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A GENERIC, COMPUTERIZED NUCLEAR MATERIALS ACCOUNTABILITY SYSTEM (NucMAS) AND ITS LAYERED PRODUCTS (u)

by

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ABSTRACT

NucMAS provides a material balance area with a computerized data management system for nuclear materials accountability. NucMAS is a generic application. It handles the data management and reporting functions for different processing facilities by storing all process-specific information as data rather than procedure. A NucMAS application is configured for each facility it supports. NucMAS and its layered products are compatible with three types of data clients. Core NucMAS has a screen-oriented user interface to support the accountability clerk as a client. Accountability clerks enter data from operating logs and laboratory analyses one to three days after actual processing. Layered products support process operators and automated systems as near-real-time and real-time data clients. The core and layered products use a data-driven approach which results in software that is configurable and maintainable.

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1. ABSTRACT

NucMAS provides a material balance area with a computerized data management system for nuclear materials accountability. NucMAS is a generic application. It handles the data management and reporting functions for different processing facilities by storing all process-specific information as data rather than procedure. A NucMAS application is configured for each facility it supports. NucMAS and its layered products are compatible with three types of data clients. Core NucMAS has a screen-oriented user interface to support the accountability clerk as a client. Accountability clerks enter data from operating logs and laboratory analyses one to three days after actual processing. Layered products support process operators and automated systems as near-real-time and real-time data clients. The core and layered products use a data-driven approach which results in software that is configurable and maintainable.

2. SUMMARY

NucMAS uses a set of generic accounting primitives to implement data management and reporting functions. These primitives update tables for accountability events/transactions and maintain current book inventory. Configuration data is used by the accounting primitives to describe the accountability event and to calculate the transaction. Configuration data is also used for the data prompts and report headings. Configuration data tables contain information about the processing facility (e.g., material forms, nuclear material codes, calculation methods, the accounting structure of the material balance area, and the inventory units where materials are measured or observed).

Users interact with NucMAS through a form (screen) and a menu line. The screen is the template for data entry and display. The menu line activates the accounting primitives.

NucMAS provides the platform for layered products. An automated data collection (ADC) application provides near-real-time accountability (NRTA) for the New Special Recovery (NSR) facility. NSR has the analytical instrumentation, distributed process control, and data acquisition systems needed for NRTA. The ADC is a NSR-specific extension of the manual data entry Nuclear Materials Accountability System (NucMAS). The ADC reads measurement and transfer data from the computers on the network. The ADC transforms this data into accountability events/transactions and maintains the current book inventory for NSR. The ADC updates the same NucMAS data tables that are updated by clerk-entered accountability events/transactions for the rest of FB-Line MBA.

NucMAS and the ADC use a data driven approach in their design. In NucMAS, accountability events/transactions are only processed if they are "well-formed". The configuration data tables provide the basis for this decision. For the ADC, the rules that govern the translation of network information into accountability events/transactions are stored as data in configuration tables.

3. THE NucMAS APPLICATION

3.1. JUSTIFICATION

Materials accounting is a collection of policies, procedures and practices used to safeguard nuclear materials. Materials accounting applies to all facilities that receive, produce, process, store, transfer or ship nuclear materials. Materials accounting has a defined boundary called a material balance area (MBA). The MBA can be a facility, a building, or a process within a building.

The nuclear material transactions involve certain basic activities. The activities are: 1) receipts and removals, 2) storage and internal transfers, and 3) inventories. Each MBA maintains records about transactions and provides reports to the central accountability group.

The record keeping function of a materials accounting system has to maintain records about the quantity, form, and locations of nuclear materials in a facility. These records have to contain enough information to trace the history of all nuclear materials from their entry into the facility until the present. Consequently, the nuclear material item or batch has to be traceable through all subsequent transformations after its entry or creation.

Accountability personnel gather transfer data and physical inventory data, compute values, maintain and adjust the books, and prepare reports. Prior to the development of NucMAS, these were manual activities without computer support. Manual processing of data lead to: 1) numerous transcription and reporting errors due to the large volumes of data and complex calculations, 2) misunderstanding and errors due to inconsistent use of terms by MBA and central accountability personnel, 3) problems in relating raw measurement data to the calculated transactions reported to the central accountability group, and 4) inconsistent implementation of manual record keeping systems among MBAs.

The development of a computerized accountability system was justified by the complexity of the record keeping and reporting requirements and the problems in supporting these requirements manually.

3.2. DEFINITION

NucMAS refers to the software application which includes the processing primitives, the user interface, the configurable and dynamic data structures, and the relational data base management system. The software application implements nuclear materials accounting and reporting requirements specified by Department of Energy orders and the site's accountability manual.

