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A MANUAL ACCOUNTABILITY SYSTEM DESIGNED TO REDUCE OPERATOR ERROR (U)

by

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A MANUAL ENTRY ACCOUNTABILITY SYSTEM DESIGNED TO HELP REDUCE OPERATOR ERRORS

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ABSTRACT

At the Savannah River Plant, the separations areas are not equipped with automated accountability systems, therefore accountability is performed manually. The accountability personnel must gather material transfer and physical inventory data, compute values, maintain and adjust the books, and prepare the necessary reports. Errors can be introduced at any one of these steps. Several years ago, the Computer Systems Engineering group was requested to develop a computerized accountability system for the separations areas that would rely on manual entry and perform the necessary computations, adjust and maintain the books, and generate the necessary reports. In addition, the system would provide a complete audit trail and help reduce operator errors. Since the separations areas are actually divided into several material balance areas, the Computer Systems Engineering group was faced with several detailed specifications. Rather than designing a computerized accountability system for each material balance area, they designed a generic system that each area could tailor to its process. The system helps in reducing operator errors by displaying simply data entry forms, performing data validations when possible, providing field help, performing all computations, and generating the necessary reports. Many validation tables are user configurable, as well as the equations for computing transfer and inventory values.

DISCUSSION

At the Savannah River Plant, the Separations Computer Systems Engineering group (CSE) was faced with the task of designing and developing a computerized accountability system for the separations areas. The separations areas contain a large number of process tanks and items, and are actually divided into several material balance areas. Currently, none of the processes are equipped with automated accountability systems. The tasks of gathering data, computing transfer and inventory amounts, maintaining and updating the book inventories, and generating reports are all performed manually. The CSE group was asked to design a system for each area that would provide the required functionality, and they were also asked to design a system that could help the user reduce errors.

The major requirements of the systems were defined by the user to be :

- Accept and maintain transfer information
- Maintain and update book balances based on transfer information
- Provide browsing capabilities on transfers based on any field
- Allow transfer information to be adjusted
- Accept and maintain physical inventory information

- o Provide browsing capabilities on physical inventory information
- o Generate necessary reports
- o Maintain an audit trail of all user data entries

Since each areas's major requirements were the same, CSE decided to develop a "generic" system that each area could configure to its own process. Requirements were expanded to allow the user to enter the information into many of the system's validation tables and to enter the necessary equations for computing transfer and inventory amounts. This would greatly reduce the software maintenance of the system since processes and process measurement systems are subject to change. It would also retain control of this type of information with the user rather then with the software group and better ensure necessary corrections would be made timely.

The software application developed is called NucMAS, which stands for Nuclear Materials Accountability System. NucMAS is written to operate on any DEC VAX processor operating under VMS, but with minor modifications, could operate on a wide range of minicomputer and some mainframe processors. The software was developed using the database product INGRES and its forth generation language "ABF". Fortran was used for any required third generation language procedures and SQL as the query language. Close adherence to the relational database model was used to provide the greatest flexibility for future additions and changes. The data input features were decoupled from the data-management and report-writing features to allow multiple sources of data and a clean data path. No data is ever overwritten, but rather superceded with new information. This preserves a complete audit trail of data entries. Process specific information is stored as data rather than in the logic. The user is provided with forms to initialize and modify this type of information.

In addition to providing the functional requirements, much time was spent developing a system that would be easy to use and help reduce operator error. This was accomplished by developing a good user interface to enter data, providing field help when entering data, providing configurable tables that the user can maintain to tailor the system to his area, and performing data validation.

The NucMAS user interface was designed as a set of menus and forms that would be easy for a user to learn and use. Menus are used to display specific functions or groupings of functions. For example, the MAIN MENU (see Fig. 1) contains grouping of functions such as MOVE, ADJUST, BROWSE, REPORTS, and UTILITIES. The MOVE function (see Fig. 2) contains specific functions such as IMPORT ITEM, CREATE ITEM, and MOVE ITEM. While NucMAS menus have been set up to group functions by major operation, they are user configurable. This allows the user to tailor the menus to his specific needs and limit functions by user if required. The user selects a function by the use of the cursor and a select key. By each function name is a brief description of that function.

