LA-UR- 97-2622

Approved for public release; distribution is unlimited.

CONF-970744--

Title: COOPERATIVE IMPROVEMENTS IN MATERIAL PROTECTION, CONTROL AND ACCOUNTING (MPC&A) AT THE MINING AND CHEMICAL COMBINE THROUGH THE RUSSIAN/US COOPERATIVE MPC&A PROGRAM

Author(s): Sara C. Scott
Sylvester Suda
William M. Buckley
Howard Kerr
Uri Gat
Michael Curtis
James H. Lee
Vasily V. Ahidkov
Konstantin V. Dorofeev

Submitted to: 38th Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, July 20-24, 1997

Los Alamos
NATIONAL LABORATORY

DISCLAIMER

MATERIAL PROTECTION, CONTROL, AND ACCOUNTING ENHANCEMENTS THROUGH THE RUSSIAN/US COOPERATIVE MPC&A PROGRAM

Sara C. Scott
Los Alamos National Laboratory, Los Alamos, New Mexico 87545

Sylvester Suda
Brookhaven National Laboratory, Upton, New York 11973

William M. Buckley
Lawrence Livermore National Laboratory, Livermore, California 94550

Howard Kerr and Uri Gat
Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831

Michael Curtis
Pacific Northwest National Laboratory, Richland, Washington 99352

James H. Lee
Sandia National Laboratories, Albuquerque, New Mexico 87185

Vasily V. Zhidkov and Konstantin V. Dorofeev
Mining and Chemical Combine, Zheleznogorsk, Krasnoyarsk Region, Russia 660033

ABSTRACT

The cooperative Russian/US Mining and Chemical Combine (Gorno-Khimichesky Kombinat, GKhK, also referred to as Krasnoyarsk-26) Materials Protection, Control, and Accounting (MPC&A) project was initiated in June 1996. Since then, the GKhK has collaborated with Brookhaven, Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and Sandia National Laboratories to test, evaluate, and implement MPC&A elements including bar codes, computerized nuclear material accounting software, nondestructive assay technologies, bulk measurement systems, seals, video surveillance systems, radio communication systems, metal detectors, vulnerability assessment tools, personnel access control systems, and pedestrian nuclear material portal monitors. This paper describes the strategy for implementation of these elements at the GKhK and the status of the collaborative efforts.

INTRODUCTION

The Mining and Chemical Combine (Gorno-Khimichesky Kombinat, GKhK, also referred to as Krasnoyarsk-26) is located within the closed city of Zheleznogorsk, Krasnoyarsk Region, Russia, and is a production facility of the Ministry of Atomic Energy of the Russian Federation (MINATOM). A unique underground site[1] at the GKhK, located on the east side of the Yenisey River, includes three reactors, a radiochemical processing facility (PUREX), a nuclear heat and electric power plant, water supply and ventilation facilities,[2] underground high-level waste storage tanks, and a plutonium oxide storage facility. A deep well injection site and an unfinished radiochemical reprocessing facility are components of the aboveground facility.

The decision to build the GKhK, a facility reported as being capable of withstanding a nuclear attack, was made in 1950.[3] The underground site chosen was the point where the Atamanov Ridge (a spur of the Sayan Mountains) intersects with the Yenisey River (see Figure 1).[2] The purpose of the combine was to assure that production of weapons-grade plutonium continued even if this capability was lost at other production facilities in the country. Because of this important role, the facility has been referred to as "The Shield of the Country."[4] Zheleznogorsk, a city of 100,000, is located approximately 10 km from the underground site.[1]

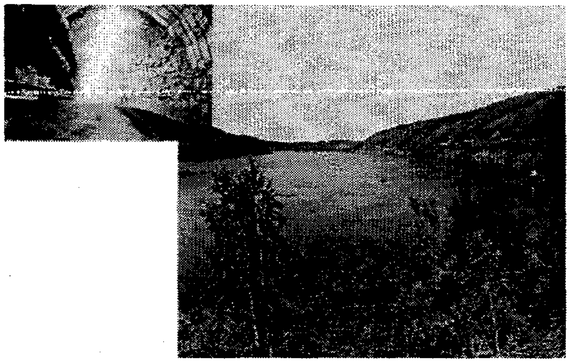


Figure 1. View of the site on the Yenisey River and an interior tunnel.

