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Title: SAFEGUARDING NUCLEAR MATERIALS IN THE FORMER SOVIET REPUBLICS THROUGH COMPUTERIZED MATERIALS PROTECTION, CONTROL & ACCOUNTABILITY

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SAFEGUARDING NUCLEAR MATERIALS IN THE FORMER SOVIET REPUBLICS THROUGH COMPUTERIZED MATERIALS PROTECTION, CONTROL & ACCOUNTABILITY

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Abstract

The threat of nuclear weapons proliferation is a problem of global concern. International efforts at nonproliferation focus on preventing acquisition of weapons-grade nuclear materials by unauthorized states, organizations, or individuals. Nonproliferation can best be accomplished through international cooperation in the application of advanced science and technology to the management and control of nuclear materials. Computerized systems for nuclear material protection, control, and accountability (MPC&A) are a vital component of integrated nuclear safeguards programs. This paper describes the progress of scientists in the United States and former Soviet Republics in creating customized, computerized MPC&A systems. We discuss implementation of the Core Material Accountability System (CoreMAS), which was developed at Los Alamos National Laboratory by the US Department of Energy and incorporates, in condensed and integrated form, the most valuable experience gained by US nuclear enterprises in accounting for and controlling nuclear materials. The CoreMAS approach and corresponding software package have been made available to sites internationally. CoreMAS provides methods to evaluate their existing systems and to examine advantages and disadvantages of customizing CoreMAS or improving their own existing systems. The sites can also address crucial issues of software assurance, data security, and system performance; compare operational experiences at sites with functioning computerized systems; and reasonably evaluate future efforts.

The goal of the CoreMAS project is to introduce facilities at sites all over the world to modern international MPC&A practices and to help them implement effective, modern, computerized MPC&A systems to account for their nuclear materials, and thus reduce the likelihood of theft or diversion. Sites are assisted with MPC&A concepts and the implementation of an effective computerized MPC&A system.

Introduction

Los Alamos provides:

- training of site staff on computerized accountability methods and relevant software tools;
- hardware for a computer network;
- CoreMAS software—a complete, working example of accountability software;
- sample documentation in Russian including requirements specifications, design descriptions, and test plans;
- training in software planning, design, and development;
- consulting; and

- software upgrades;
- but no maintenance.

MPC&A in Russia

As a nuclear-weapon state, the USSR was exempt from obligations that were mandatory for non-nuclear weapon states. MPC&A systems that existed in the USSR were based on principles that are different from those in material balance areas (MBA) at safeguarded facilities and enterprises. All non-nuclear weapon states party to the NonProliferation Treaty have had to incorporate material balance principles into their State's Systems for Accounting and Control of nuclear materials (SSAC). Similar principles were used in designing SSACs in some nuclear-weapon states, e.g., the United States, Great Britain, and France.

The main feature of MPC&A systems developed in the USSR and still used in the Russian Federation is that they are based on financial bookkeeping accounting and ignore the principles of measured material balances. Financial accounting is concerned with the technical and economic metrics of an enterprise, whether it is a manufacturing plant for products containing nuclear material or radioactive substances, a nuclear power plant, a research reactor, or an irradiated-fuel reprocessing plant. Data such as the mass of the nuclear material and its enrichment level are secondary to the financial accounting. However, the physical properties of material (for example, chemical composition, mass of heavy metal, and enrichment) can be derived only through direct or indirect measurements or by calculation. All measurement methods and instruments, including calculations, are subject to measurement error. Some measurements, for example, measurements of irradiated material or material contained in the technological production waste, may be very difficult and subject to significant measurement errors. The financial-based control and accounting system rules out any notion of measurement error. Measurement errors are considered only from the viewpoint of meeting requirements based on specifications of feed material, by-products, and final products.

Manufacturers in Russia provide Product Passports with their products, which declare the nuclear material data for the product. As a rule these passport data do not evaluate relevant measurement errors or confidence intervals of errors associated with the data. It is assumed that products containing nuclear material are manufactured in accordance with the corresponding technical specifications and the true content and composition of the nuclear material is within the range prescribed by those technical specifications. Thus, nuclear material accounting by facilities using these products is based on the passport data provided by the manufacturer. This accounting based on passport data can be applied to itemized products containing sealed nuclear material, e.g., fuel rods or fuel assemblies for reactors or parts of nuclear weapons, which can be accounted for and controlled by means of manufacturer's tags and seals (item accounting and identification). However, nuclear material in other forms (for example, tablets, powder, small non-identifiable rods or spheres, and liquid material—in bulk and semi-bulk form) in general cannot be accounted for and controlled by item accounting and identification and need measurement practices, which are incompatible with the principles of financial accounting. The material accounting system that was based on the principles of financial accounting does not take into account shipper-receiver differences, material unaccounted for, or re-evaluation of accounting data due to new measurements performed at the facility site.