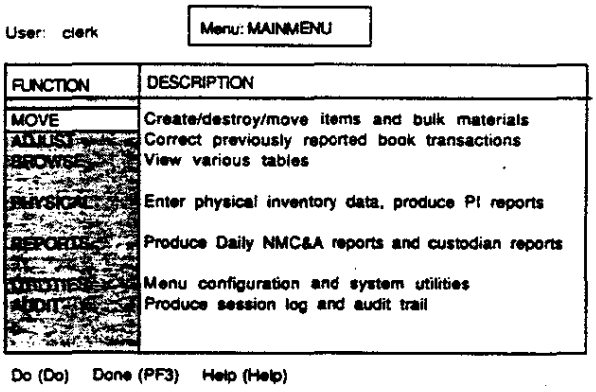

Figure 1 - NucMAS MAIN Menu

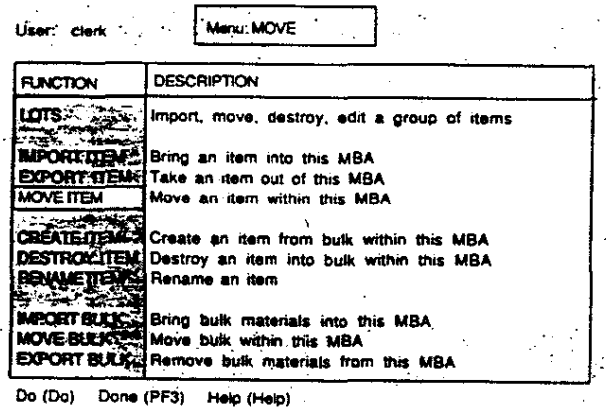

Figure 2 - NucMAS MOVE Menu

Once a specific function has been selected, the user is presented a form. A form is typically a set of data entry fields if information is to be entered and saved, or tables and query fields if information is to be browsed. All forms are kept simple and standardization has been used as much as possible. The various operations that can be performed in a form are shown at the bottom with the appropriate key in parentheses by the operation name. For example, in the MOVE ITEM form (see Fig. 3), some of the operations he can select from are : Field Help (F11) Save Event (DO) Comments (F13).

If required information is already stored in the system, such as source location and material amounts in our example, then it is automatically retrieved and filled into a form for the user. Data entry fields are shown in reverse video with mandatory ones slightly brighter. If color monitors are used, mandatory fields can be displayed in a different color. The cursor has been set to go to the next logical field after the return key, but the user can tab to any field within the form to re enter information.

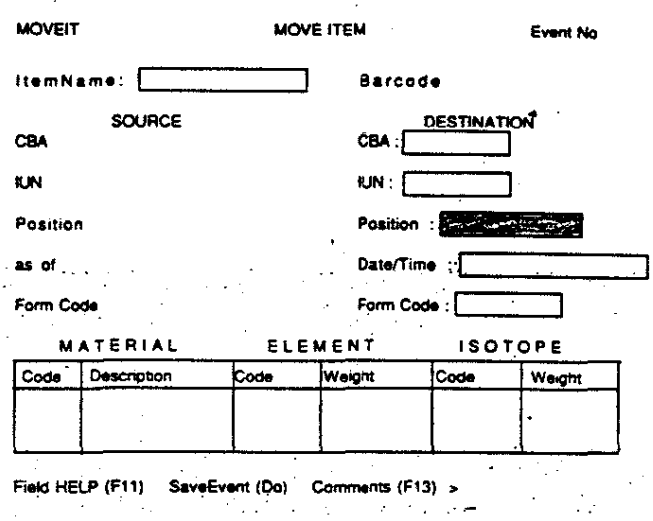

Figure 3 - NucMAS MOVE ITEM Form

The BROWSE TRANSXAC form is an example of a form used to browse information (see Fig. 4), which for this particular case would be transfer information. All fields which the user can use to query by are in reverse video. He can enter information in as many fields as he chooses. Any query can also be qualified with the wild card symbol (*). For example, if the user wants all events that had a source batch name that began with ABC retrieved, he enters ABC* into the source item/batch name query field. If no query is entered, the first record in the data tables is retrieved and the user can press a key to step through additional records. This browse form displays one record at a time, but other browse forms display a table so that multiple records can be viewed. The user can then scroll through the table to browse all the desired information.