3.3. MAJOR REQUIREMENTS

The requirements for NucMAS are:

Accept and maintain information on transfers, material form changes, and measurements of nuclear materials.

Maintain and update a current book inventory of items and bulks by material type code.

Accept and maintain physical inventory information.

Allow transfer information to be adjusted.

Generate daily, monthly, and physical inventory reports.

Maintain an audit trail of all user data entries.

Provide browsing capabilities for transfers, material form changes, measurements of nuclear materials, and for physical inventory information.

3.4. SOURCE OF ACCOUNTABILITY DATA

The source of the data determines temporal relationship of NucMAS' current book inventory to the actual disposition of nuclear materials in the facility. The sources of the information are:

Accountability clerks manually enter data into NucMAS from operating logs one to three days after the change in inventory status occurred.

Process operators enter data directly into NucMAS (in the place of or in addition to operating logs) near to the time the change in inventory status occurred.

Automated distributed control and analytical measurement systems provide data for NucMAS at the time the change in inventory status occurred.

NucMAS has to support all three views because data acquisition for a facility can have a mixture of manual, near-real-time, and real-time components. Consequently, it also has to operate in a multi-user environment where clerks, operators, and data acquisition systems have concurrent access to NucMAS.

3.5. GENERIC SOLUTION

Each MBA's implementation of materials accounting took on characteristics attributable to manual procedures it adopted and the composition of nuclear materials it processed. These implementations had different vocabularies and methods. The users perceived their implementation as the expression of the "real" accountability requirements.

Four sets of functional requirements were written for the four MBAs. After intensive examination of the requirements documents, the fundamental needs of all MBA's were determined to be the same. A basic set of functions was extracted as the design basis of NucMAS.

A prototype was used to determine the difficulty of developing a generic product, to clarify user needs, and to refine the user interface. The prototype revealed no overwhelming problems with a generic approach.

The single product for MBA computerized accountability has many advantages. Manpower costs for development, training, and maintenance are significantly less for one implementation than four. The single product provides a common environment for accountability clerks and a single interface to the central accountability group.

3.6. ACCOUNTABILITY EVENTS AND TRANSACTIONS

An accountability event is a qualitative description of the change in inventory status. An event is the what, when, and where about the change in status. Its attributes are event number, time, event type, source, destination, material name, material form, and calculation name.

An accountability transaction is the quantification of the amount changed. The amount is recorded in the reporting unit of the material type code. The material type code is associated with the material form of the event. Material forms can contain more than one material type code. Therefore, an event is associated with one or more transactions. A transaction's attributes are event number, transaction number, material type code, transaction type, elemental grams, elemental method, isotope grams, isotope method, time, report date.

Nuclear materials are inventory objects having two subtypes. The subtypes are items and bulks. Items are nuclear materials in containers whose integrity is protected by tamper indicating devices. Items can change locations at book value as long as the tamper indicating device is intact. Bulks are nuclear materials in process. Examples are a plutonium solution in a process tank or plutonium oxide in a weight pan. A change in inventory status involving bulks requires measurements to characterize the amount involved in the transaction.

The item and bulk concept is consistent with the way nuclear materials are processed. It is also consistent with the physical inventory procedures where items are observed and bulks measured. Physical inventories are done periodically to determine the amount and location of nuclear materials in a MBA at a particular instant in time. The physical inventory is reconciled with the book inventory to determine an inventory difference.

Examples of accountability events are move item, move bulk, create item from bulk, destroy item into bulk, import item, re-measure item, export item, import bulk, and export bulk. Import/export item, destroy item, and move item events use the book value of the item to quantify the nuclear material amounts in the transaction. Import/export bulk, create item, and move bulk events have their transactions calculated from measured values. A calculation method is associated with all move bulks, create items from bulks, and re-measure items.

3.7. GRANULARITY IN RECORD KEEPING

A MBA has physical and logical properties. It is contained within a physical protection zone. It is also logically associated with a set of control balance accounts (CBAs). Each MBA prepares reports for the central accountability group. The daily report is grouped by CBA and material type code. Each grouping has the beginning balance, transactions, and ending balance for that material type code.

The user configures the CBA into physical entities called inventory units. This division supports whatever granularity is needed for the physical inventory function. Inventory units are those locations in the CBA where measurements of bulks are made or items observed.

If inventory units are configured, the MBA's inventory status is associated with physical locations as well as the logical CBAs. NucMAS then has a material tracking view of the process. Current book inventory is a relation that contains the reported status of all inventory units and CBAs. Current book inventory identifies the items and totals the bulk amounts for each material type code. The temporal relationship between current book inventory and reality depends on the data acquisition method.

