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COMPUTERIZED MATERIALS PROTECTION, CONTROL, AND ACCOUNTABILITY AT THE INSTITUTE OF PHYSICS AND POWER ENGINEERING

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Abstract

As part of a multifaceted approach to protecting its nuclear materials, The Institute of Physics and Power Engineering (IPPE) at Obninsk, Russia, has been computerizing its materials protection, control, and accountability capabilities. This is being accomplished in collaboration with the CoreMAS team at Los Alamos National Laboratory. Such international cooperation in applying advanced science and technology to managing and controlling nuclear materials will help reduce the threat of nuclear weapons proliferation by preventing acquisition of weapons-grade nuclear materials by unauthorized individuals, organizations, or states. One important characteristic of IPPE is that it encompasses several facilities that manage nuclear materials, and three of these facilities already operate their own independent (or independently developed) computerized accounting systems. This paper focuses on the importance of compatibility between the computerized accountability systems at the facilities, the ability of the individual systems to communicate with a single site-wide system, and the necessity of coordination between facilities in designing and developing computerized systems. We believe that the lessons learned at IPPE in coordinating these efforts have wide-ranging significance for other sites with multiple facilities.

Unique Characteristics of IPPE

The Institute of Physics and Power Engineering (IPPE) is a scientific research and development laboratory in Obninsk, Russia. IPPE research and development focuses on nuclear power engineering, fundamental and applied investigations, and nuclear technologies for the national economy. Within IPPE, there are several major facilities with highly enriched uranium and plutonium. As delineated in the on-going program of nuclear material consolidation, there will be about 17 material balance areas (MBAs) that use a single accounting system with common requirements and unified procedures.

Most of the MBAs of IPPE use nuclear material in item form. Those include research reactors, critical facilities, accelerators, and other research facilities. The total number of nuclear materials items on the IPPE site is about 200,000. In addition, nuclear material in bulk form is handled in some MBAs where nuclear materials processing or reprocessing of irradiated fuel is carried out.

At the initial stage of development of the computerized materials protection, control, and accountability (MPC&A) system, the final structure of MBAs that was to result from the nuclear materials consolidation program still had not been determined. So the creation of the computerized accounting system started not from the site-wide level but from the level of separate facilities [the Fast Physics

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Facility (BFS), the Central Storage Facility (CFS) for nuclear materials, and the Technological Laboratory for Fuel Fabrication (TLFF)]. Each of these MBAs has unique features:

- The BFS is a multiitem facility, where the major technological processes require periodical movements of large numbers of nuclear materials items (tens of thousand) within the MBA. No characteristics of nuclear materials items are changed.
- In CSF nuclear materials are stored both in the item form and in the bulk form. Movements within the CSF MBA are rare, but shipments to other MBAs and receipts of materials from other MBAs are frequent. No characteristics of nuclear materials items are changed.
- The TLFF processes nuclear materials, thereby changing their characteristics. However, the amount of nuclear materials in this MBA is not very large.

Each facility has its own development team, which developed an isolated, computerized accounting system covering only its own single MBA. Unfortunately, the development of these local computerized accounting systems was not coordinated, and, as a result, different concepts were used for locations, materials, and containerization. The database management systems (DBMS) and the database designs were different. None of the resulting isolated local computerized accounting systems was universal enough to be used everywhere, and there was no communication among the three systems. In addition, even though most IPPE nuclear materials are located at the above three facilities, there was a significant amount of materials outside of these three local computerized accounting systems. In order to enable communication between the systems, IPPE initiated the task on the Integrated Material Accounting System (IMAS).

The Role of a Site-Wide System at a Site with Multiple Facilities

A network-based site-wide system can ensure integration of isolated computerized accounting systems into a single system and can provide communication and reporting to a higher-level system. This system should provide timely and reliable information about amounts of nuclear materials in authorized locations at any facility at the site. Several MPC&A functions should be provided:

- tracking of nuclear material movements between the facilities within the site;
- material balance closure both on the facility level and on the site-wide level;
- inquiries about status, description, and history of any nuclear material within the site;
- reporting to a higher level [to a Federal Information System (FIS), etc.]; and
- communications to other sites (possibly, through the FIS) concerning external shipments and receipts.