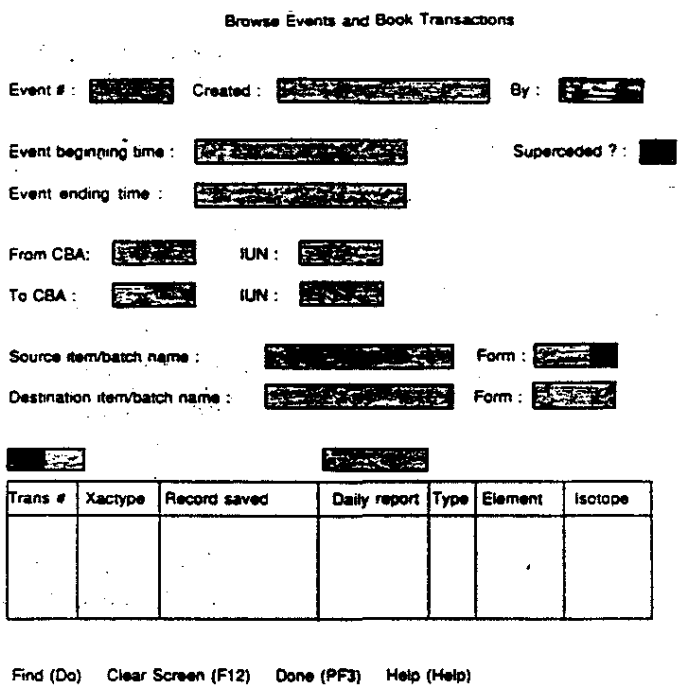

Figure 4 - NucMAS BROWSE TRANSXAC Form

Most data entry fields on forms have help available to the user. Field help utilizes what is referred to as direct control. The user places the cursor in the appropriate field and presses the field help key. He is presented with a table listing the valid choices for that field. The user places the cursor on his choice, presses a select key, and the choice is filled into the form. This helps the user enter the correct information easily by eliminating the need to remember and type in the information. It is also extrememly useful for dynamic information such as item names. If a user needs to move an item, and he can not remember its specific name, he can get field help and be presented with a listing of all current item names while he is still in the form. For this particular case, he can also limit the list of choices by use of a query field.

Many of the fields on a form are validated against a set of allowable values, or what is referred to as a validation table. The validation is performed as soon as the user tabs out of the field to alert the user immediately if there is an error. When an error is detected, the user is requested to correct the entry. When the data in a form is to be saved, all fields are validated again. A save of the data in a form is not performed until all fields are valid. Data validations are performed on such data fields as source locations, destination locations, and material form. Measurement data can also be validated if the user chooses to configure range checks. This is discussed in more detail later in the paper.

Most of the validation tables used to check field entries are configured by the user himself. These validation tables include such information as the material balance areas (MBAs), the control balance accounts (CBAs), the inventory unit names (IUNs), and the material forms. The CBAs are a smaller breakdown of an MBA. The IUNs are a smaller breakdown of a CBA. The forms used to enter this information are also kept very simple. By allowing the user to configure these tables, the descriptions are those of the user, and the user can keep the lists up to date with his process. If new measurement points are required, the user can quickly add then to his system.

Aside from user configurable validation tables, NucMAS also has user configurable equations that are used for computing transfer and physical inventory amounts. The user creates or edits calculation methods with the CALCEDIT function. The user enters each variable description, variable name, and variable type into simple forms. Variables can be either a measured value, looked up in a table, an intermediate calculation, or a final calculation. A measured variable requires no equation, a looked up variable requires the Look Up Table Name and the value to base the looked up value on, and an intermediate or final calculation requires an equation. Equations are

entered in reverse polish notation. For example, to add two numbers a and b together, the user enters the equation "a b + =". Figures 5 thru 8 show some of the calculation method steps and step details for a bulk physical inventory measurement based on a ruska volume and sample concentration.

CALCEDIT Calculation Method Name: 8.1

Method Description: RUSKA CALCULATION

for Transaction Type: pmsbk Physical Inventory - Bulk

and Matl Form: UPS U.PU.NP Solution Range Check

No	Step Description	Variable Name	y/N	Type
5	RUSKA READING	ruska	N	M
10	DENSITY	density	N	M
15	TANK TEMPERATURE	temp	N	M
20	TEMPERATURE CORRECTION	c	N	L
25	HC DENOMINATOR	hcdenom	N	I
30	HC	hc	N	I
35	SLOPE	a	N	L
40	INTERCEPT	b	N	L
45	VOLUME TEMP CORR	tc	N	I
50	PU G/L	puconc	N	M