The three GKhK underground reactors are water-cooled, graphite-moderated, channel-type reactors. They are natural uranium fueled and utilize a ring of highly enriched uranium (HEU) elements to increase the reactivity and stabilize the power density. The first two reactors, referred to as AD and ADE-1, began operation in 1958 and 1961, respectively. These reactors were operated in the entrained flow mode; the cooling water was returned directly to the Yenisey River.[5] AD and ADE-1 were decommissioned in 1992. The third reactor, ADE-2, began operation in 1964[1] and utilizes a closed cooling cycle. This reactor is scheduled to be decommissioned by 2000;[6] however, it still provides the essential electricity and steam to Zheleznogorsk.

Prior to 1994, the GKhK shipped weapons-grade PuO_2 to other weapons manufacturing facilities throughout Russia. However, in October 1994, the GKhK was notified by Minatom that the state order for PuO_2 had been eliminated, effective November 1, 1994.[3] Because the GKhK was still operating the dual-purpose reactor ADE-2, it was necessary to address the storage of the PuO_2 that continued to be produced. This led to the implementation of a temporary PuO_2 storage area. A long-term storage area has been designed and construction initiated so that it would be ready for use by 1998.[7]

IMPLEMENTATION OF THE GKhK/US MPC&A COOPERATIVE PROJECT

In January 1996, at the sixth meeting of the Gore-Chernomyrdin Commission, six new sites were added to the existing MPC&A cooperative program between MINATOM and the Department of Energy. The Joint Statement detailing this agreement was signed by Minister of Atomic Energy V. Mikhailov and Secretary of Energy H. O'Leary. One of the new facilities was the Mining and Chemical Combine in the Krasnoyarsk region in Siberia. Accordingly, an initial site visit by the US GKhK MPC&A Project Team to the combine was arranged and took place June 24–28, 1996.

The result of the initial MPC&A Project meeting was a commitment by both the US and Russian participants to work together to implement the project at the GKhK. Priorities for technical tasks were also identified. These priorities and subsequent communications regarding the facility led to the development of 14 technical task order agreements, which were signed between October 1996 and February 1997.

MPC&A UPGRADE STRATEGY

For purposes of MPC&A upgrades, the Mining and Chemical Combine can be considered as composed of three components: the PuO_2 storage facility, the radiochemical processing facility, and the reactor plant. Because the PuO_2 storage facility contains the most attractive nuclear material in significant quantities, it was decided to focus the initial efforts on upgrading the protection of the material in the storage area. Limited implementation of MPC&A elements in this relatively manageable area also has the advantage of facilitating familiarization with the technology, associated procedures, and ascertaining the utility of the technology for more widespread deployment in other areas at this particular site. Future phases of the project will target the radiochemical processing facility, the reactor plant (including the HEU storage area), and the new PuO_2 storage area for MPC&A upgrades.

The specific MPC&A elements that are being implemented at the PuO_2 storage facility include special nuclear material (SNM) portal monitors, metal detectors, a computerized nuclear material accounting system, a video surveillance system, gamma-ray and neutron counting measurement systems, an upgraded communication system, access control technology, tamper indicating devices, an upgraded physical inventory plan, bar code technology, and computerized scales and weight systems, as well as other physical protection features (e.g., oxide container tie downs and upgraded vault doors).

To assure that all new and existing MPC&A elements at the GKhK are well integrated, an upgraded MPC&A Plan is being developed. The plan development is being performed in parallel with the implementation of MPC&A technologies/methodologies in the PuO_2 storage area. To accomplish this, an outline of an MPC&A plan for the entire facility is being developed, and during the first fiscal year of the project, a detailed plan for the PuO_2 storage facility will be completed. The MPC&A Plan will also provide a framework for continued safeguards upgrades through subsequent project tasks and even beyond the lifetime of the cooperative MPC&A project. This MPC&A upgrade strategy is shown schematically in Figure 2. Although this strategy provides an overall framework for the project, specifics regarding upgraded MPC&A plan development and MPC&A element selection and implementation are continually being refined and improved through mutual discussions and workshops.

