UCRL-JC-123173-Rev 1

CONF-960767--29

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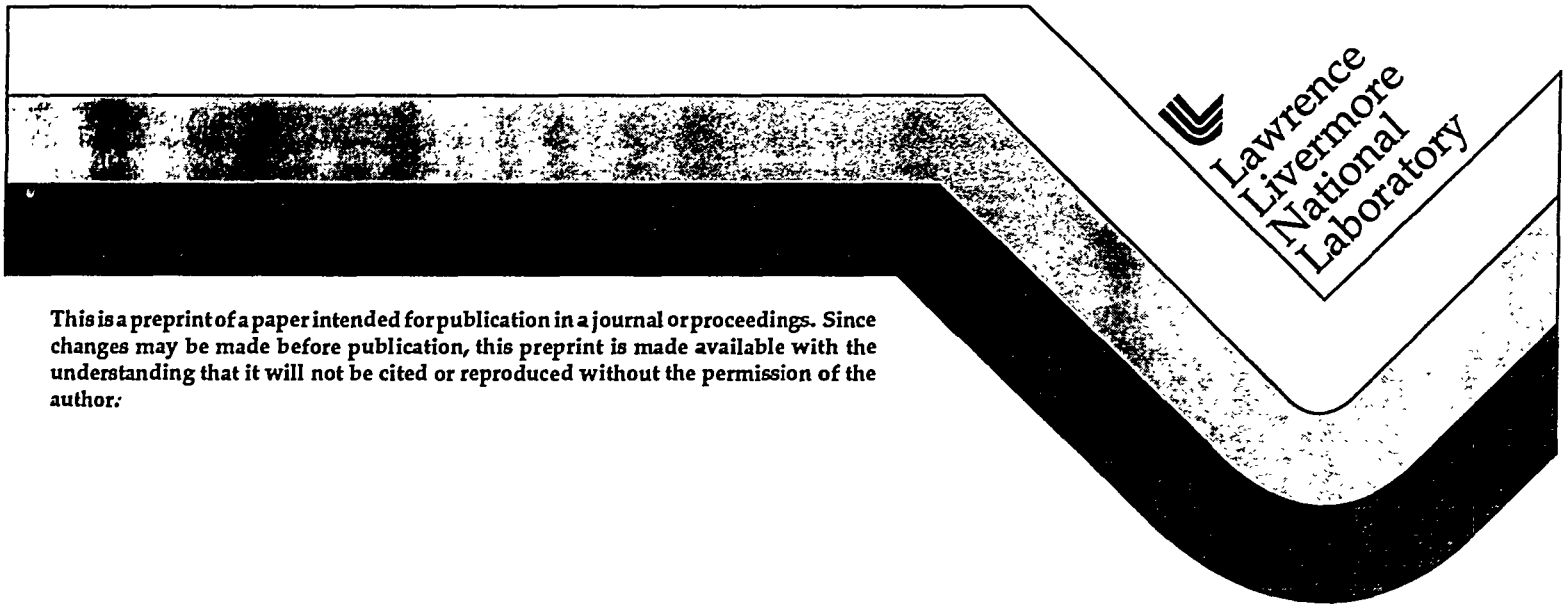
This paper was prepared for submittal to the
37th Annual Meeting of the Institute of Nuclear Materials Management
Naples, Florida
July 28 - August 1, 1996

July 24, 1996



U.S./Russian Lab-to-Lab Materials Protection, Control and Accounting Program Efforts at the Institute of Inorganic Materials*

