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## Nuclear Material Accounting for Ukraine

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# Nuclear Material Accounting Software for Ukraine

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## Abstract

Among the needs identified during initial surveys of nuclear facilities in Ukraine was improved accounting software for reporting material inventories to the regulatory body. AIMAS (Automated Inventory/Material Accounting System) is a PC-based application written in Microsoft Access<sup>TM</sup> that was jointly designed by an U. S. / Ukraine development team. The design is highly flexible and configurable, and supports a wide range of computing infrastructure needs and facility requirements including situations where networks are not available or reliable. AIMAS has both English and Russian-language options for displays and reports, and it operates under Windows 3.1, 95, or NT 4.0<sup>TM</sup>. AIMAS functions include basic physical inventory tracking, transaction histories, reporting, and system administration functions (system configuration, security, data backup and recovery). Security measures include multilevel password access control, all transactions logged with the user identification, and system administration control. Interfaces to external modules provide nuclear fuel burn-up adjustment and barcode scanning capabilities for physical inventory taking. AIMAS has been installed at Kiev Institute of Nuclear Research (KINR), South Ukraine Nuclear Power Plant (SUNPP), Kharkov Institute of Physics and Technology (KIPT), Sevastopol Institute of Nuclear Energy & Industry (SINEI), and the Ministry of Environmental Protection and Nuclear Safety / Nuclear Regulatory Administration (MEPNS/NRA). Facility specialists are being trained to use the application to track material movement and report to the national regulatory authority.

## Introduction

AIMAS was developed as part of the U.S. Department of Energy (DOE) Assistance Program to Ukraine in Material Protection, Control, and Accounting (MPC&A). This is a cooperative effort involving specialists from the U. S. and Ukraine. [1-4]

The main goal of this work was to achieve a capability that meets the material control and accounting needs of the facilities and the state-level International Atomic Energy Agency (IAEA) reporting requirements. A key strategy to achieve strong user acceptance and ownership has been to involve users in every aspect of the software life cycle. The following development approach, the spiral paradigm, has been used:

- Field an initial software prototype early
- Involve U. S. and Ukrainian Materials Control & Accountability (MC&A) experts and developers

- Take an evolutionary approach (build a little, test a little)
- Use feedback from users to help to define enhancements
- Leverage commercial off-the-shelf hardware and software to achieve a robust, supportable system, and
- Maintain a strong level of in-country training and support

Simplicity, redundancy, and security have also been major design objectives. AIMAS makes minimal demands on the computing infrastructure of a facility and can operate as a stand-alone system on low-end PCs running Microsoft Windows 3.1, 95, or NT<sup>TM</sup>. For larger facilities, data corresponding to different material balance areas (MBAs) can be distributed over multiple AIMAS computer systems. Item transfers between MBA databases that reside on different computers can be synchronized with diskettes. A transaction verification process is enforced by the software to assure that items transferred are properly entered on the correct destination computer. Any PC can assume the duties of a failed PC to maintain high system availability. AIMAS also creates backup files and performs consistency checks to recover from a system failure (such as loss of power to the CPU during a database transaction).

AIMAS functions include basic physical inventory tracking, transaction histories, reporting, and system administration functions (system configuration and security). External applications interface with AIMAS to provide burn-up adjustment capability and bar code data entry. Both English and Russian language versions (screens, online help, and user documentation) exist. AIMAS supports all IAEA transactions and reporting requirements. Other features include multilevel security, support for facility-defined fields and reports, and a configuration wizard to help guide the system administrator through the initial configuration or reconfiguration of the MC&A system.



A key element of our strategy to achieve strong user acceptance and ownership was to involve users in every aspect of the software life cycle. AIMAS was developed using a spiral methodology that involved user testing and feedback during each prototyping cycle. Moreover, training and support has been transitioned to the Ukrainians. AIMAS users regularly meet to share ideas and receive hands-on training at the George Kuzmycz Training Center located in Kiev. These meetings are organized and conducted by Ukrainians using instructors drawn from the facilities and support contractors.



