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by

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ABSTRACT

Applicable portions of the eighteen Quality Assurance criteria of Subpart H, 10 CFR 71 are incorporated into a relational data base system which has been designed to manage the spare parts control system for a fleet of spent nuclear fuel casks. The system includes not only parts in warehouse storage but parts in use in the field plus casks, ancillary equipment, test equipment, support devices, and even personnel. It provides a high degree of assurance that any device for which a condition for certification has expired will be flagged for recertification testing or removal from service well before the critical date.

INTRODUCTION

In 1987 ORNL contracted with Transnuclear, Inc. to provide a summary of Transnuclear's experience in the operation of a fleet of spent nuclear fuel shipping casks. The first phase of that summary dealt primarily with handling the system hardware. The second phase, published in 1988, described computer software that had been developed in support of the cask fleet parts control system, with Quality Assurance (QA) being a salient factor in the design of the software. The results of that work form the basis for this paper.

Commercial organizations may have both sophisticated warehousing and comprehensive QA programs but these are not ordinarily integrated; QA is usually applied only as an audit function of the warehouse. In the nuclear industry, the concept of parts control should be expanded from the conventional concept in two ways. First, it should apply not only to parts in the warehouse but also to those in active use. Second, the control of parts should be built around the QA program requirements to support materials traceability, certification status, etc. Subpart H of 10 CFR 71 includes 18 criteria for QA in cask design, fabrication and operation. This paper discusses how a QA/Inventory software program is used to support the operations phase of a transport system wherein all procurement, testing, personnel qualifications, equipment certification, etc. are audited automatically with each data entry that reflects a transaction. The QA overview is applied to operations on a real-time basis.

DISCUSSION

The characteristics of a software system for the control of parts in inventory for a spent nuclear fuel Transportation System are described in this paper. The system, based on programmable relational data base micro-computer software, was developed by Transnuclear, Inc. and is provided here as an example of how a software system can support QA requirements. In this concept, the term "parts in inventory" is used very broadly, and includes not only replacement parts, but active cask systems, testing equipment, ancillary equipment and personnel.

Outwardly, the program is a typical inventory control system. Purchase Orders are prepared for the procurement of parts, Receiving Reports record incoming items, parts are issued from stock when a Parts Requisition slip is presented, and even an occasional Journal Entry is needed to cover what would otherwise be a gap in an audit trail (e.g., a change in location of a part). A record of each transaction is routed through a computer system operator for entry into the system. Each type of transaction has its unique data entry form (or "screen", so called because they appear only on the CRT monitor) and it is during this data entry that many checks and tests are applied.

The data base described in this paper consists of about 45 files, or data tables[1]. Each file serves a unique purpose (inventory status, testing status, supplier data, etc.) but each file also includes an attribute (e.g., "part number") that is common to at least one other file in the system. Thus every file can be related (hence, "relational data base") to every other file in the system, directly or indirectly.

Approximately half of the files in the system are records files, with the remainder divided between transaction files and archival files. Records files reflect the current status of whatever is being monitored (inventory quantities, test due dates, etc.). Transaction files are used to accumulate new data, then are depleted as those data are used to update record files. Archival files are used to store permanently all completed transactions. There are, in addition, about a dozen data entry screens and a like number of report forms. The manner in which these various files and screens relate to one another is shown in Figure 1, System Menus. Data can be entered into the system only by using one of the existing data entry screens, either for introducing new items or updating existing items. It is within the built-in editing capability of these data entry screens that much of the quality

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[1] A file consists of a two dimensional data matrix in which the columns identify attributes of a given item while the rows of data each reflect a unique record, or entry, into the file.

assurance comes into play. Each entry may have one or more limitations on what will be accepted. Some of the decisions are based on logic, some are based on limits of numeric ranges, some entries are mandatory under certain conditions, and other entries are calculated by the program as a result of other entries. When the data entry form is processed, the information that it contains may be directed to as many as five different files. This eliminates transposition errors that are likely to occur if data were copied five times.

Prior to the entry of each new item into the computer, the complete characterization of that item is made, in this example using fourteen criteria, and the information is approved by representatives of Engineering, QA, and Operations. Changes require the same approval. The file which contains all of these complete characterizations is called the "master" file. The fourteen criteria (or item attributes, or file column headings) are listed as follows and the manner in which QA is incorporated is discussed for each.