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ABSTRACT

The All-Russian Scientific Research Institute of Inorganic Materials (VNIINM) performs research in nuclear power reactor fuel, spent fuel reprocessing and waste management, materials science of fissionable and reactor structural materials, metallurgy, superconducting materials, and analytical sciences. VNIINM supports the Ministry of Atomic Energy of the Russian Federation (MINATOM) in technologies for fabrication and processing of nuclear fuel. As a participant in the U.S./Russian Lab-to-Lab nuclear materials protection, control and accounting (MPC&A) program, VNIINM is providing support for measurements of nuclear materials in bulk forms by developing specifications, test and evaluation, certification, and implementation of measurement methods for such materials. In 1996, VNIINM will be working with Brookhaven staff in developing and documenting material control and accounting requirements for nuclear materials in bulk form, Livermore and Los Alamos staff in testing and evaluating gamma-ray spectrometry methods for bulk materials, Los Alamos staff in test and evaluation of neutron-coincidence counting techniques, Oak Ridge staff in accounting of bulk materials with process instrumentation, and Pacific Northwest staff on automating VNIINM's coulometric titration system. In addition, VNIINM will develop a computerized accounting system for nuclear material within VNIINM and their storage facility. Our paper will describe the status of this work and anticipated progress in 1996.

INTRODUCTION

The Institute was founded in 1945 to solve problems relevant to nuclear weapons in the area of materials science and technology. The Institute was initially called the "Institute of Special Metals". For over thirty years the Institute was headed by Academician A.A. Bochvar, the founder of Russia's school of materials science and nuclear technology. In 1993, the Institute was renamed as A.A. Bochvar's All-Russian Scientific Research Institute of Inorganic Materials (VNIINM). In 1994, the status of the State Research Center of Russia was given to the Institute.

Since its beginning, VNIINM has been providing scientific and technological support in the production of fissionable and radioactive materials and in the processes of manufacturing nuclear weapons from these materials. VNIINM developed along with the "Mayak" enterprise the plutonium separation technology at the Mayak processing facilities. Along with its work in nuclear weapons, VNIINM is Russia's lead materials science and technology institute in the development of fuel and construction materials for nuclear power systems. VNIINM began work in 1953 on the development of stainless steels with improved radiation

and corrosion resistance for nuclear fuel rods. In 1966, VNIINM embarked on the development of fuel rods for the safe handling of radioactive wastes. VNIINM in collaboration with the "Mayak" enterprise and other enterprises has developed and successfully implemented new technology for the vitrification of liquid high-activity wastes

Today, VNIINM faces new and complex problems related to the significant reductions in military arsenal and nuclear weapons. Now VNIINM's work in materials science and technology is on safe dismantlement, storage, cleanup, and utilization of the fissionable and other weapons materials. Solutions to these problems require fundamentally new approaches and the creation of new technologies that address efficiency, reliability, safety and environmental concerns. Some of VNIINM's current efforts are: significant reduction in the volume of liquid radioactive wastes in plutonium separation process, new approaches and instrumentation for the plutonium separation process, development of an environmentally acceptable technology for production of mixed uranium-plutonium fuel, radioactive waste management, environmental restoration of chemical and radioactive contaminated areas, and development of a tritium cycle for fusion reactors. VNIINM has a strong analytical capability with not only the traditional "wet" chemistry and mass spectrometry, but it also includes atomic emission and absorption spectroscopy, coulometry, IR spectrometry, nuclear magnetic resonance, alpha- and gamma-ray spectrometry, neutron and charged-particle activation analysis, liquid and gas chromotography, and x-ray fluorescence analysis. With this capability VNIINM provides the Russian Ministry of Atomic Energy (MINATOM) with the measurement of bulk nuclear materials and metrology for MC&A. In addition, VNIINM's experience in plutonium processing and nuclear fuel fabrication make it well qualified to support the enhancement of MPC&A in Russia. Several of the U.S. laboratories in the MPC&A program have tasks with VNIINM to 1) develop and document requirements for measurements of fissile materials in bulk forms, 2) introduce U.S. equipment for measurement of fissile materials in bulk forms on a trial basis at MINATOM, and 3) test and evaluate an automated coulometry unit developed by VNIINM for measurements of plutonium and highly-enriched uranium concentrations. The following sections of this paper provide details on these tasks.