## Major AIMAS Features

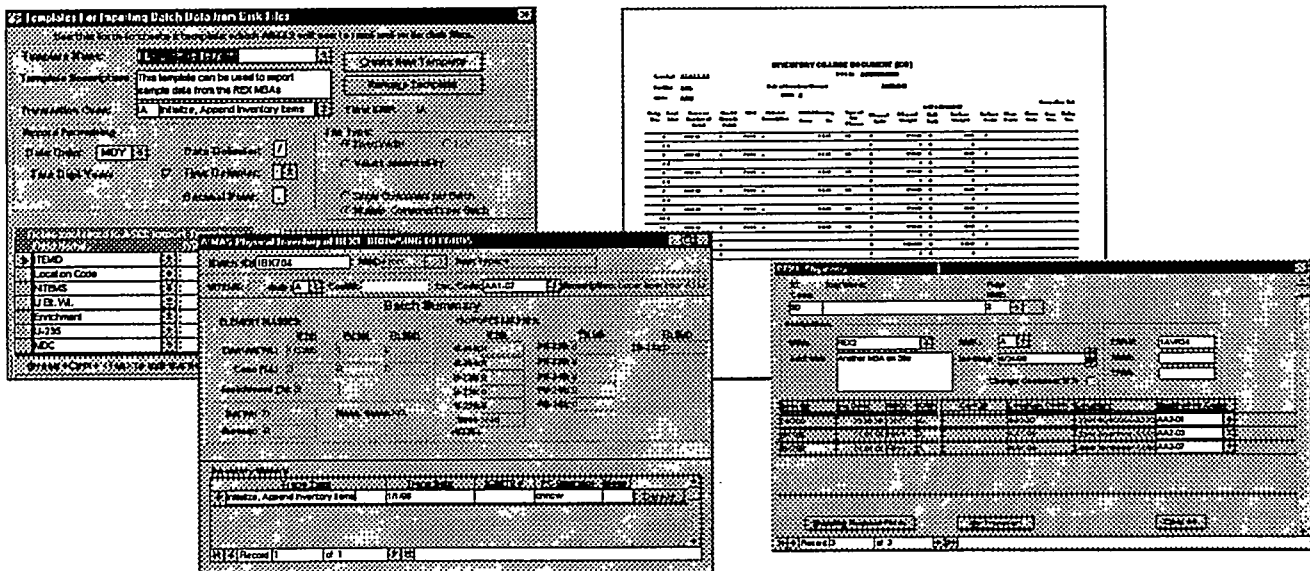
### Configuration

Before running AIMAS for the first time, a set-up wizard creates an initialization disk used to configure the AIMAS computers. The system administrator specifies the MBAs that make up the material and accounting system, and how the MBAs are distributed (if divided among more than one PC). In addition, the system administrator specifies the item locations within each MBA, the flow and inventory key measurement points (KMPs), and the standard item descriptions common to all MBAs. This assures that the locations and descriptions, which are used in AIMAS data input form the drop down lists, are consistent on all AIMAS computers. In addition, the system administrator can customize the database for their facility through the User Defined Fields (UDFs) and reports.

The configuration wizard can also be used to reconfigure AIMAS. This function can add or remove PCs, MBAs, KMPs, and locations from the system. An "update disk" is created by the configuration wizard, which updates each PC that is part of the MC&A system. AIMAS can even move an entire MBA and all the related accounting tables from one PC to another.

### Rebatching

AIMAS tracks material at the item (or batch) level. A batch item may be composed of sub-components that are identified and grouped by isotope type. AIMAS accommodates the different means of batch storage and material accounting in use at various facilities. Also, AIMAS allows for the possibility of creating batches by describing the sub-components of the batch, as well as rebatch transactions where one or more existing batches are separated or recombined to form new batches.



Elements of the AIMAS graphical user interface. From left to right: template for ASCII data import/export, inventory browser, inventory transfer document, and a multi-item shipment form.

### *Inventory forms*

The main browser form displays the fields for a particular batch item in the inventory. Navigation buttons permit moving through records (forward, back, first, last, find). A subform may be opened to view all historical transactions for a particular item (listed with most recent transactions at the top). Currently there are twenty-one (21) different transactions, including domestic receipt or shipment, accidental gain or loss, discrepancy between shipper and recipient, nuclear losses or production, etc. The records in the historical data subform are automatically generated and provide an audit trail of all transactions.

Data entry functions are also available from the main browser form for import, transfer, edit, and new item creation. A filter can be applied to change the order of records (sorted on a specified field) or to display a subset of the inventory (for example, view only fuel assemblies of a certain type). The inventory can also be viewed as a data table (spreadsheet) which allows scrolling, rearranging and/or hiding columns, and creating *ad hoc* reports. The table view also permits records to be easily copied and pasted into other applications, such as a word processor or spreadsheet.