1. PART NUMBER. The arbitrarily assigned part number is unique to the part to which it is assigned. The system will not accept assignment of an identifying number to a new part if that number has been assigned previously. A part number cannot be assigned to, or used in, any other file unless it exists in the master file. The part number is the common link between most of the other files. Its use provides assurance against ambiguity in the item it represents.

2. DESCRIPTION. The description is a series of key words in descending order of descriptive importance. It, along with the next three items can be used to identify an existing part number if the latter is not known.

3, 4, & 5. SIZE, MATERIAL AND UNITS. These are used to supplement the description of the part. A linking together of item 2 and these three items, along with the catalog number, is copied from this file onto any purchase order for replacement parts so that the description is always accurate and consistent.

6. SUPPLIER. Each supplier is assigned a unique three digit code. The code is included in the master file and is the common link to a file containing supplier's names, addresses, etc., plus a notation as to whether a given supplier is approved for procurement of items important to safety. The supplier code that exists in the master file is always the last supplier that was used for ordering that part. When editing a purchase order form (which the program can display simply by entering a part number) the operator may change quantities but, for parts important to safety, may not change the supplier information. If supplier information is to be changed, it must first be changed in the master file. This

can be done only after the procurement documentation (see item 11, below) is changed and approval is granted. The steps required to change the procurement documentation are similar to those for any other design change.

7. MANUFACTURER. The manufacturer is specified so that the supplier may not make arbitrary substitutions when filling a purchase order.

8. CATALOG. Whenever a supplier code is changed in the master file the corresponding catalog number is erased. The operator must enter the new catalog number from the paperwork authorizing the supplier change.

9. LIFE. Some items, elastomer gaskets being an example, have a limited shelf life. For elastomer gaskets, the date of "cure" of the plastic is taken as the start of shelf life. The "life" of an item for this purpose is the period of time during which the material will function as intended minus the time duration that the part may remain in service. When the cure date of the gasket is entered as a part of the receiving information, the "life" will be added to that date. The end result is a notation on the parts label (it is printed automatically from receiving report information) stating, "This part must be installed or discarded on or before (date)." Manual calculations are eliminated.

10. SAFE. If the notation as to whether a part is important to safety is affirmative, the program initiates additional checks. For example, there must be an entry for the next attribute (CERTS) or the system will simply stop at that point until a valid entry is made. Also, following an affirmative indication, other files in the system are automatically appended with the codes for test requirements for recertification of that part.

11. CERTS. Any item that is important to safety should be ordered with sufficient documentation so that there is no misunderstanding as to the intent of the order. For some catalog items (bolts, shackles, etc.) this documentation, a Parts Data Sheet, will consist of a complete description of the part and will have been approved by both the project manager and the QA representative. A copy of the appropriate document must accompany the purchase order to the supplier with the requirement that the supplier provide assurance that the order was filled accordingly. For a custom fabricated item, a Procurement Specification is prepared which includes drawings, material specifications, references to all appropriate national standards, the testing to be performed and the requirements for reporting results of the testing. Both types of documents will have a unique identification designation; this designation is entered into the record field for this

column. When a purchase order is prepared for any part that is important to safety, the system will not process the order without including the document identification as a part of the order.

12. TESTS. Some parts that are important to safety require recertification for use after a specified in-service time. There is a separate file for all such part numbers, in which up to seven test requirements may be noted. The test requirements themselves are coded to indicate who does the testing, the type of test and the interval between tests. For example, GM.5 identifies a gage that must be recalibrated by the manufacturer every six months (0.5 yr.); VT denotes an annual visual testing requirement for personnel to qualify for visual inspections. A written procedure is required for each recertification test. If the test is completed satisfactorily, the designated testing interval is added to the test date and a new due-date is calculated by the program. Test participants' employee identification numbers may be included in the results and if the qualification of a test participant for that particular test has expired, the program will not accept the test results.

    It should be noted that serially numbered parts are identified by both part number and serial number. For example, six casks of the same model with SAR requirements for seven tests will be tracked as 42 separate items. If certain parts are interchangeable, such as containment covers, impact limiters, etc., those are tracked separately from the cask body.