3.8. THE USER INTERFACE

The user interface facilitates manual data entry by: 1) providing context sensitive field help, 2) by performing data validation, 3) by having simple and consistent data-entry forms, and 4) by having a hierarchy of menus to group related functions and move between groups.

The user interface is a screen-oriented frame. The frame consists of a form and a menu-line. The screen is a form which has fields for the entry/display of data. The menu-line has a set of operations that can be applied to the form.

The form displayed to the user is either a menu or a data-entry form. The menu form is a set of accountability functions (Figure 1). Menus activate sub-menus (Figure 2) or data-entry forms (Figure 3). The data-entry form invokes the accountability primitives that process the data.

The relation NUCFUNC establishes the menu and data-entry forms the user can access. It also establishes the hierarchy of menus and the set of data-entry forms assigned to a menu. The attributes of NUCFUNC are user, application name, object name, object type, description, menu name, and menu line.

The data-entry form is the template for the user entered data or the display of information resulting from a query. Data-entry fields are shown in reverse video. Mandatory data fields have to be filled before operations are applied to the data. Data entry is supported with context-sensitive field help. Field help provides the user with a choice of allowable entries which can be selected with the cursor. The cursor moves to the next logical field after the user presses the enter key.

Most data-entry fields are validated against the configuration data. The validation is activated on the exit of a field. If the validation detects an error, the cursor returns to the invalid field. The user then sees an error message asking for a correct entry. Prior to saving information in a form, all fields are validated again to ensure only "well-formed" data are stored in the data base.

Data is never overwritten but just superseded with new information. This axiom preserves a complete audit trail of data entries. The name of the user entering data is also stored with the data.

3.9. PROCESSING OF EVENTS AND TRANSACTIONS

Events are typed into a small set of allowable accountability primitives. The user's choice of frame explicitly declares the event type. The data-entry form is tailored for the event type. The data is validated and stored in the event relation. The primary key is the event number which becomes part of the primary key of other relations associated with the event.

Transactions are entered directly with a quantity for each material code associated with the material form. Or, transactions are calculated by a calculation method configured by the user. The calculation method prompts the clerk for values of variables used in the calculation. The values are either measurement data or variables interpreted by a "look up" relation.

Immediately after the calculation of or the entry of final values, transaction(s) is/are stored and the transaction processor is invoked. The transaction processor updates current book inventory. Current book inventory provides the validation of item event types. The item validation requires item events to be entered in the same order in which they occurred. Bulk events are not validated for ordering because the measurements used in the calculations are not usually available in real-time.

The transaction processor makes the appropriate changes to current book inventory. It next updates the corresponding transaction rows with a report date and a code indicating successful processing.

The event and transaction relations together constitute a general ledger. The current book inventory is a journal that contains information about the current state of the MBA and the history of all previous states.

4. NEW SPECIAL RECOVERY AUTOMATED DATA COLLECTION

4.1. BACKGROUND

New Special Recovery (NSR) facility processes plutonium scrap and has the analytical instrumentation, distributed process control, and data acquisition systems needed for Near-Real-Time Accountability (NRTA). NSR is a new control balance account (CBA) within the existing plutonium finishing MBA. For NSR, NucMAS has a facility-specific extension to NucMAS, the NSR Accountability Control Function (ACF). The NSR ACF contains the automated data collection (ADC) application. The ADC reads measurement and material transfer data from the computers on the network. The ADC transforms this data into accountability events/transactions and maintains the current book inventory for NSR. The ADC updates the same NucMAS data tables that are updated by clerk-entered accountability events/transactions for the rest of the plutonium finishing material balance area (MBA).

NSR receives scrap containing Special Nuclear Material (SNM) of material code 50. Material code 50 has total grams of elemental plutonium as its reporting unit. NSR dissolves the scrap in nitric acid and, if necessary, purifies the solution with ion exchange. The solution is transferred to a solvent extraction process for additional processing before return to plutonium finishing.

NSR's distributed control system (DCS) and analytical systems are supported by the NSR Instrument Control Function (ICF) and the NSR Data Management Function (DMF). The ICF transmits its and the DMF's information to the NSR ACF. The Plutonium Storage Facility (PSF) is a vault for off-site receipts and has automated stacker/retriever, laboratory, surveillance and monitoring systems. The Plutonium Storage Computer (PSC) transmits to the NSR ACF data about vault status and material movements. The NSR ACF transforms network information from NSR process computer functions (DMF, ICF, PSF) to changes in NSR's accountability status for the plutonium finishing MBA.

Near-real-time accountability for NSR is the capability to: (1) move in-process materials to optimum locations for measurements without process interruption and (2) compute a book-to-physical inventory difference and a limit of error on that difference within 24 hours. Process computer systems automatically transmit the accountability measurement data to the NSR ACF to maintain a current book inventory. Manual data input by accountability clerks and process operators provides the additional information required for physical inventory.