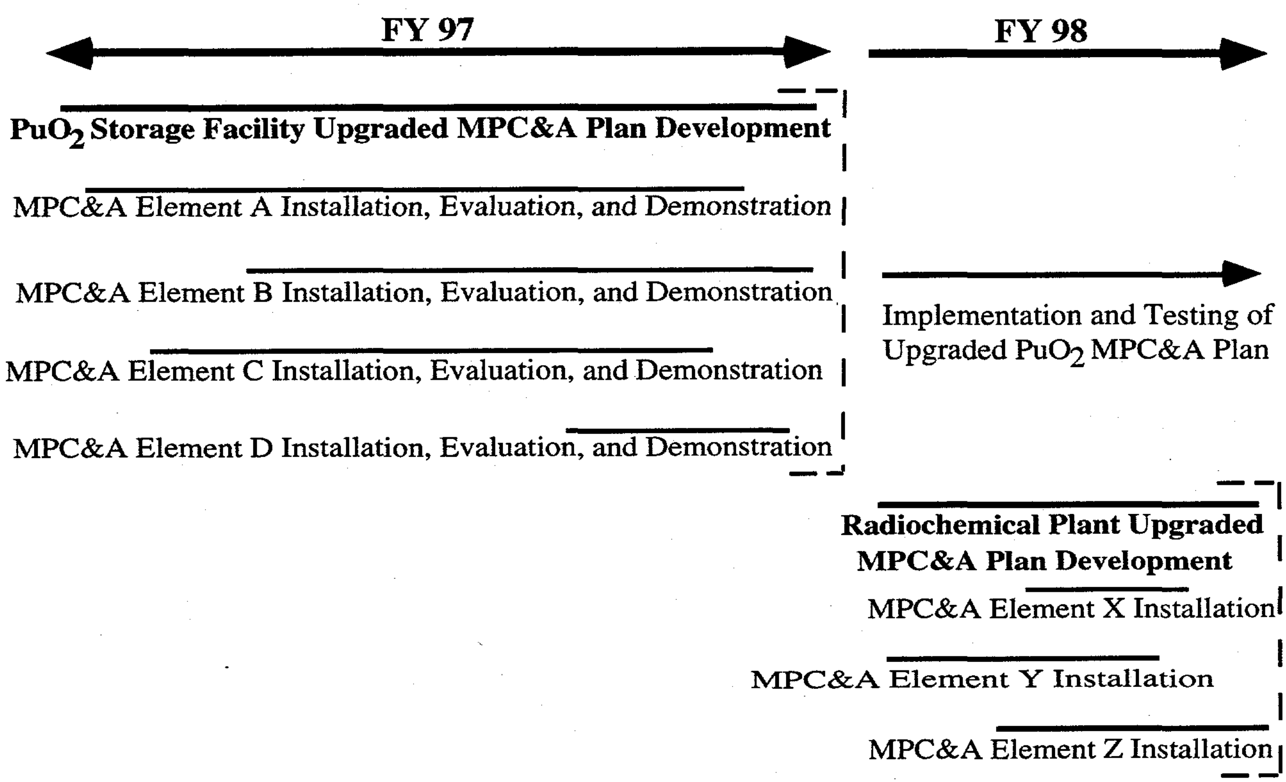


Figure 2. Schematic of the GKhK MPC&A project approach: Development of MPC&A plan in parallel with installation and evaluation of MPC&A equipment and development of techniques and procedures.

RESULTS

1. Training

During the first year of the project, training was an important area of emphasis. A summary of the training delivered to the GKhK personnel is provided in Table 1. The training aspect of the project provides an introduction to new technologies and an opportunity for the GKhK personnel to assess the potential applicability of different types of equipment/methodologies to their own facility. However, one of the most important results of the workshops is the dialogue regarding the sometimes different approaches by Russia and the US to MPC&A issues. The workshops that are most successful are those in which both the workshop leader(s) and the attendees from Russia and the US gained information and mutual understanding that will help direct future activities/advances in their areas of expertise.