Enhancing MPC&A in the Former Soviet Republics

In accordance with the State Law on the use of atomic energy in Russia in force since 1995, the principle of measured material balances must be introduced into the practice of nuclear material accounting, control and management in Russia. Thus, in a relatively short period of time, the present concept of nuclear material accounting must be radically changed. Based on recent research, the total number

of MBAs that must be established in the nuclear industry of Russia, including R&D facilities and institutes, is estimated to be about 350, depending on how MBAs are defined. About 150 of these are MBAs where nuclear material is present in bulk and semi-bulk form.

A key component of any program to enhance MPC&A systems in Russia and other republics of the Former Soviet Union (FSU) must be the introduction or improvement of computerized material control and accountability systems for facilities that manage nuclear materials. Such systems should be based on the most advanced computer technologies and introduce the principle of a measured material balance into the practice of nuclear material accounting. It is an enormous endeavor to achieve this goal in a timely manner considering the stock of materials accumulated over decades and located at hundreds of facilities. It has to be mentioned that there are still no Russian state regulations concerning the implementation of nuclear material control & accounting, initial physical inventory taking, verification of a real nuclear material inventory, or reporting requirements.

Taking these circumstances into consideration, it is hard to overestimate the importance of international cooperation in this field. CoreMAS, which was developed by the US Department of Energy, is intended to contribute to the promotion of modern computerized accountability technologies in the FSU. FSU specialists have an opportunity to learn from material accounting technologies that are based on the principle of measured material balance and that, in a very condensed and integrated form, are incorporated into the CoreMAS design. The CoreMAS approach, documentation, and corresponding demonstration software package enable sites to evaluate existing systems and examine the advantages of customizing CoreMAS or improving existing systems.

Useful Features of CoreMAS

The following features incorporated into the CoreMAS design are intended to contribute to understanding the modern computerized accountability approach:

1. near-real time accounting based on implementation of networked client-server architecture;
2. utilization of commercially available software products to support a secure environment for confidential nuclear material;
3. incorporation of a Measurement Control Program as a vital part of any material accounting system;
4. hierarchical structuring of material locations;
5. containerization and decontainerization with hierarchical structuring of container content;
6. unique identification of accountable items at the facility level; and
7. MBAs and sub-MBAs and their correspondence to the facility locations.

The distribution of the CoreMAS software presents a unique opportunity to educate and train those responsible for developing computerized MPC&A systems that implement the principle of measured material balances.

Russification of CoreMAS

On the other hand, there are some difficulties in customizing CoreMAS for Russian language facilities. The most important one, mentioned above, is the current lack of State regulations related to practical implementation of the law on the use of atomic energy in Russia. These regulations are under development. The most crucial issues relating to customization of the reporting modules of CoreMAS involve determining the following:

1. the list of materials to be accounted for and reported to State accounting systems;
2. a definition of accounting and reporting units such as nuclear material batch and item;
3. coded descriptions of material forms (for example, physical, chemical, package, status, and use);
4. a definition of accounting procedures to be reported to the State Supervisory bodies (such as the so-called re-batching procedure, blending of nuclear materials with different enrichments and/or elements, shipper-receiver differences, material unaccounted for, or inventory differences);
5. content and format of accounting reports; and
6. standards for statistical evaluation of accounting and measurement discrepancies.

Among the key difficulties related to CoreMAS customization for Russian facilities, at least three must be specifically mentioned:

1. There is a problem of a facility with multiple, overlapping MBA structures. This is due to the expectation of providing accounting reports to more than one body:
   - The State MPC&A system,
   - The Ministry's branch,
   - MPC&A,
   - The Russian State Supervisory Agencies (such as Gosatomnadzor),
   - The International Atomic Energy Agency in case of implementation of International Safeguards, and
   - An Inter-Governmental Body in the case of Bilateral Safeguards.

   Even if formats of these reports would be standardized, there is a need to establish and maintain a number of MBA structures, each of which may require different accounting and reporting procedures in relation to the same physical event.
2. Almost half of the MBAs in Russia are to be established for nuclear facilities dealing with nuclear materials primarily in a bulk or semi-bulk form. Computerized accounting systems for such facilities must incorporate statistical evaluation packages capable of dealing with quite large experimental errors.
3. Due to the confidential nature of nuclear material data, the security of any computerized material accounting system handling such data must be certified by the Russian State. This is difficult to achieve because it is necessary to evaluate the source code of all software components and incorporate security checks and procedures prescribed by State regulations (depending upon the level of secrecy for treated information) into the system design.

Conclusions

The CoreMAS team at Los Alamos National Laboratory collaborates with sites to create MPC&A systems that meet their needs, assisting sites without imposing solutions. At present we are collaborating with over 20 sites. Some sites are using our toolset, some are using our database design, all are writing their own code. Future enhancements to the CoreMAS software include input from bar code scanners, statistical packages, report modules for the evolving Russian state reporting requirements, and report modules for IAEA reports. Future enhancements to the CoreMAS project include a new software system called E/Z MAS, which is intended for small to moderate facilities with modest MPC&A needs. It will have limited functionality and will be easy to install, enhance, and run. It uses the Microsoft Access database management system and will have an HTML interface, providing an intranet system.

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