Description of Current MPC&A Tasks

The Brookhaven National Laboratory (BNL) has a task with VNIINM to develop and document the material control and accounting requirements for measurements of fissile materials in bulk form. This task developed from a proposal by VNIINM to provide MINATOM facilities with information on methods available throughout the world for measurement of fissile materials in bulk form. The requirements document from this task will specify measurement methods for all materials of interest and the required accuracy and precision of both destructive and nondestructive measurements.

The workshop was conducted under the contract between BNL and VNIINM as an activity of the first task order, "Development and Documentation of MC&A Requirements for Measurements of Fissile Materials in Bulk Form." As specified in the task order, the objective of the workshop was to present and discuss MC&A requirements for fissile material in bulk form. The workshop was coordinated by BNL in the U.S. and by VNIINM in Russia. The workshop consisted of two parts, the first at Oak Ridge National Laboratory (ORNL) July 10-12, 1996, and the second at the Idaho Chemical Processing Plant (ICPP) July 15-17, 1996. The focus of the workshop was not on measurements per se, but on addressing questions such as the following:

- What kind of measurements for MC&A need to be made and where?
- How many measurements need to be made?
- How accurate do the measurements need to be?
- How can the measurement uncertainty be determined and used to evaluate material balance data?

There were eleven Russian participants at the workshop, representing VNIINM, the Mayak Production Association, the Novosibirsk Chemical Plant, the Chepetsky Mechanical Plant, the Institute of Physics and Power Engineering, the Siberian Group of Chemical Enterprises ("Tomsk"), Mining and Chemical Combine ("Krasnoyarsk-26"), and VNIIA ("Institute of Automatics"). Activities at the workshop included presentations by both U.S. and Russian participants and follow-on discussions, a tour of a shut-down pilot-scale experimental reprocessing facility at ORNL, tours of the process line and analytical laboratory at ICPP, and a demonstration of bubbler-probe volume measurement equipment on the process line at ICPP. The Russian participants expressed considerable interest in the MC&A system at ICPP, especially in the bubbler-probe manometry system and in the integration of process, measurement, analytical laboratory, and safeguards computer systems. The Russian participants also showed significant interest in the fact that state-of-the-art computerized measurement systems can and have been installed in an existing 1950's-vintage reprocessing plant, namely, ICPP. At the end of the workshop, the U.S. and Russian participants agreed on the following 5-point preliminary

statement of conclusions regarding measurement requirements:

1. Each facility dealing with fissile materials should maintain a current material balance based on measurement data.
2. Each facility should periodically carry out a physical inventory and assess the results of the physical inventory. The frequency and quality of inventory measurements should take into account in particular the type of facility and materials involved.
3. All values used for computation of inventory difference should be based on measured values. If measurement is not possible, values should be based on the most reliable possible estimates.
4. Inventory difference should be evaluated by comparison with the limit of error on inventory difference (LEID). LEID should be computed by statistical propagation of uncertainties in measurements or estimates.
5. Taking into consideration cost and practicality, every effort should be made to minimize measurement uncertainty.

VNIINM will prepare a full report on the workshop. This report, one of the deliverables under this task, will summarize the presentations and discussions and present all relevant conclusions.

The Lawrence Livermore National Laboratory (LLNL) has a task with VNIINM, which was originally proposed by VNIINM, to test and evaluate gamma-ray isotopic measurement methods developed by LLNL and Canberra. The gamma-ray analysis methods incorporated in MGA and MGAU will be tested under laboratory conditions on samples of uranium and plutonium. VNIINM will provide demonstrations of U.S. gamma-ray isotopic measurement and data-analysis methods to interested Russian colleagues. VNIINM will report on comments and feedback obtained during this demonstration. VNIINM will also report on the results of their test and evaluation of the U.S. methods on selected uranium and plutonium materials.

LLNL has provided VNIINM with a multichannel analyzer, a high-resolution, planar germanium detector, an IBM-compatible PC for instrument control and data-analysis, and appropriate instrument control and data-analysis software. In July, four VNIINM staff members participated in a workshop/training session on the use of this hardware and the MGA and MGAU data-analysis software.