Table 1. Summary of Workshops Attended by GKhK Personnel

Subject	Location	Date
Transportation and Security Demonstration	Eleron, Moscow	September 1996
Radiation Monitoring Workshop	Obninsk	October 1996
Fundamentals of Nondestructive Assay	Los Alamos	November 1996
Communications	Novosibirsk	November 1996
Physical Protection Workshop	Tomsk Polytechnic Institute	December 1996
Tamper Indicating Device Workshop	Obninsk	December 1996
Overview of Computerized Accounting	Los Alamos	January 1997
Computerized MC&A Software Development	Los Alamos	January 1997
CoreMAS Software Development Training	Los Alamos	January 1997
Bar Code Workshop	Obninsk	January 1997
MC&A Effectiveness Workshop	GKhK	February 1997
Safeguards Effectiveness Evaluation Workshop	GKhK	February 1997
MPC&A Plan Workshop	Savannah River	March 1997
Radio Communications Workshop	Hanford	March 1997
International Physical Protection Forum	Obninsk	April 1997
Physical Inventory Workshop	Obninsk	May 1997
Access Control Workshop	Livermore	May 1997
International Communications Exhibition	Moscow	May 1997
Vulnerability Assessment, Physical Protection, and MC&A Overview	Obninsk	June 1997
Preinstallation Tank Volume Measurement Workshop	Brookhaven	June 1997
Tamper Indicating Device Workshop	GKhK	June 1997
Software Implementation	Obninsk	June 1997

For the MPC&A Plan training, the Russian/US Project Team decided to take a more interactive approach than is often employed. The workshop format was a series of interactive discussions on MPC&A plan topics. The facility-specific information that was generated during these discussions was simultaneously entered into an electronic template. (The *Draft Material Control and Accountability Plan for the Proposed Hypothetical Russian Fissile Material Storage Facility*[8] was used as the template.) Some of these discussions were supplemented with short presentations by Russian and/or US experts on subjects including statistics, integration of physical protection with MC&A methods, and measurement control.

Savannah River Site, the meeting host, also arranged for site tours that emphasized the MPC&A plan elements being addressed. For example, at K-Reactor the tour included discussions of authorized locations, material balance areas, material movement and access, a demonstration of an inventory using a bar code reader, and physical security elements. In addition, they arranged for expert personnel to attend all of the interactive discussions sessions. This was an important component of the workshop because it helped provide an element of "real-life" MPC&A experiences to the discussions.

2. Equipment Delivery and Installation

A schematic of the PuO_2 storage facility, Figure 3, shows functional locations for equipment installation in that area. The PuO_2 storage area is enclosed by the radiochemical processing facility, Figure 4; upgrades at the radiochemical processing facility entrance will also be performed during this phase of the project. A current view of the storage area is shown in Figure 5. At this time, one SNM portal monitor and two hand-held radiation detectors have been delivered to the GKhK. An additional portal monitor is in transit. The target installation date for the MPC&A elements shown in Figures 3 and 4 is October 1997.