Figure 5 - NucMAS CALCEDIT Form showing Bulk Physcal Inventory Method

STEPEDIT EDIT STEP DETAIL

Step Number: 10

Type: M Description: DENSITY

Variable Name: density

Range Check Flag: N Range Check Override:

High Alarm: 0.000
High Warning: 0.000

Low Warning: 0.000
Low Alarm: 0.000

Done (PF3)

Figure 6 - NucMAS STEPEDIT Form showing step details for a measured variable

STEPEDIT EDIT STEP DETAIL

Step Number: 20

Type: L Description: TEMPERATURE CORRECTION

Variable Name: c

TABLE LOOK UP (Use FUNCTION_NAME PARAM1 PARAM2 PARAM3)

LOOKUP 81C density c

Range Check Flag: N Range Check Override:

High Alarm: 0.000
High Warning: 0.000

Low Warning: 0.000
Low Alarm: 0.000

Done (PF3)

Figure 7 - NucMAS STEPEDIT Form showing step details for a lookup variable

STEPEDIT EDIT STEP DETAIL

Step Number: 25

Type: I Description: HC DENOMINATOR

Variable Name: hcdenom

EQUATION (Please use reverse Polish notation)

24.3 temp - .000018 * 1 + 25 temp - c * density + / =

Range Check Flag: N Range Check Override:

High Alarm: 0.000
High Warning: 0.000

Low Warning: 0.000
Low Alarm: 0.000

Done (PF3)

Figure 8 - NucMAS STEPEDIT Form showing step details for an intermediate calculated variable

The variable names and descriptions are those that will be most meaningful to the user, and the order of the inputs will be that created by the user. This is very useful if information is being taken from a data sheet, because the same descriptions and order can be used. If the data sheet is modified, the user can modify the equation without any software changes.

For each variable, the user can also set two range checks and the action to be taken if they are exceeded. This would allow the user to set "never exceed limits" such as 0 to 100 for a gauge, and "warning limits" to alert the user if the value is outside the norm. If set, these range checks will be performed when the user tabs out of the field to alert him immediately. Again, because the information is stored as data, the user can modify them as his process changes.

By placing control of this information with the user, it ensures that when changes are made within a process, any necessary modifications to the measurement system can be made very quickly. It allows the user to set up multiple calculation methods for a measurement if they exist in the process. It allows easy modifications to calibration equations and constants.

SUMMARY

While computer systems exist for performing accountability, many programs have focused primarily on functionality. In the area of reducing operator errors, the things that most readily come to mind are the ability of a system to perform the computations, generate the reports, and perform some data validation. There are new areas in software design that were incorporated into NucMAS (Nuclear Materials Accounting System) that also help reduce errors. These include a series of menus and forms for the user interface that are simple and easy to learn, field help for data entry, data validation for most data entry fields including measurement data, and configurable validation tables and equations that the user can maintain.

Slide 1 (Title)

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SLIDE 2 (OUTLINE)

OUTLINE

- Key Features that Help Reduce Errors
- Background
  - System Requirements
  - System Development
  - System Installation
- Details on Key Features

Slide 3 (Key Features)

KEY FEATURES

- User Interface
- Field Help in the Forms
- Data Validation
- Configurable Validation Tables
- Configurable Equations

Slide 4 (Background - Requirements)

System Requirements

- Accept and Maintain Manual Entries for Transfers
- Maintain Books Based on Transfer Info
- Accept and Maintain Manual Entries for Physical Inventory
- Provide Browsing Capabilities
- Generate Reports
- Maintain Audit Trail

Slide 5 (Background - Development)

System Development

- One "Generic" system
- Software Products used
  - Ingres, ABF, SQL, and Fortran
- Relational Database Model
- No Data is Ever Overwritten
- Process Specific Info Stored as Data
  - forms are provide to initialize and modify info

Slide 6 (Background - Installation)

System Installation

- DEC VAX processor operating under VMS
- One Installation of NucMAS per MBA
- Several installations per processor

Slide 7 (User Interface)

USER INTERFACE

- **Menus**
  - **List of functions**
  - **Cursor Used to Make Selection**
  - **User Configurable**
- **Forms**
  - **Kept Simple**
  - **Easy to Move Around**
  - **Data Entry Fields in Reverse Video**
  - **Mandatory Fields Highlighted**

Slide 8 MAIN MENU
Slide 9 MOVE MENU
Slide 10 MOVE ITEM Form