### *Reporting*

Currently, AIMAS can generate the following:

- ☐ Inventory Change Documents (ICDs),
- ☐ Material Balance
- ☐ Book Inventory List (BIL),
- ☐ Itemized Inventory List (used to report results of Physical Inventory Taking (PIT) process)
- ☐ General Ledgers,
- ☐ Subsidiary Ledgers,
- ☐ Facility Layout (show layout map of AIMAS data configuration for the facility), and
- ☐ Transaction history reports.

In addition AIMAS can generate ASCII files compatible with the Swedish-designed state reporting system for the purposes of reporting Inventory Change Documents (ICDs) and Itemized Inventory Lists (IILs).

### *Material receipts/ transfers*

AIMAS has the capability to handle single or multiple item transfers within an MBA (between KMPs) or between MBAs. For a multiple item transfer, the user can either check off which items to transfer or use a select query to define the transfer set. If a transfer is made to a location corresponding to a database table on the same PC, the transfer is recorded immediately and the physical inventory and transaction history tables are updated. If the transfer is made to an MBA or KMP corresponding to a database on a different PC, then the item information must be transferred to the destination PC by creating an *MBA Transfer Disk*. AIMAS prompts the user to insert a floppy diskette into the originating PC and generate the transfer file. This MBA transfer diskette must be

inserted into the receiving PC to transfer the records. After the records have been transferred, the MBA transfer diskette must be returned to the originating PC to close out the transaction. Until the transaction is closed, the items are marked "IN TRANSIT" to indicate that the transfer transaction has not been verified.

AIMAS validates the destination location in all batch-processed receipts or transfers and provides a drop-down list for the manual data entry of receipts and transfers. Items cannot be "stored" in invalid locations. This feature reduces the risk of one type of subversion.

AIMAS also has import and export capabilities to transfer records between other (non-AIMAS) computer systems. These capabilities are described in the section *External Interface Support* below.

### *Security*

Security measures include multilevel password access controls, all transactions logged with the user ID, and system administration controls. There are three classes of AIMAS users: system administrator (a privileged account used to create other accounts and configure the AIMAS system), read/write user, and read-only user. The latter can browse data but make no data entries.

Security and redundancy is further enhanced by computers with fully removable media. The standard system hardware configuration calls for a single drive bay that accommodates a removable SCSI disk with a key lock to permit all MC&A activity to be isolated from general purpose computing. Two SCSI boot disks are used with each system, one for training and general purpose computing and one for the MC&A application only. With administrative controls (limiting access to the MC&A disk to authorized personnel for MC&A application only), this reduces the possibility of unauthorized access to the MC&A data and the possibility of virus contamination from general purpose users of the system. In case of a computer system failure (not involving disk failure), the removable MC&A drive may be used in any other MC&A computer configured for removable media. In the case of disk failure, tables for the failed system can be moved to another MC&A computer from backup data.

### *System Administration Utilities*

AIMAS provides the system administrator with several features for system configuration management and security. AIMAS has support for users that require different levels of access. The system administrator is a special user that has privileges to create user accounts and configure the AIMAS systems. Below the system administrator are two classes of users: read/write user (has the ability to view, enter, modify, report, and transfer data), and the read/only user (can only view data and generate reports). The system administrator can also configure the drop-down lists that appear in AIMAS, as well as perform functions previously described during the initial setup.

### *Fault Tolerance*

Because of the importance of maintaining data integrity, AIMAS has been designed to tolerate system failures that might otherwise result in data corruption or loss. Several types of failures and recovery mechanisms are described below:

Re-write Shipment Disk. Should an AIMAS transfer disk become lost or corrupted, a new one may be written for any unverified shipment.



Manually verify receipt of shipment. Should a shipment disk become lost or corrupted after receipt, the items contained in that shipment may be manually verified.

Automatic Backup / Restore functionality. Each time AIMAS starts, a backup copy is made. Ten consecutive backups may be accumulated on a rolling basis that represent the most recent ten starts. AIMAS detects on startup if there was a system failure or improper exit during the last session, and forces the restoration of the recovery data file. Data recovery can only be performed by the AIMAS system administrator.