The Pacific Northwest National Laboratory (PNNL) has a task with VNIINM to automate a coulometric titration system for analysis of mixtures of plutonium and uranium. Several methods were reviewed and VNIINM has selected one for automation. VNIINM has written a description of the chosen method and prepared a list of equipment to automate it. PNNL has ordered the equipment. VNIINM will develop procedures and test the automated process.

The Los Alamos National Laboratory (LANL) has four tasks with VNIINM; three of which involve the application of neutron coincidence counting and high-resolution gamma-ray spectrometry to the measurement of total uranium and plutonium in bulk materials. The objective of one LANL task is to determine the utility of neutron coincidence counting for MPC&A use in Russian institutes and facilities with bulk materials. This task will evaluate the ability of U.S. neutron coincidence counting (NCC) to meet measurement and operating requirements. The other two LANL tasks will address the combination of neutron coincidence counting (active-well (AWCC) for uranium and passive for plutonium) with high-resolution gamma-ray spectrometry (HRGS) for isotopic information to determine total uranium and plutonium content in bulk material. Each of these tasks will hold concurrent workshops/training sessions for personnel of facilities that handle bulk material in the use of NCC and HRGS.

The fourth LANL task is to develop and implement a computerized MC&A system for accounting of nuclear materials in VNIINM and its storage facility. Processing work with nuclear materials in various forms: metals, dioxides, salts, and solutions occur in several buildings at VNIINM. The objective of this task is to create a computerized system for timely information on the location and the quantitative and qualitative characteristics of this nuclear material at VNIINM. The first stage of this task includes the development of requirements for a computerized MC&A system at VNIINM. The subsequent stages of this task are to develop, implement, and demonstrate a computerized MC&A system at VNIINM.

Future Work

LLNL has initiated discussions with VNIINM on enhancements to the physical protection systems at VNIINM's storage facility. If needed, the U.S. laboratories would provide support for enhancements of entry and exit control, physical barriers, intrusion detection, and video assessment measures. ORNL is discussing with VNIINM a possible task in demonstrating the use of process control instrumentation in an operating Russian enterprise for accounting of bulk materials. LANL is planning a task to have VNIINM develop uranium and plutonium standards for both destructive and nondestructive measurements. These standards would be used by the

verification of their instruments and techniques.

As follow up to the bulk materials measurements workshop, BNL is planning a task to develop and demonstrate at VNIINM rapid physical inventory procedures and confirmatory measurements for bulk materials. The first part of this task will involve counting, identification (e.g. use of bar codes), and tamper-indication device checking of containerized bulk materials. In the second part of this task, VNIINM will determine the requirements and goals of a rapid inventory for bulk materials in process flows and tanks. ORNL will work with VNIINM for implementation of process measurement equipment for inventory measurements of bulk materials in processing plants.

Conclusions

With over fifty years of experience in the development of processes for bulk fissile materials, VNIINM is well qualified to support the MPC&A activities at those Russian institutes and enterprises processing and handling bulk fissile materials. We envision VNIINM participating in the U.S./Russia MPC&A programs by providing support for measurement of fissile materials in process and bulk forms. This support will be in developing specifications, test and evaluation, certification, and implementation of measurement methods for such materials. There are now contracts in place with VNIINM to 1) develop and document requirements for measurements of fissile materials in bulk form, 2) introduce U.S. equipment for measurement of bulk fissile materials on a trial basis at MINATOM operating facilities, and 3) automation of a VNIINM developed coulometry unit for Pu and HEU concentration measurements. Once the requirements for methods for measuring fissile materials are completed, then further work will be developed with VNIINM to test and evaluate U.S. and Russian hardware and procedures for measuring fissile materials in process and bulk form. This would be followed by installation with VNIINM support of proven equipment at operating Russian enterprises.

*Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48. Work supported by DOE's Office of Arms Control and Nonproliferation, NN-40.