13. &
14. These are record items that are used for administrative assistance to the system managers and auditors. For example, the date last accessed is a convenient indicator of whether the record has been used within a recent time frame. The calculated "lead time" for procurement of an item will flag unrealistic delivery date requests.

The above describes one of the twenty or so records files. The other files are subject to similar cross checking as they are being generated or used.

Another way of looking at how QA is incorporated into the database system is to relate it to several of the 18 criteria given in Subpart H of 10 CFR 71.

1. Procurement Document Control (10 CFR 71.109, criterion 4) Each part that is important to safety is described on a Parts Data Sheet for off-the-shelf items or in a Procurement Specification for special items. Each document is prepared by an engineer, based on the requirements of the SAR, and approved by the Quality Assurance representative. When any

item is purchased it must conform exactly to these specifications. All of these procurement documents are identified in the master file. When a part is procured, the appropriate document is included automatically on the purchase order as a condition of purchase. When the material is received, the identification automatically appears on the receiving report as an item required for acceptance of the order.

A requirement of the procurement document control system is that each revision of a document be distributed to all holders of controlled copies. The computer manager is on the controlled distribution list. An entry is made on the document cover sheet as to when the revision number is updated in the computer files. This entry may be audited by calling up the updating record from the archive files.

2. Instructions, Procedures, and Drawings (10 CFR 71.111, criterion 5)
The system is designed to identify all of the parts in each drawing. From this, one may list all of the inventoried parts required for any given assembly. It may be used by designers to compare parts used in a new design with items already on inventory in order to minimize inventory investment. It may be used to provide various listings specifically related to parts important to safety. It also provides data for cost estimating. The quality related contribution of the system in this area is the elimination of errors as parts are referenced in related work.

3. Control of Purchased Material, Equipment, and Services (10 CFR 71.115, criterion 7)
A receiving report can be printed, except for quantities received, by entering only a purchase order number and item number into the system. The report form will include any certification requirements that must accompany each part from the vendor. The operator may change quantities, indicate backorders, etc. If the item has a limited shelf life the operator must include a "date of manufacture" as a part of the receiving information or the system will not accept any of the information.

4. Identification and Control of Materials, Parts and Components (10 CFR 71.117, criterion 8)
As each receiving report is processed, identification labels are printed for attachment to each part while it is still in the receiving area. The labels for nonconforming parts are attached to red tags for rejects or yellow tags for "hold" even though the printed labels include such status in bold letters on the label. Only green-labeled parts are sent to inventory or to the field; the rest remain in areas designated for nonconforming parts.

The entire parts control system is intended to provide identity and useability control with a minimum of errors. Each part is assigned a unique part number which is the key to all information related to that part from the time it is first specified for use. Numerous cross-checks that are built into the system effectively eliminate the chance for incorrect identification of any given part.

5. Test Control (10 CFR 71.123, criterion 11)
The tests to which various components are subjected, and the frequency of those tests, are defined in the SAR. Each test procedure is handled as a controlled document. As part of the document control procedure, the identity and revision number are entered into the parts control system. If there is disagreement between test reports and system procedure identification, the test results are not accepted by the system. If the test is accepted by the computer system, it automatically calculates the due date for the next testing, to the proper standard, of that item. Any item requiring multiple testing is recorded as many items as there are test requirements. If a cask, for example, requires seven different tests, even at varying time intervals, and it has tested satisfactorily within the due date for six of the tests but not for one of them, the cask is reported as out of compliance. The exception to this rule is for personnel. A technician may be overdue in maintaining qualification for performing one procedure but that will not preclude the technician from performing another for which he or she is currently qualified.

One of the best features of the system is the ease with which it produces a listing of the status of all testing for every item in inventory or in the field. This listing, an example of which is shown in Table 1, is sorted by "next date" for which each test is due. By the simple procedure of separating the list before and after the current date, one can see exactly which items are out of certification and the reason why. The listing also is a useful planning tool for scheduling future testing, by category.

6. Control of Measuring and Testing Equipment (10 CFR 71.125, criterion 12)
In this system, measuring and testing equipment (M & TE) are assigned a part number (and serial number, if necessary) and the system provides all of the controls normally associated with M & TE control procedures, with the addition of automatic flagging of recertification testing dates.