The limit of error on the inventory difference is minimized by measuring in-process inventory at optimum locations. Physical inventory observations determine the amount of nuclear material in the CBA by material code for reconciliation with the book inventory. The observations are taken over a time interval during which the state of the process is constant (i.e., no transfers across CBA boundaries). When materials in the dissolver lines reach optimum measurement locations, samples are taken to determine the inventory of accountability tanks. Operators poll the DCS for measurement data for those locations with at-line non-destructive assay (NDA) monitors. Items are verified by observation. The book inventory from the end of the previous daily accounting period is adjusted incrementally by selecting and applying subsequent book transactions until its status matches the timing of the PI observation. This inventory plan is accomplished without interrupting the process and results in a minimal limit of error for the inventory difference. The book-to-physical inventory difference for the CBA is calculated. The limit of error on the inventory difference is manually determined and available within 24 hours. The book inventory is adjusted to the physical inventory on a subsequent daily report.

4.2. NSR ACF SUMMARY

The NSR ACF processes messages it receives from the ICF and the PSC to record changes in inventory status and to update current book inventory. The NSR ACF is compatible with: (1) manual entry of accountability events/transactions for material movements without auto-messages (messages sent from computers on the network), (2) manual entry of accountability events/transactions that substitute for failed auto-messages, (3) manual entry for physical inventory observations, and (4) manual entry for supporting shipment/receipt of nuclear material 741 accounts. The NSR ACF is an extension of standard NucMAS and provides NSR with automated data collection and shipper/receiver account processing. NSR ACF meets timing, bookkeeping and reporting requirements for near-real-time accountability. The NSR ACF consists of five major modules: the Message Input Function (MIF), the Message Output Function (MOF), Message Processing Function (MPF), the OPeratoR (OPR) interface function, and the Control Panel Function (CPF). The MIF, MPF, and MOF are the components that provide the automated data collection function (ADC).

The NSR ADC has input, processing, and output functions. The MIF reads messages from remote computers into a table for subsequent processing. The MPF translates the messages into accountability events and material code 50 gram bookings. The MOF provides the DMF and ICF with information about item compositions when it receives the appropriate triggering actions.

MPF's interaction with the NucMAS tables exactly imitates the NucMAS' processing of manually entered events and transactions. The MPF calculates the gram value of total plutonium for each event and updates the transaction list and current book inventory. The MPF observes all rules that ensure item and bulk movements are consistent with the NSR configuration. The MPF detects any out-of-spec messages and provides error information to assist the user in correcting the data. The missing data has to be obtained manually from the DMF. The correction uses NucMAS' clerk interface for entering the appropriate accountability event and/or book transaction associated with the failed message.

4.2.1. Message Input Function (MIF) Summary

Messages are sent to the NSR ACF by the Instrument Control Function (ICF) and the Plutonium Storage Computer (PSC). These messages have qualitative and quantitative information about process events that occur in NSR or PSF. The maximum message length is 320 bytes. The first two bytes indicate the destination of the message. Bytes four and five indicate which one of the 34 types of messages this message is. The succeeding bytes contain data such as date, time, material identity, and measurements.

A task in either the PSC or ICF writes the message across the NSR computer network. The task opens a channel across the network which activates a MIF executable image called the Generic Reader. It reads the message and returns an "ACKNOWLEDGE" character string. After all messages have been written, the network connection is severed between the remote writer task and the Generic Reader.

The Generic Reader then checks the contents of a configuration file. This file contains node, database, and mailbox names that are the actual destinations of the message. The Generic Reader then opens a network channel for each destination. Either a SERVER_TYPE1 or SERVER_TYPE2 image is activated for each destination. A SERVER_TYPE1 image stores the message in a table of the specified database. A SERVER_TYPE2 image stores the message in a mailbox.

The original message contains only one destination. However, the Generic Reader forwards the message to the locations specified in the configuration file. This design allows the message to be stored in either a database table or mailbox on any number of platforms in the computer network.

4.2.2. Message Processing Function (MPF) Summary

The MPF has the message processing components that give the NSR CBA its near-real-time characteristics. The MPF operates in a monitoring loop that parses a message received by the MIF. The MPF determines the message's disposition based on data in configuration tables. Data in configuration tables contain most of the rules that determine how messages are translated into accountability events and book transactions. Having the rules as data in tables instead of source code means that a change in message specifications or in NSR's physical process are easily handled. New data or revised data is entered into the tables instead of changing the source code and re-compiling a new executable image. This data-driven strategy simplifies the software architecture and makes the design more general and flexible.