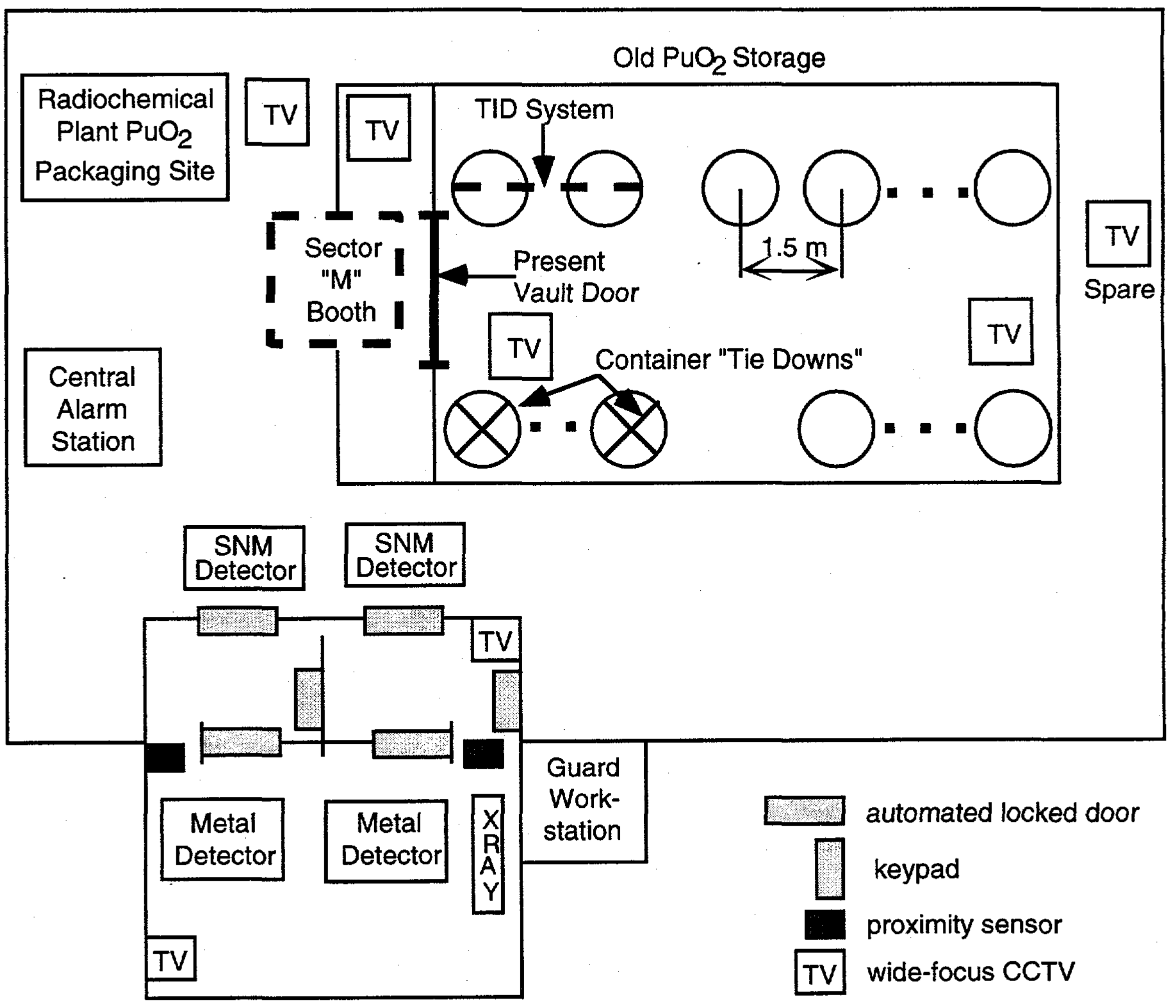


Figure 3. Schematic of the PuO_2 storage area MPC&A upgrades.

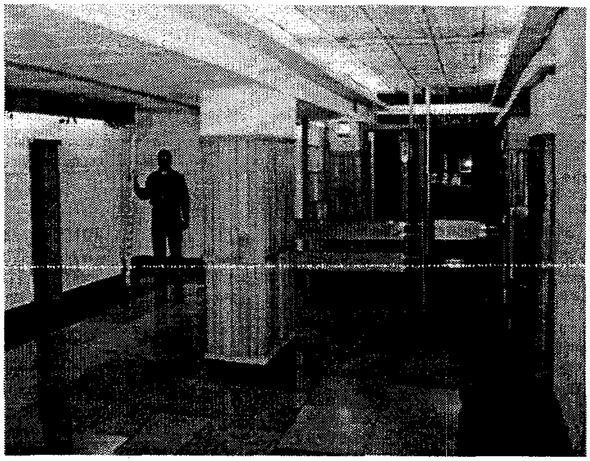
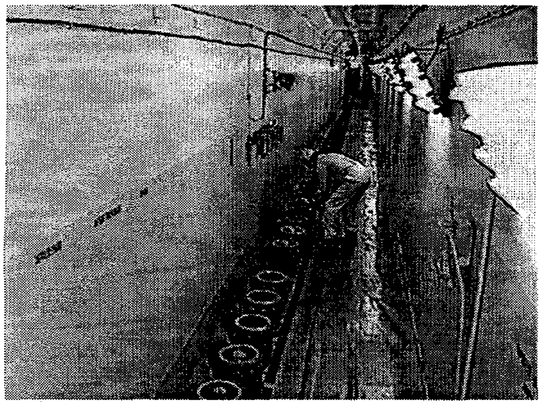


Figure 4. Entrance to the radiochemical processing area.