7. Handling, Storage, and Shipping (10 CFR 71.129, criterion 13)
All parts are handled as individually tagged items and each is assigned an identified storage location. Safety-related items

are so noted on their computer-generated identification labels (see item 4, above) and are stored in locked cabinets.

If special shipping instructions are required, they appear on the Parts Data Sheet or on the Procurement Specification which will always be included with the procurement order.

8. Inspection, Test and Operating Status (10 CFR 71.129, criterion 14)
Computer generated status tags, otherwise known as certification stickers, are attached to all equipment requiring periodic recertification. The audit trail for these stickers is found in the test control feature of the system.

9. Nonconformances (10 CFR 71.131, criterion 15) and Corrective Actions (10 CFR 71.133, criterion 16)
Instances of nonconformance may come to light in materials receiving, in testing, and through observation in the field. It is vital that nonconforming parts be accurately identified and physically segregated from useable parts. Automatic generation of identification labels, as a result of processing nonconformance reports, will help accomplish this. It is also important that records reflect the true status of inventories, testing schedules, and performance histories. If a part fails a test it will have a nonconformance number assigned and the test date will not be updated, keeping the item in the "overdue" category until successfully retested or discarded. When an item is discarded, pertinent data enter the system through an accounting technique known as a Journal Entry. The Journal Entry is used to fill any gap that might otherwise occur in an audit trail.

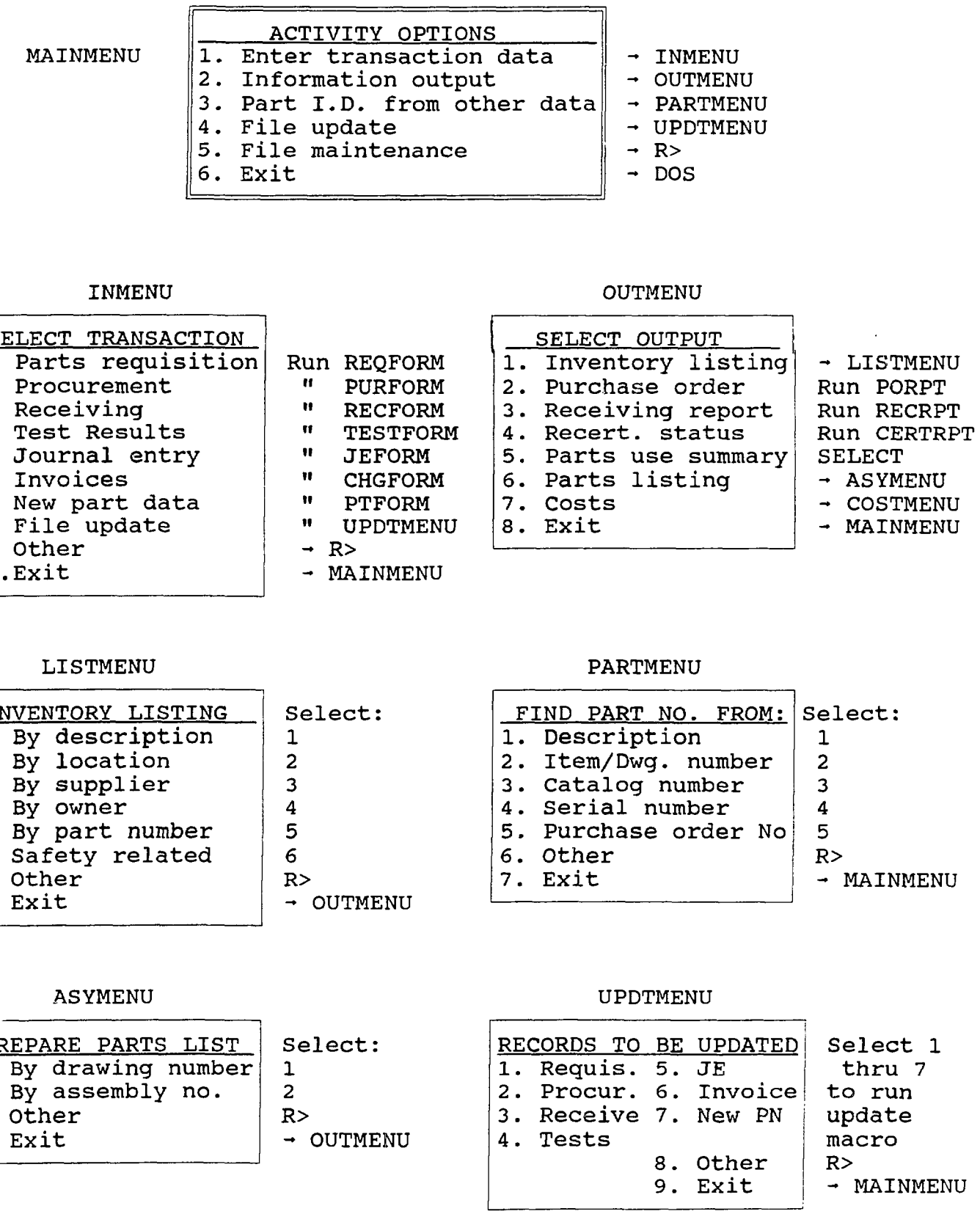
10. Quality Assurance Records (10 CFR 71.135, criterion 17)
The system helps provide quality control on a real-time basis, and provides easily followed audit trails over the history of a given part or groups of parts. It is very flexible in generating reports, either routinely or as requested for special purposes. The archival files are readily accessed for quick and highly selective information retrieval.