A SERVER_TYPE1 image stores the message in a specified database table MESS. The MPF operates as a monitoring loop which hibernates for a short time interval if there are no messages to process. The MPF uses the configuration data table MESS_DETAILS to determine the message type and to parse the key information in the message into variables. The MPF then uses the configuration data table AUTO_ENAMES to retrieve the event-name and to determine which sub-routines to activate. The event-name is a unique value of the domain for the attribute event-name. The event-name is used to retrieve the event's accountability description from the configuration data table EVENTPROFILE. It has the source and destination control balance accounts (CBA), source and destination inventory units (IUN), material form, event description, and calculation name.

4.2.3. Message Output Function (MOF) Summary

The NSR ACF is predominantly a receiver of information from other computer systems. The MOF provides the NSR ACF with the capability to transmit information to the other computers for explicitly defined instances. It also contains the error handling module for itself and the MPF. The MOF also informs the other NSR computers when the NSR ACF is undergoing an orderly shutdown and when it is on-line again.

The MOF responds to the ICF's request for information about plutonium weight and item location for receipts. When this item information is needed, the ICF invokes MOF's SEND_FEED_CAN_DATA program via networking utilities. The program returns the requested information based on the current status of the NucMAS data base.

The MOF produces PSF specific reports. These reports are used by Operations and are not transmitted to the central accountability office. One report is a comparison of the PSF's inventory with the inventory on record in NucMAS. The other report is for discrepancies discovered and resolved during the processing of receipts.

The MPF and MOF use the same program to provide information about an error. The error is detected by the activating module which passes the program name, an error number, and a configurable error message to the error handler. If Fortran or database errors occur, they are stored along with the three parameters in table ERROR_LIST. Each error or group of related errors is assigned a unique problem number. The problem number and the number of the message being processed when the error occurred, are stored in table PROBMESS.

4.3. MESSAGE PROCESSING FUNCTION (MPF) DESIGN DETAILS

4.3.1. Procedure

The procedural aspects of the MPF are shown in the Jackson diagram titled "Message Processing Function (Figure 4)." At an overview level, it is a three step sequence. The first step returns the run flag. A set run flag is interpreted by the MPF as a signal to keep executing. The second step is an iteration that processes messages until the run flag is reset. And the third step is an exit procedure.

The iteration is executed zero or many times depending on state of the run flag. The iteration is expanded into three sequential steps. The first step returns the minimum message number in table MESS which has not been processed. The second step is a selection. The MPF either hibernates for 10 seconds if no message is found or processes the message. The third step returns the state of the run flag. The iteration is executed again if the run flag is still set.

The processing of the message is expanded into three steps. The first step is parsing the message. It uses table MESS_DETAILS to load all the variables associated with a specific message with the data contained in the message. The procedure "GET_AUTO_ENAMES" is the second step. It uses the table AUTO_ENAMES to determine the appropriate procedure to call. The selection is based on finding the row in table AUTO_ENAMES that matches the variables in the message. The matching is on the attributes of message type, source, destination, criterion1, and criterion2. Since more than one row can be returned in the selection, multiple events are processed iteratively. The determination of which procedure to activate is based on the "mpf_process" attribute of AUTO_ENAMES. The order in which the procedures are activated is based on the process order attribute of AUTO_ENAMES. The third step sets the message processing status for the message in table MESS.

The "mpf_process" attribute of AUTO_ENAMES has seventeen distinct entries. Five entries support the Message Output Function processing. Two entries logically link and de-link transport cans with feed cans. Five entries are used to process the item events/transactions of create item, destroy item, move item, re-measure item, and receive item. Four entries are used to process transfer and sample bulk events/transactions. The entry, DO_NOTHING, is for any message that does not translate into an accountability event or transaction.

4.3.2. Transfer And Sample Bulk Events/ Transactions

Bulk events have two categories. Transfer bulks have messages that indicate the movement of plutonium solution from one tank to another. Sample bulks have messages that give the analysis of a sample taken from one of four tanks. The design of the MPF treats both categories as independent transactions. In both cases, the information needed to update the database with an accountability transaction is distributed among many messages. The information contained in transfer and sample messages is temporarily stored in tables EVENT_PAD and MEAS_PAD. This information is retained in these "pad" tables until the MPF has all the messages needed to form an accountability transaction.

Transfer bulk uses the current book inventory of the tank divided by the pre-transfer volume to determine concentration. The amount transferred is change in volume multiplied by the concentration.

Sample bulk uses the sample concentration multiplied by the volume at sampling to adjust the inventory of the sampled tank. The difference between current book inventory and the inventory at sampling is either transferred to or from the sending tank.