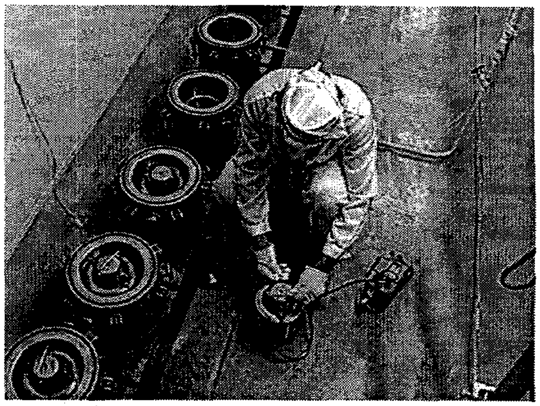


Figure 5. Interior of the PuO_2 storage area.

In addition to the equipment shown in Figure 3, scales and balances are being procured. These will be installed in the radiochemical processing area where the PuO_2 is packaged for transportation to the storage facility. The gamma spectroscopy and neutron counting equipment will be installed in a side room/alcove of the PuO_2 storage area. A bar code kit, containing the basic components required for initial implementation of this technology, is being delivered to the combine; the bar code technology will ultimately be applied to the PuO_2 containers in the storage area. An assortment of tamper indicating devices was delivered to the facility during the workshop at the GKhK in June. The combine personnel selected the multi-lock devices and will implement them on the PuO_2 containers. Two lead stamp seals will be applied to the wire tails of the device. The installation/implementation timeframe for these technologies ranges from October to December 1997.

The Russian language version of ASSESS (vulnerability assessment software) and the required corresponding hardware have been installed. Because of classification requirements, the workshop that provided an introduction to this tool utilized the spent fuel storage building at the RT-2 plant as the basis for modeling and analysis (RT-2 is the unfinished aboveground radiochemical reprocessing facility). Modifications were made to the facility model to account for the target as actual plutonium oxide storage containers. An MC&A program effectiveness evaluation overview was also introduced at this workshop. The evaluation of the actual PuO_2 storage area by GKhK personnel is in progress.

Outside of the mountain facility, an upgraded radio communication system will be installed; the target date for implementation is December 1997. Extension of this system, to include an upgraded communication system within the mountain, is planned. The computerized MC&A accounting system, CoreMAS, has been installed in one of the GKhK administration buildings in Zheleznogorsk. This will be integrated into the other MPC&A elements as shown in Figure 6. The plan for linking this system to the appropriate areas in the mountain site, 10 km from the city, is shown in Figure 7.