To achieve these functions, compatibility between local systems and their ability to communicate with a site-wide system are essential. Local facility-level systems can effectively communicate with each other if they

- use the same database design and database management systems;
- use the same concepts of locations, accounts, nuclear material items, containerization, nuclear material control, etc.;
- use the same approach for identifying nuclear materials, containers, locations, tamper indicating devices (TIDs), etc.;

- use the same procedures for shipment and receipt of nuclear material;
- ensure the same level of data security for materials moved from one facility to another;
- carry out physical inventory taking (PIT) based on the same philosophy;
- use the same approach for redoing PIT results and material balance closure; and
- use common codes of nuclear materials as prescribed by the higher-level information system.

Collaborations Between Facilities

After the decision had been made to integrate the facility-level computerized accounting systems into a single system, a new team was established that was responsible for developing the site-wide system, coordinating the design and development of the systems, and harmonizing activities carried out by the different facility groups.

It was agreed that the local area networks at the facilities would be kept as they were and connected to the site-wide computers. The databases of the facilities will continue to reside on their local servers, but the site-wide system will have its own server with a database for the additional 13 MBAs not covered by the existing computerized accounting systems. Thus, the four servers will maintain all information about nuclear materials at IPPE.

The next step was to modify the facility-level systems to implement a common database management system and to ensure effective communication to the site-wide system. As a result of discussions with the US-CoreMAS team, Microsoft Windows NT operating system, Microsoft SQL Server DBMS, and Visual Basic for user application development were chosen as a development platform. It was also agreed that, in accordance with the Windows NT approach, there would be four nuclear materials accounting domains in the IMAS, which would cover all 17 MBAs. These domains of IMAS are the Central domain, Central Storage Facility domain, BFS domain, and TLFF domain. The Central domain will be a master domain, and its primary controller will also control other domains through trusting relationships. Each of the other four domains will trust to the master domain.

Discussions of development of common concepts of locations, accounts, nuclear material items, containerization, and nuclear material control were carried out at joint meetings of the facility groups. Harmonizing the concepts was one of most difficult tasks because (1) the concepts influenced the basic algorithms of facility accounting systems and (2) this was done at the very beginning of joint development work when a sufficient level of mutual understanding had not yet been achieved.

Another difficult task was to reach agreement on procedures that should be used at all facilities for shipment and receipt of nuclear material, procedures of measurement of nuclear materials characteristics, and measurement control procedures. All these are to be implemented as functions of the computerized accounting systems. However, because the nuclear material measurement systems are not yet completed at the IPPE facilities, it was agreed that only those parts of the above procedures that are clear now should be implemented at the first stage.

After agreement had been achieved on the major concepts of accounting systems, a common database design was necessary. The most appropriate way was to accomplish a common design by developing the database core, including those entities that are obligatory for all facilities. The database core would be developed by the site-wide team and would be agreed to by all facility teams. In addition to the

obligatory entities, each facility team was free to include in the database the entities necessary to incorporate specific features of the facility. No problems occurred at any of the facilities in implementing the common system for identifying nuclear materials, containers, locations, or TIDs or in implementing the common approach for data security.

It was also agreed that there would be a core of functions required by all facilities and that individual facilities would add any functions specific to their needs. It was recommended that all developers use similar user interfaces and similar color schemes for common functions.

Current Status of Computerized Accounting at IPPE Facilities

At present, the collaboration between the facilities has been established and can be considered a fruitful one. All facility-level groups of developers use the same database core design, the same concepts of accounting system objects, the same database management system, etc. Thus, computerized accounting at the IPPE is being reconstructed as a united whole in accordance with a system approach in which it is assumed that the design of any system is an integral one.

The new version of the computerized accounting system at the BFS facility is almost complete and is aimed at operating as a constituent of the integrated IPPE system. It should be noted, however, that the BFS system cannot yet be considered a part of the integrated system because its connection with the site-wide server has not yet been installed. Nevertheless, the system is used to meet the requirements of the facility. Those include tracking nuclear material items, containers, and TIDs within the BFS MBA; inquiries concerning nuclear materials, containers, locations, TIDs, and history; support for regular physical inventory taking; expansion of the database for BFS nuclear materials; shipment of nuclear materials to TLFF and receipt of nuclear materials from TLFF (without communication to the TLFF server through the network, the information is temporarily transferred on diskettes); and administration of data access in the BFS computerized accounting system. Information about more than 50,000 items has been entered and is maintained in the database of the BFS system.