4.3.3. Processing Of A Sample Bulk Transaction

The processing of a sample to constitute a move bulk transaction is shown in the Jackson diagram titled Store Sample Bulk Inventory (Figure 5). At an overview level, it is a sequence of seven processing steps. The steps are: (1) determine an eventname, (2) does this event already exist, (3) save event, (4) is this a bulk event or physical inventory observation, (5) save the measurement data, (6) is there enough measurement data to calculate the transaction, and (7) complete the transaction.

4.3.3.1. Get Sample Eventname

The first step, which determines an eventname, expands into a selection. The processing takes one of three paths. The first path is an implicit transfer. The sample is the result of moving material into the NSR Multipurpose Waste Handling Tank for a source where there are no auto-messages. The sample run number contains a transfer flag which is decoded into the source for the transfer. The table AUTO_ENAMES has the eventname for this case.

The second path is an implicit transfer to the NSR Sample Assay Catch Tank. All samples are dumped into this tank after analysis. The table AUTO_ENAMES also has the eventname for this case.

The third path results in adjustment of the inventory in the sampled tank to the sample concentration multiplied by the volume at sampling. The sampled tank identity and the batch run number are used to select the source tank for the transfer from table EVENT. The source tank and sampled tank identity are used to select the eventname from table ADJ_SAMPLE_ID.

The eventname is the index into table EVENTPROFILE which contains the qualitative information about the event. EVENTPROFILE also has the calculation method.

4.3.3.2. Does Event Exist

All bulks have multiple messages associated with their processing. This module determines if the message is a new event or if the message is associated with an already existing event. This decision is based on the results of a query on table EVENT_PAD. It prevents table EVENT from being updated more than once by messages associated with the same event.

4.3.3.3. Save Event

If the event does not already exist in the database, this message is a new event. The tables EVENT and EVENT_PAD are updated.

4.3.3.4. Priority

When a sample is pulled, a priority flag is set to indicate if the sample is physical inventory observation or a sample bulk event. This flag is in the sample record message. If the sample is physical inventory observation, tables EVENT and EVENT_PAD are updated to indicate this information.

4.3.3.5. Save Measurement Pad

This processing updates table MEAS_PAD with the analytical information contained in the message.

4.3.3.6. Enough Measurement Data

This processing determines if this message along with the previous messages has enough information to compute the tank's inventory. This check is performed by comparing the number of measurement data rows in table MEAS_PAD with the number of measurement variables required to perform the calculation. The name of the measurement variables, the historic variable, and final calculation steps are stored in the data configuration table, CALCSTEPS.

4.3.3.7 Book Event

If the event is not a physical inventory observation and if all the variables needed for the calculation are available, then the process BOOK EVENT, is activated. BOOK EVENT expands into five sequential processes. The first process updates table MEASDATA with rows in table MEAS_PAD associated with this event. The process ADC_ CALCULATOR is then activated to calculate the grams of material type code 50 for this transaction. Next, table BOOKXAC is updated with the transaction information. The process SUBMIT EVENT is then called which updates table CURBOOK to maintain the current book inventory for the material balance area. The final process erases the rows in the "pad" tables associated with this event.

If the event is a physical inventory observation and all the variables needed for the calculation are available, then an alternate processing path is taken. The first process updates table MEASDATA with rows in table MEAS_PAD associated with this event. The final process erases the rows in the "pad" tables associated with this event. The physical inventory observations do not adjust current book inventory but are compared to current book inventory to determine the inventory difference.

5. CONCLUSIONS

NucMAS uses accountability primitives to process changes in status of nuclear materials which constitute accountability events/transactions. These accountability primitives are applicable to any material balance area because they are data processing abstractions. The primitives post changes in nuclear material status to underlying tables based on configuration data. The configuration data contain the specific information about the control balance accounts, the physical nature of the process, the materials processed, and the calculations to perform for the material balance area.

The Automated Data Collection extension is an NSR-specific layered product for NucMAS. Its modules use additional sets of configuration data. The additional configuration data provides the framework for translating the process and analytical messages into an eventname, a calculation method, and the identity of the accountability primitive to activate. This translation is compatible with all NucMAS concepts and processing.

The Automated Data Collection extension is a product that progressed from conception to successful demonstration in fourteen months. The rapid development and implementation was possible because: (1) NucMAS provided the concepts for the underlying accountability engine and (2) the applications platform used a relational database with a non-procedural language for data queries and updates.