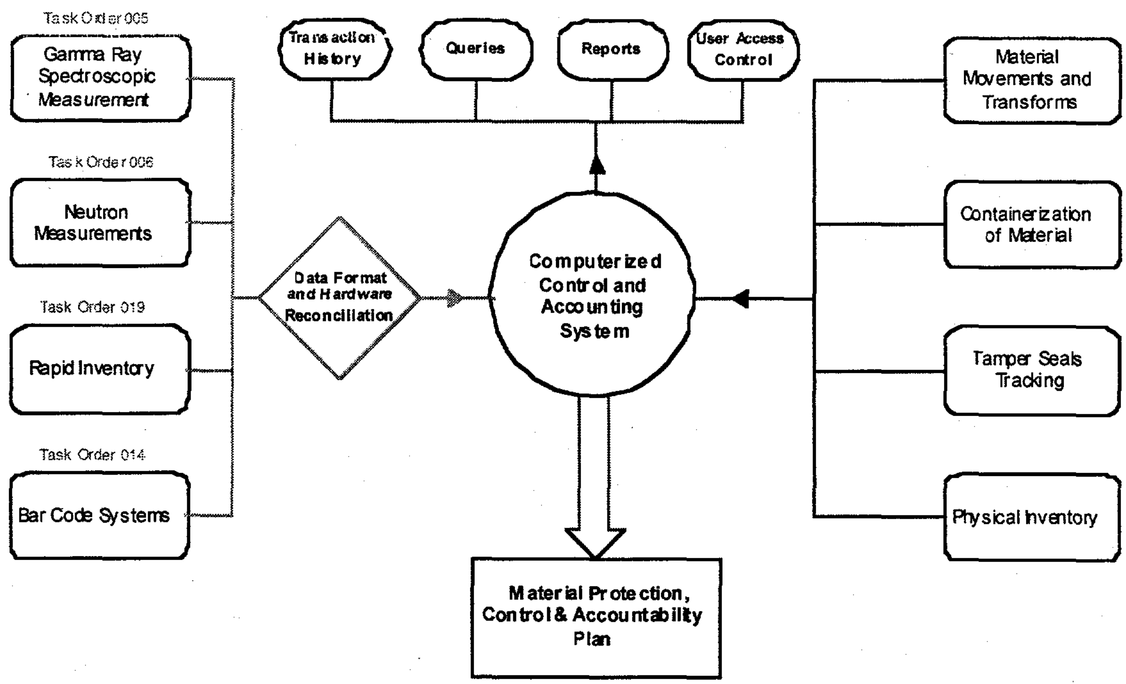


Figure 6. Computerized Control and Accounting System integration with other MPC&A elements.

3. Upgraded MPC&A Plan Development

The GKhK has prepared the first draft of an upgraded MPC&A plan. This includes an outline of the plan for the entire facility and a detailed plan for the PuO_2 storage facility. This draft was developed by merging the existing GKhK MPC&A plan with the information in the template generated at the Savannah River MPC&A Workshop and by adding additional details as required.

SUMMARY

MPC&A upgrades that will result in significant nuclear safeguards improvements for the PuO_2 storage facility are underway. Future activities will include MPC&A upgrades to the radiochemical processing area and the reactor plant. These upgrades are critical because plutonium oxide production at this facility will continue for the next 5–10 years and storage of the plutonium material is currently expected to continue indefinitely. Although this mountain facility has obvious inherent security advantages, MPC&A upgrades provide an important added measure of protection and assurance.