At the Central Storage Facility, the new version of the computerized accounting system is in an advanced stage of development with more than 50% of functions available for operation. Computerized accounting development at the IPPE is under pressure from other MPC&A tasks that need the support of computerized accounting immediately. For this reason, the software development in the Central Storage Facility was divided into two stages. At the first stage, those functions were implemented that were necessary for regular physical inventory taking; expansion of the database for CSF nuclear materials; tracking nuclear materials, containers, and TIDs within the CSF MBA; and automated data collection. Other functions are expected to be implemented by October 1998. On the other hand, the CSF server has been connected to the site-wide server; thus, the CSF system is better integrating the IPPE site-wide system than is the BFS system. Information about more than 11,000 nuclear material items has been entered and is maintained in the database of the CSF system.

At the TFLL, urgent need resulted in early development of those functions that provide automated data collection and information processing during shipment of nuclear materials to and from BFS (here, too, without communication to the BFS server through the network, the information is temporarily transferred on diskettes). Other functions are expected to be implemented by November 1998.

As a part of the site-wide-level system, the primary domain controller, the dedicated server, and one client have been installed in the Central domain. Communication to the CSF domain is provided through a fiber optics cable. Data from the 13 MBAs are in the Central domain database, which uses the core database design agreed upon for the integrated system. Information about more than 5000 nuclear material items has been entered in the database.

The software development for the site-wide system was divided into three stages. At the first stage, the software was developed and implemented, which provided functions requiring the interface of the site-wide server with servers of other domains (the interface with the CSF server was implemented). These functions included tracking nuclear material movements within the IPPE site; support for standard queries about nuclear material characteristics, locations, and containers; support of standard queries about nuclear material control measures (TID tracking support, etc.); and resolution of shipper-receiver differences during nuclear materials movements between MBAs. The second stage assumes development of software and procedures for control data entry, data access, data back-up, and data security, which should be completed by September 1998. The third stage, including generation of standard reports, should be completed by October 1998.

One important feature of the site-wide-level system is providing communication to the FIS. The IPPE participates as a pilot site in the development of FIS. Procedures have been developed for generating reports in the format prescribed by FIS, encrypting these reports, and sending them to FIS through the Internet. This software has also been installed on the server of the Central domain.

In order to complete the development of the IPPE integrated computerized accounting system, it is necessary to install the local area network, which will provide communication between the facility-level systems and the site-wide system. It is expected now that the network can be installed late this year. The major task for the next year will be to start operation of the integrated system, including the system management and maintenance procedures for interaction of the facilities of different departments of the institute with the site-wide level, as well as to accumulate the operating experience necessary for further improvements of the system.

Collaborations with the US–CoreMAS: a Sample System

The CoreMAS project at Los Alamos National Laboratory (LANL) was established to assist sites around the world in implementing computerized accounting systems to account for their nuclear materials, thus reducing the likelihood of theft or diversion. This ongoing collaboration has involved over 25 facilities in 7 countries, and the exchange of information and experiences has benefited all involved. The main thrust of this effort has been to establish a forum for exchanging ideas and sharing resources. The collaboration between the CoreMAS team and the IPPE computerized accounting teams began over three years ago, and the result has been the four systems described in this paper. Assistance available to nuclear facilities includes computer hardware, commercial software, working examples of LANL-developed accountability software, training for site teams, sample documentation, consulting, and advice. The goal of the collaboration is for sites to achieve MPC&A systems that meet their needs, so the sites work with LANL in a partnership. These partnerships have involved interactions with sites that have no computerized accounting system and with sites such as IPPE that have MPC&A systems in place.

Conclusions

A lack of coordination of activities of several groups at the initial stage of development resulted in the implementation of local systems at the facility level that did not fit together. As a result, significant effort and time were required to establish mutual understanding and cooperation of different groups and to agree upon, develop, and accept a common basis for correcting and improving the facility-level systems.

This experience confirmed the necessity of a system approach for developing computerized accounting systems at sites with multiple facilities. A site should be considered as a united whole, and common concepts and a common approach should be established at the very beginning of system development, before facility-level system development starts.