References:

The following papers about NucMAS have been presented at professional meetings and published in the proceedings:

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User: clerk

Menu: MAINMENU

FUNCTION	DESCRIPTION
MOVE	Create/destroy/move items and bulk materials
ADJUST	Correct previously reported book transactions
BROWSE	View various tables
PHYSICAL	Enter physical inventory data, produce PI reports
REPORTS	Produce Daily NMC&A reports and custodian reports
UTILITIES	Menu configuration and system utilities
AUDIT	Produce session log and audit trail

Do (Do) Done (PF3) Help (Help)

Figure 1. NucMAS MAIN Menu

User: clerk

Menu: MOVE

FUNCTION	DESCRIPTION
LOTS	Import, move, destroy, edit a group of items
IMPORT ITEM	Bring an item into this MBA
EXPORT ITEM	Take an item out of this MBA
MOVE ITEM	Move an item within this MBA
CREATE ITEM	Create an item from bulk within this MBA
DESTROY ITEM	Destroy an item into bulk within this MBA
RENAME ITEM	Rename an item
IMPORT BULK	Bring bulk materials into this MBA
MOVE BULK	Move bulk within this MBA
EXPORT BULK	Remove bulk materials from this MBA

Do (Do) Done (PF3) Help (Help)

Figure 2. NucMAS MOVE Menu

MOVEIT MOVE ITEM Event No

ItemName: [ ] Barcode

SOURCE | DESTINATION
CBA | CBA : [ ]
IUN | IUN : [ ]
Position | Position : [ ]
as of | Date/Time : [ ]
Form Code | Form Code : [ ]