11. Audits (10 CFR 71.137, criterion 18)
Routine data processing in a properly designed system will provide a set of computer files which may be accessed by an auditor to verify compliance with required procedures and specifications.

CONCLUSIONS

Quality Assurance is a cornerstone of any nuclear program. Of the three phases of a spent fuel shipping cask program (design, fabrication, and operations) the first two are well structured and executed. The QA aspects of the third phase historically have been less well defined. This report has endeavored to show how a rigorous treatment of the control of spare parts and operational equipment, including personnel, can contribute significantly to the Quality Assurance of the Transportation System. While Quality Assurance has been emphasized throughout this paper, one should not loose sight of the fact that the program is, primarily, one of inventory control. One may readily obtain information on quantities available, locations of items presently being stored or used, and whether reorder quantities have been reached, in addition to the Quality Assurance-related information discussed in this paper. With no special modification, the program may be used by the Health Physics Department to track personnel and instrumentation for testing due-dates, and for historical data. The Document Control function may also be considered for expansion within the system, similar to that presently used for procurement document control. The software is considered to be a living program in that the cross checks, logic analyses, and audit trails continue to evolve through use and analysis of the results.

Figure 1. PARTS CONTROL MENUS



RECERTIFICATION STATUS REPORT

DATE: 05/20/92 PAGE 1

PART NO.	SERIAL NO.	LOCATION	OWNER	DESCRIPTION	TEST CODE	CERT. REF.	NEXT TEST DUE DATE
1122	6.1	A-Yard	01	Cask, Shipping	T2	E-5678	03/15/92
4332	TN038	A-Hold	01	Thermometer	GM1	E-5771	03/20/92
0562	SN/19	A-Yard	01	Pin, Lifting	T6	E-5790	03/22/92
1122	6.1	A-Yard	01	Cask, Shipping	T4	E-5823	04/03/92
1123	7.2	A-Yard	01	Cask, Shipping	T2	E-5856	04/23/92
0990	532	Aiken	01	XJohnson, Kathy	VT	A-0878	05/15/92
2579	01	Dresden	03	Pump, Vacuum	TM.5	A-1025	05/20/02
1657	13	A-13C	01	Gage, Vacuum	GM.5	A-1135	05/31/92
1123	6.1	A-Yard	01	Cask, Shipping	T2	A-1223	06/16/92
0865	487	Aiken	01	XSmith, Joe	TR	A-1002	06/30/92
0990	532	Aiken	01	XJohnson, Kathy	25	A-0590	08/15/92
2334	21	Rowe	01	Yoke, Lifting	LT	E-5743	09/22/92
1122	6.1	A-Yard	01	Cask, Shipping	T2	E-5777	09/25/92
2143	12	B-34A	01	Gage, Pressure	MP.5	A-1011	10/12/92

Table 1.
Example of Recertification Status Report