### *Physical Inventory Taking / Closing Accounting Period*

AIMAS accommodates the creation of the BIL report, the PIT Verification Form, and procedures to close the books. The BIL is printed and is used to "take inventory". Then, the verification form is used to log the results of this activity. Verified items are simply marked on the form. The form also allows for changing item composition, discovering a new item not previously in the book inventory, and for failing to find an item. (These three events have special IAEA-recommended PIT codes assigned to them.) When completed, the accounting period is closed and a new one begun. The IIL is printed and electronically written for upload into the State accounting system and all new reports begin with the verified material balances.

### *External Interface Support*

AIMAS provides a generalized import/export feature to provide an external interface to other applications. The ASCII data input / output (I/O) functions have been recently expanded to allow additional transactions and to accommodate the sub-component data structure to support batches. AIMAS can now batch-process receipt, transfer, and various nuclear reactions transactions. It also creates a special comprehensive table in a separate Access<sup>TM</sup> database file for printing item bar code labels. Imports can be made from character delimited or fixed field-width ASCII files.

AIMAS permits the user to create and store templates describing the format and fields of the import/export file. Items that are imported are held in a temporary table and examined by AIMAS for format errors (for example, does a date field contain a valid date?) and are previewed in a data sheet before committing to the AIMAS database. Templates can be reused later to simplify the process of performing periodic data imports or exports. For example, this feature could be used to make periodic burnup adjustments that are calculated by another computer program. Another common use of the import is to transfer records to AIMAS from another MC&A system such as for receipt of a shipment from another facility.

### **Future Directions**

High among the objectives of the DOE MPC&A assistance programs to successor states of the former Soviet Union is fostering the development of a nuclear safeguards culture that will ensure the continued use of the safeguards enhancements. If this goal is to be reached, local specialists must perceive the new technologies as improvements over existing methods. Also they must become comfortable using the new technologies and become familiar with operation and maintenance. These conditions are best realized by involving local specialists in the design, implementation, evaluation, training and support of the new technologies.

In developing AIMAS for nuclear material accounting in Ukraine, the participation of local specialists is an integral component of the chosen methodology. This approach included consultations with local safeguards specialists at both the sites and the national regulatory authority. MC&A and software specialists were identified who would work with the U.S. team in the development of the software. These individuals form the core of the support and teaching staff for AIMAS in the future.

Personalized user training and product assistance are key to assuring the acceptance and use of a new software product. The U.S. team is supporting on-site training of MC&A specialists using Ukrainians who are familiar with AIMAS. In addition, intensive workshops are being held at the George Kuzmycz Training Center in Kiev on MC&A topics, including nuclear material accounting software. The AIMAS courses have been prepared in Russian by local experts and are presented by local experts. This training will continue as specialists from additional sites in Ukraine evaluate and use the software.

As the local specialists become experts in the use of AIMAS it then becomes imperative that they develop the capability to maintain and modify the program to meet changes in the technical and regulatory environment. Local specialists have been heavily involved in testing of AIMAS. In the next phase of development they will be the predominant contributors in converting AIMAS from a 16-bit to 32-bit product. This enhancement will improve the maintainability, usability and upgradability of the code to assure the lowest possible total lifecycle costs. The process of working jointly on the conversion will better prepare Ukraine to become self-sufficient in supporting AIMAS without U.S. help in the future.

Certain nuclear facilities in other former soviet republics have also expressed an interest in evaluating AIMAS for nuclear material accounting. In Kazakhstan, specialists at the National Nuclear Center at Kurchatov have adapted a version of AIMAS for use at their facility. The staff at the VVR-K reactor in Almaty is also evaluating AIMAS. Managers of the DOE MPC&A Assistance Programs have supported this use of the AIMAS software.

## References

- [1] ROCHE, C.T., et al., Status of U.S. Programs for Material Protection, Control, & Accounting Assistance to Ukraine and Kazakhstan, Proc. 1995 ANS Meeting, Jackson Hole, WY (1995) 142-147.
- [2] KUZMYCZ, G., et al., The U.S. DOE MPC&A Assistance Program to Ukraine, Proc. 38<sup>th</sup> Annual INMM Meeting, Phoenix (1997).
- [3] EWING, T.F., et al., MC&A Software Assistance to Ukraine, Proc. 38<sup>th</sup> Annual INMM Meeting, Phoenix (1997).
- [4] SHEPPARD, G.A., et al., The U.S. DOE MC&A Assistance Program to Ukraine, Proc. 39<sup>th</sup> Annual INMM Meeting, Naples, FL (1998) 212-215.

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