MATERIAL		ELEMENT		ISOTOPE	
Code	Description	Code	Weight	Code	Weight

Field HELP (F11) SaveEvent (Do) Comments (F13) >

Figure 3. NucMAS MOVE ITEM Form

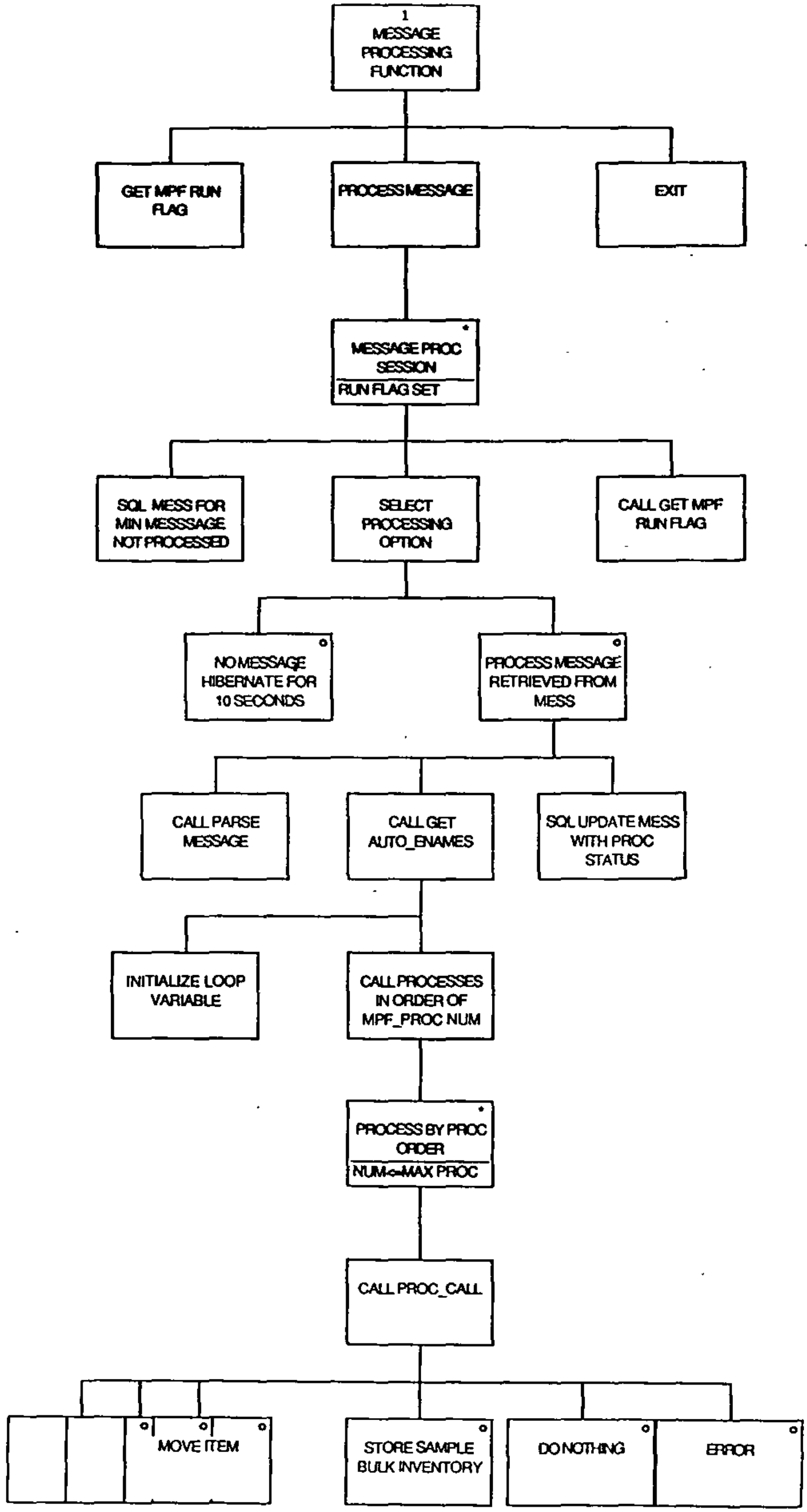

Figure 4. Message Processing Function

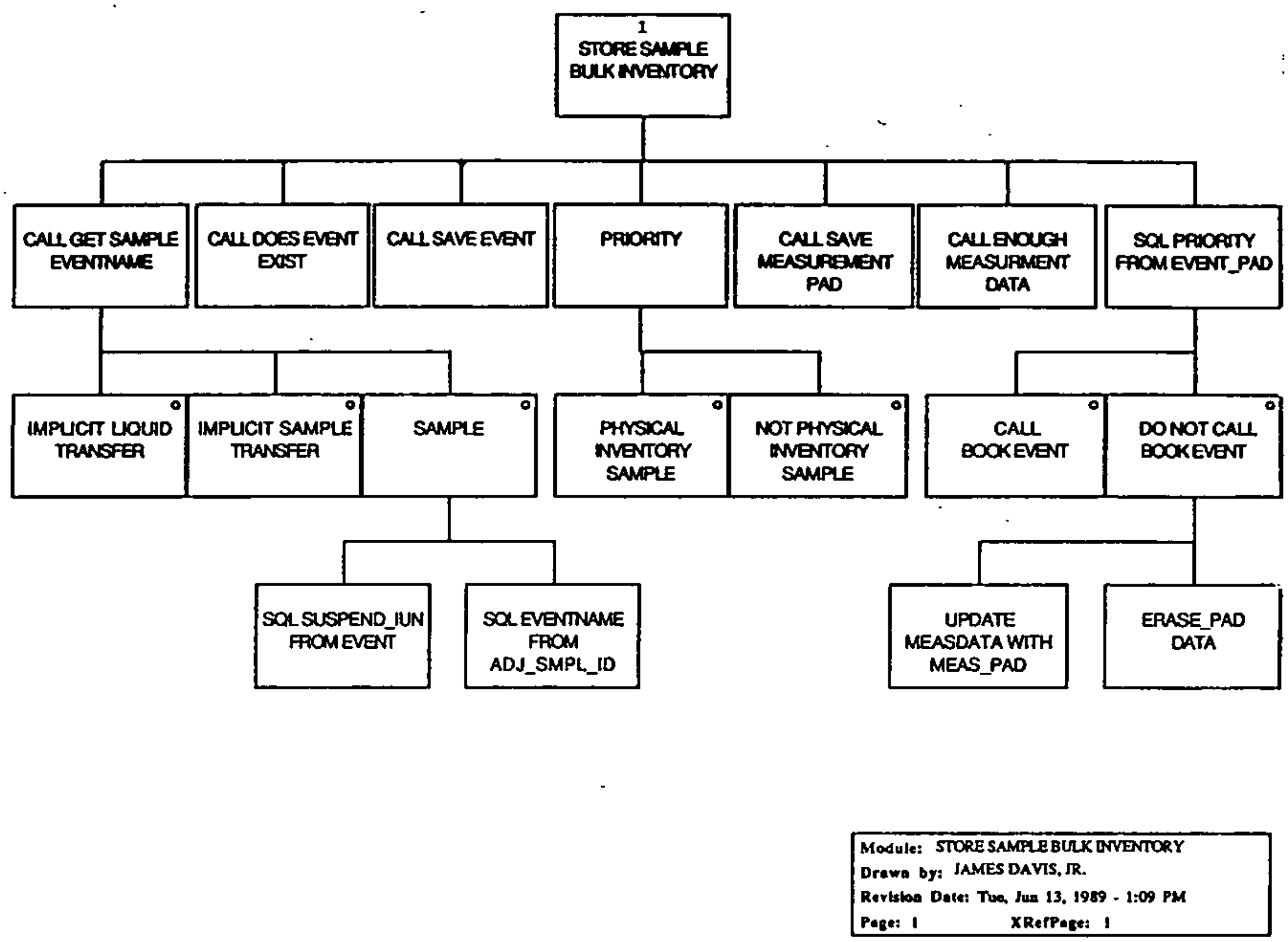

Figure 5. Store Sample Bulk Inventory