Draft Network Plan for Computerized Control and Accounting System

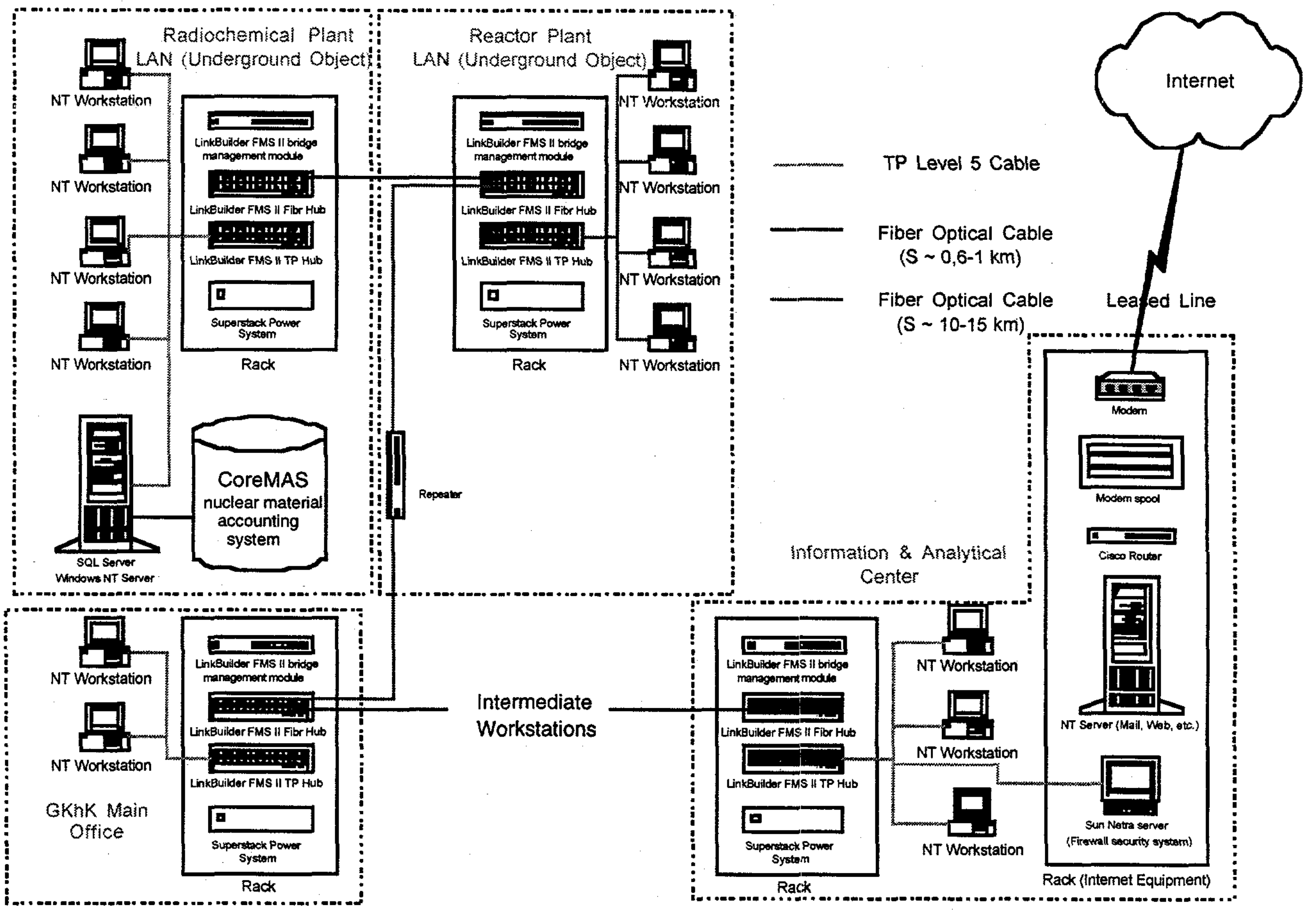


Figure 7. Schematic for linking the computerized accounting system to GKhK site areas.

ACKNOWLEDGMENTS

The authors would like to gratefully acknowledge all of the Russian and US personnel supporting the numerous technical components of this project. We also acknowledge the help of Nellie Schachowskoj for her many hours of help in communications with the GKhK. Carolyn Smith has been invaluable with respect to obtaining Individual Validated Licenses for shipment of equipment. In addition, we thank the secretarial and travel staffs at the National Laboratories for their excellent support in helping us prepare for our the Joint Project Team meetings in Russia.

REFERENCES

1. T. B. Cochran, R. S. Norris, and O. A. Bukharin, "Making the Russian Bomb: From Stalin to Yeltsin," Westview Press: Boulder, Colorado, 1995, p.149.
2. P. V. Morozov, "Integrated Mining and Chemical Enterprise," Applied Technologies Scientific Production Center, Zheleznogorsk, Russia (1996) phone: 391-973-39-10.

3. I. Morozov, "What is Plutonium Today for the People?" *Moscow Literaturnaya*, 19 (February 1997).

4. Y. A. Shirmanov, "The Shield of the Country," 1983.

5. S. M. Vakulovsky, I. I. Kryshev, A. I. Nikitin, Y. V. Savitsky, S. V. Malyshev, and E. G. Tertyshnik, "Radioactive Contamination of the Yenesei River," *J. Environ. Radioactivity* **29**(3), 225 (1995).

6. D. Lockwood, "U.S., Russia Agree to Phase-Out of Nuclear Weapons Reactors," Arms Control Today, 24 (July/August 1994).

7. V. Zhidkov, GKhK Deputy Chief Engineer, personal communication.

8. "Draft Material Control and Accountability Plan for the Proposed Hypothetical Russian Fissile Material Storage Facility," prepared by the Los Alamos National Laboratory MC&A Project Team, November 15, 1993.

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