pellets.

Site

ITEP covers 36 hectares of land and is surrounded by a 3.5-kilometer-long perimeter. Work with uranium occurs inside buildings in a "local zone." This area has an 800-meter perimeter, which separates the fissile materials from the rest of the facility and requires special clearance for access.

The site employs approximately 500 researchers and 1000 technicians. Research at the site focuses primarily on high-energy physics and nuclear reactor physics. Research also is conducted in the area of proton therapy. In addition, there are 17 commercial ventures that rent space from the institute. These ventures

generate approximately 15% to 20% of ITEP's revenue.

MPC&A Upgrade Approach

Cooperation efforts between ITEP and DOE to upgrade MPC&A were outlined in a September 1996 memorandum of cooperation. The approach to developing cooperative projects at ITEP followed a seven-step process:

1. An initial visit to establish contact and to perform an initial assessment of ITEP's needs was performed in September 1996 under DOE leadership and supplemented with staff from the DOE national laboratories.
2. A more detailed technical visit to examine the current MPC&A system and to begin establishing a system design was accomplished in November 1996.
3. Introductory PPS and MC&A training courses to familiarize ITEP staff with MPC&A methodologies and to acquaint U.S. designers with ITEP's unique requirements were completed in February 1997.
4. A site characterization was developed to identify the material and existing MPC&A systems at ITEP and establish requirements for the final system design. This was finalized in March 1997.
5. PPS and MC&A designs were developed as the basis for the equipment upgrades. The final designs were agreed to in April 1997.
6. Several major contracts were negotiated to perform the upgrades identified in the final PPS and MC&A designs. The contracts were agreed to in April 1997.
7. MPC&A equipment installation was completed in January 1998 and a commissioning ceremony took place on February 24, 1998.

MPC&A Upgrade Activities

The training, site assessment, PPS, and MC&A upgrade activities are described in greater detail below.

Training

MPC&A training was an important first step in achieving cooperation with the ITEP staff. The training objective was to create: (1) a sense of "buy-in" from the facility as ITEP specialists develop MPC&A system designs and gain understanding of the U.S. recommended MPC&A methodology; (2) a common understanding between U.S. designers and their ITEP counterparts; and (3) greater insight on specific facility needs than could otherwise have been obtained.

SNL trained ITEP personnel in U.S. recommended approaches and methodologies to PPS design and analysis. This introductory training covered the fundamentals of detection, delay, and response. LANL provided training in basic MC&A concepts, Non-Destructive Assay (NDA), computerized accounting, SNM portal monitor operations, and tamper-indicating devices (TID). A bar code training course was conducted by ORNL at ITEP. All introductory training was completed by February 1997 and detailed training was completed by January 1998.

Site Assessment

The initial technical exchange, held at ITEP in November 1996, was the foundation for understanding the basic MPC&A upgrade requirements. ITEP provided a site characterization, which described the special nuclear material located at all facilities at ITEP, the perceived threat, and the actual layout, condition, and operation of existing MPC&A systems. The PPS design and MC&A design were developed based on the findings identified in the site characterization.

MC&A Upgrades

A preliminary MC&A design, based on the findings identified in the site characterization, was developed to increase the ability to track and account for fissile materials at ITEP. ITEP system designers were ultimately responsible for the final design. The MC&A design was completed in February 1997, and the system was operational by January 1998.

The design called for five MC&A upgrades:

1. Storage boxes, storage racks, and a transport safe were constructed to facilitate the use of TIDs as access control devices during storage and transport of SNM.
2. The guard force has been provided with hand-held radiation detectors to be used in responding to alarm situations and in random surveillance of personnel.
3. Non-destructive assay (NDA) and mass measurement instruments provide the first capability for ITEP to measure the quantity of SNM on inventory.
4. The accounting system software selected for ITEP is the E/Z MAS system, which was designed for facilities with relatively simple operations (e.g., non-processing facilities). Use of the E/Z MAS system simplifies implementation and reduces the time and expense required for training system operators.
5. MC&A upgrades were performed by ITEP with technical support and training by U.S. experts.

Nuclear Material Measurement System

PPS Upgrades

A preliminary PPS design was developed based on the findings identified in the site characterization. A design review was conducted at ITEP in February 1997. A final design was created and agreed to after the design review. The design included:

1. Establishment of a local zone Central Alarm Station (CAS), including
   - an alarm communication and display system;
   - video assessment monitors;
   - an access control system; and
   - communication improvements for the guard force
2. Relocation of the response force inside the local zone
3. Upgrades to the fissile material storage building and MAKET reactor, including:
   - interior intrusion detection sensors;
   - video alarm assessment cameras;
   - physical barriers to delay access to material storage areas; and
   - access control card readers

Alarm Communication and Display System

Under subcontract to ITEP, Eleron was awarded primary responsibility for the ITEP physical protection upgrades. Eleron created the conceptual, preliminary, and final designs. The alarm communications, display, and access control functions were integrated into the Eleron-manufactured Evridika system. The system was designed to handle the sensor inputs for a small site. It is a newer, but scaled-down version of Eleron's Zircony system. Other system components, including interior intrusion detection sensors, video cameras, and card readers are manufactured either in Russia or other countries.

The CAS, containing the Evridika system, was relocated within the local zone. The CAS will monitor alarms and coordinates response only for the local zone. The existing CAS will continue to monitor alarms for the remainder of ITEP facilities.

The ITEP guard force currently uses hand-held radios and a base station radio for coordinating its routine and emergency actions. Additional radios, operating on the same frequencies, have been supplied to supplement the communications system.

ITEP staff either performed or subcontracted other physical upgrade tasks, such as hardening doors and windows. One such task is the construction of a vehicle portal for searching and controlling access of vehicles entering or leaving the local zone.

While system designers used U.S. approaches to PPS design, designs were developed according to internationally recognized recommendations in INFCIRC/225/Rev.3, *The Physical Protection of Nuclear Material*. Not all of the upgrades identified in the PPS design were implemented; only the components that would complement existing systems and provide protection against theft of special nuclear material were recommended.

Summary

The ITEP facility contains significant amounts of fissile material. Loss of these materials could have consequences reaching beyond the borders of Russia. This problem was recognized at a very high level within both the U.S. and Russian governments. DOE's MPC&A program has actively addressed these concerns. The following MPC&A upgrades have been completed at ITEP.

1. *Training*: Provided training in modern MPC&A systems.
2. *Site Assessment*: Conducted a site characterization to assess the nuclear materials at the facility and to determine the requirements for MPC&A upgrades.
3. *MC&A Upgrade*: Upgrades included systems supporting both nuclear material accounting (computerized accounting system, SNM measurements, bar coding) and nuclear material control (TIDs, SNM portal monitors, hand-held radiation detectors, containment devices).
4. *PPS Upgrade*: Physical protection system upgrades included: establishment of a local zone CAS, access control, intrusion detection, video assessment, delay elements, and guard force communications.

Commissioning Ceremony

A commissioning ceremony was conducted on February 24, 1998 to recognize the completion of these upgrades. The upgrades, designed and implemented in conjunction with the facility operators, will complement existing systems. The system design was accomplished employing recognized MPC&A methodologies and international recommendations. As a result, the fissile material at ITEP will be more secure from potential theft or diversion.

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[1] *Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.*