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Author(s): Bruce H. Erkkila
Joe Claborn

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MODERNIZING COMPUTERIZED NUCLEAR MATERIAL ACCOUNTING SYSTEMS*

Bruce H. Erkkila and Joe Claborn
Safeguards Systems Group
Los Alamos National Laboratory
Los Alamos, New Mexico 87545 USA

ABSTRACT

DOE Orders and draft orders for nuclear material control and accountability address a complete material control and accountability (MC&A) program for all DOE contractors processing, using, or storing nuclear materials. A critical element of an MC&A program is the accounting system used to track and record all inventories of nuclear material and movements of materials in those inventories. Most DOE facilities use computerized accounting systems to facilitate the task of accounting for all their inventory of nuclear materials. Many facilities still use a mixture of a manual paper system with a computerized system. Also, facilities may use multiple systems to support information needed for MC&A. For real-time accounting it is desirable to implement a single integrated data base management system for a variety of users. In addition to accountability needs, waste management, material management, and production operations must be supported. Information in these systems can also support criticality safety and other safety issues. Modern networked microcomputers provide extensive processing and reporting capabilities that single mainframe computer systems struggle with. This paper describes an approach being developed at Los Alamos to address these problems.

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INTRODUCTION

The history of nuclear material accounting began with the first inventories of nuclear material in the 1940s. Early accounting systems consisted of manual entries in journals and index cards. Today we have advanced to sophisticated computerized systems that provide timely access to data and generate comprehensive reports. Computers are an important tool for nuclear material management and accounting. By accurately accounting for the location, type, and quantity of materials, large inventories of nuclear material can be managed and safeguarded effectively. Computerized accounting systems contain data other than just locations and quantities. Information such as assay measurement methods and equipment, measurement control data, container details, and item characteristics and history can be valuable information for the management of nuclear material inventories. Such data can make possible detailed audit trails, statistical analysis of inventory differences, and analysis of measurement instrument performance.

Existing material accounting systems can be classified into three categories:

(1) **Mainframe-class computer systems:** As these computers age, they become expensive to maintain. Many of the software developers who implemented these systems have gone on to other projects and are not available for

software enhancements. In these systems, data is cumbersome to enter and more difficult to retrieve.

(2) **Manual systems:** These are paper systems in which it is also difficult to input and retrieve data. Manual systems become very ineffective for large inventories of material.

(3) **Stand-alone personal computer systems:** Sometimes a word processor or spreadsheet is used. Sometimes a desktop database system is used. While easier to use, these systems lack the data accessibility needed in today's nuclear material management environment. These systems rarely provide an auditable data history.

The availability of low-cost networked personal computers and database servers makes it possible to create material accounting systems that are easy to learn, easy to use, and cost-effective to implement. Maintaining the data in a relational database allows data to be viewed in ways that were previously very difficult. These systems, when properly implemented, provide a full audit trail of material transactions.

TYPES OF SYSTEMS

Manual Paper System

Description. A simple accounting system can use index cards and log books. An index card could be used as a ledger card in the traditional accounting sense. Each index card would contain information relating to one item in the material inventory.

Each time the item is moved, an entry is made on the card and in the log book. Other information such as the nuclear material amount, type, confirmation measurements, and date last decayed could also be kept on the card. When the index card is filled, it is filed and a new card is started. The log book (a journal of transactions) can be maintained by an individual who is responsible for fulfilling the reporting requirements.

Advantages. The advantages of such a system are few. It is simple to understand and to implement. With very little investment, material items can be tracked. The paper system can also be augmented to keep track of other information as needed.

Disadvantages. The disadvantages of such a system are numerous. A paper system is hard to maintain. The records for a paper system can be misplaced and even lost. Data maintained on paper is subject to unauthorized alteration and access. Data retrieval is slow and awkward. The index cards and log book are difficult to synchronize. Trying to generate material balance reports are labor intensive and difficult. Reconciling book inventory to physical inventory is very difficult due to the potential for numerous transcription and recording errors. The reconciliation is made more difficult by the lack of information about the transactions. The more information retained about the materials, the more difficult the system is to use.

Computerized Batch System

Description. In the 1950s the index cards were replaced with 80-column punched cards and the log book was replaced with files of information on a computer tape or disk. All material transactions are accumulated into "batches," which are then processed. The information required to process the transaction is submitted on some type of paper report. The information is keyed into the computer from the report and submitted for processing. The

processing includes updating various tape and disk files. Submitting and processing are generally handled by someone other than the person handling the material.

Advantages. Once the material information has been captured in a computer readable format, many types of processing are possible. Reports with various contents can easily be generated. The current "book" inventory can be computed. The materials balance, grouped by material type, can be calculated. The material information can be stored in a secure place where it is less likely to be altered in an unauthorized manner.

Disadvantages. Because the transaction information is recorded by accounting clerks (typically 1-3 days after the actual occurrence), the accounting data may be out of date at the time of the report. As with a paper system, transcription errors are possible and are difficult to detect. Reports tend to be hard-coded making it difficult to supply the unanticipated report request. Almost all batch-computerized systems were implemented on mainframe computers. Mainframe computer systems are expensive to maintain and are costly to modify.

Computerized Near-Real-Time System

Description. A computerized near-real-time accounting system captures the accounting data as close to the source as possible. Process operators enter data directly into the system immediately after each reportable occurrence. It is desirable to capture data from process control systems as much as possible to eliminate manual data entry errors. The database of accounting information is updated as soon as the information is entered. Users can be limited by security features to only those locations and materials for which they have access. Examples of the current generation of near-real-time systems include the Materials Accounting Safeguard System (MASS) at Los Alamos and the Nuclear Materials Accounting System (NucMAS) at Savannah River Site. These systems are implemented on mainframe computers and "dumb" terminals. The user interface is typically made up of line-oriented commands or is menu driven.

Advantages. By capturing the data as close to the source as possible, the occurrence of errors is greatly reduced. Transcription errors are eliminated as the data is only handled once. Reports are easily generated, and the unanticipated report request can be met by an ad hoc report generator. By eliminating any paper involved in the system, the error rate of data capture is greatly reduced. Any information captured on paper is not only inaccessible from a computer but is in danger of being lost. Computer-stored data can be easily presented in a variety of formats. The process operator is able to view the accepting data in one way while the materials management specialist is able to view the data in a different way. Other advantages are the lower cost of hardware and the ease of software modification.

Disadvantages. Any system that requires the operators to enter data requires a high level of training for its operators. This is a small price to pay for the benefits of a computerized accounting system. Any computerized accounting system will have a limited life span and management must plan for its timely replacement.

The Next Generation

The next generation of computerized near-real-time accounting systems will take advantage of the reduction in computer hardware costs by using a powerful server to maintain the material database and personal computer "clients" to provide the user interface. The clients are networked to the server by

Ethernet or telephone connection. Either connection provides the familiar "Windows" environment whereby the process operators can easily enter the accounting data and interact with the computer operating system. The next-generation computerized systems will store information in relational or object-oriented databases.

At Los Alamos we are following this approach with the Local Area Network Material Accountability System (LANMAS) project. The declining cost and increased performance of personal computers (the 486 and Pentium microprocessor-based computers) provide the foundational structure for the accountability system. The availability of low-cost network hardware and high-performance database servers (Microsoft SQL Server) coupled with a multitasking, secure operating system such as Windows NT provides a powerful tool set that can be used to develop accountability systems for nuclear materials. In the LANMAS project, we are developing core functions and a database design that can be extended by sites implementing near-real-time accountability systems. By assisting sites in developing their site-specific extensions to the core software, the resulting system has all the benefits of custom software without the normal high price of such software development. The LANMAS core set of functions includes the following:

- Material Movements - The LANMAS core tracks the movement of material within the site boundaries.

- Material Transforms - The core supports the recording of material transformations including material splits, combinations, and decay.

- Containerization - The core supports containerization of material in multiple containers.

- Tamper Indicating Devices - The core supports the tracking of tamper indicating devices.

- Reports - The core supports standard and ad hoc queries and reports.

- Inventory History - The core supports a complete item transaction history.

- NMMSS Compatibility - The core will be compatible with reporting all required data to NMMSS.

CONCLUSION

Many sites in the DOE complex are anticipating upgrades to their computerized accounting systems. With the availability of powerful microprocessors, modernization will mean switching from mainframe computers to new generation personal computers. This modernization will mean less costly systems, standardization in hardware and software, and more consistent data complex-wide. We are anticipating these changes with the development of LANMAS. Any DOE site will be able to take advantage of this project by incorporating the LANMAS core software with their site-specific software. This should significantly reduce the cost of upgrading.