LOS ALAMOS PLUTONIUM FACILITY WASTE MANAGEMENT SYSTEM

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ABSTRACT

This paper describes the new computer-based transuranic (TRU) waste management system (WMS) that is being implemented at Los Alamos National Laboratory's (LANL's) Plutonium Facility. The WMS is a distributed computer processing system that is stored in a Sybase database and accessed by a graphical user interface (GUI) written in Omnis7. The WMS resides on the local area network at the Plutonium Facility and is accessible by authorized TRU waste originators; radiation control technicians (RCTs); and Nondestructive Assay (NDA), quality assurance (QA), Safeguards and security, Waste Management Facility, and waste management personnel for data input and verification. The WMS has transformed TRU waste paper trail into a computer trail, thereby saving time and eliminating errors and inconsistencies in the process.

INTRODUCTION

The Nuclear Materials Technology (NMT) Division, as the landlord of Los Alamos National Laboratory's (LANL's) Plutonium Facility, has recognized for many years that cradle-to-grave tracking of transuranic (TRU) waste could be accomplished most expeditiously by a computer network-based, real-time data generation and tracking system. Toward this goal, LANL Plutonium Facility's waste management system (WMS) was conceived in 1991, and launched in 1993 with a week-long meeting of users and programming personnel to determine system requirements.

Phased implementation of the WMS inside the Plutonium Facility began in August 1995, with the submittal of waste information by the waste originator to the materials management and waste management groups. Full implementation at LANL's Plutonium Facility was implemented in mid-1997. Advantages realized so far by the use of this system include reducing the duplicated effort required in transferring information from one group to another; and standardization of waste-naming conventions for the entire facility, which makes it much easier to review waste generation data for one or any number of processes. The WMS has also eliminated transcription errors, calculation errors, missing certification signatures, and incorrect discard authorizations; reduced the time required to originate paperwork and review that paperwork for accuracy; and eliminated the need for a data entry clerk at the Plutonium Facility.

MANUAL PAPER TRAIL FOR TREATMENT AND PACKAGING OF TRU WASTE

The following text describes the pertinent details of the TRU waste certification and packaging process at LANL's Plutonium Facility as the process existed before the implementation of the WMS. This description serves as a "before-and-after" picture to highlight the quantum leap in data handling that is represented by the WMS.

The documentation trail for a TRU waste item begins with the generation of the item. The originator completes a form called the Waste Origination and Disposition Form (WODF), giving the item an identification number and identifies the waste item matrix, originating process, date of origin, weight with and without packaging, volume, and regulated materials in the item. The originator signs and dates the form, thereby ensuring that the waste item was appropriately characterized. A TRU waste management

technician then visually inspects the item and verifies the originator's characterization. The waste management technician determines whether the item is a solid waste or a waste form destined for cementation. The technician then signs and dates the WODF. For a debris-type waste, the item is bagged out of the glove box system in a materials management room and sent to the Nondestructive Assay (NDA) laboratory for nuclear material assay. The assay information is recorded on the WODF, and is signed and dated by the person who performs the measurement. For a liquid waste, the item is mixed and sampled. The sample is then removed from the glove box system and sent for radioanalysis.

Once the radioanalysis assays are returned, a waste management technician calculates the special nuclear material (SNM) and the uncertainty in the item's measurement. The assay information and identification of the instrument used are recorded on the WODF and signed and dated by the waste management technician who is performing the calculations. One use of the assay information is for waste management personnel to determine that the amount of SNM in the item is not practically recoverable from the matrix and, therefore, can be disposed. The waste management technician performs the calculation, enters the results on the WODF, and determines whether the item is below the discard level by comparing his calculation to tables of discard values. The waste management technician then checks a box to indicate whether or not the item met the discard limits. The technician then signs and dates the WODF.

When it is determined that a waste item is discardable, the waste item is sent to the solid waste packaging room or to the cementation process. For a solid waste, the item is added to an empty or partially filled waste container with the appropriate categories of LANL TRUPACT-II (Transuranic Package Transporter-II) Content (TRUCON) codes. The physical description (identification number, weight, etc.) of the item is copied to a log sheet for the container, which is called a discardable waste log sheet (DWLS), and the discard information is added. The technician then signs and dates the entry. As other items are added to the container, a running total of the SNM plus twice the uncertainty in the individual item measurement is kept on the log sheet to ensure that the criticality limit for the container is not exceeded.

A cemented waste item is treated in the waste container by adjusting the pH of a solution or adding a soluble particulate to acidic-solution. Cement is then added to the container to immobilize the treated waste in the container. A non-soluble particulate would be added to the cement paste. Liquid waste (normally plutonium contaminated nitric acid evaporator bottoms) is combined into feed tanks and subsequently split from the tank into drums. The cementation process is based on the drum volume, and the amount of waste to be added to the drum is calculated based on the acid solution, caustic solution, solid, water, and cement ratios (A/C/S/W/C). The waste management technician calculates the ratios for each waste item that is going into a drum using a calculation work sheet (CWS) and enters the data along with a calculated SNM, SNM uncertainty, weight, and volume on the Cement Fixation Data Sheet (CFDS). When processing a cement drum, waste items are commonly split; therefore, the SNM and SNM uncertainty must be recalculated. A second waste management technician for verification recalculates all calculations. Discrepancies are corrected, and both technicians sign and date the CWS and CFDS. During processing, weights, volumes, and a running total of the SNM plus twice the uncertainty in the individual item measurement is kept on the CFDS to ensure that the SNM limit for the container is not exceeded. Other steps on the process are also recorded on the CFDS (e.g., pH readings, weights, volumes, time, etc.). When cement has set, the drum is removed from the glove box system, and the data from the WODF, CFDS, and CWS are transferred to the DWLS.

A full container is closed and a tamper-indicating device (TID) is installed. The DWLS already contains information about the container and packaging configuration (e.g., waste container identification number, tare weight, and whether it contains lead shielding).
Once a container is full, the individual package weights for a solid waste container are summed, and the tare weight of the container is added to obtain a calculated gross weight. The container is then put on a

scale. The scale weight is compared with the calculated weight, and the scale weight is entered onto the DWLS. A solid waste container then goes through a confirmation assay for radionuclide content, and the result of the assay is compared with the calculated SNM total. NDA laboratory personnel sign and date the assay information. For a cemented waste container, the weights and volumes are verified during processing, and the scale gross weight is the accepted weight for the drum. These volumes and weights are entered onto the DWLS. The net weight is then calculated and entered onto the DWLS. For a cemented waste container, no confirmation assay can be done because of the lead shielding in the drum. The SNM and uncertainties are totaled, and the weights of any hazardous materials are summed.

When the container has passed the weight and assay checks, the pertinent information on the DWLS is transferred to the transuranic waste storage record (TWSR), the official document for transmitting the container to the LANL Waste Management Facility. The TWSR has already been started for the container, including the waste container identification number and the signed and dated empty container integrity inspection. Additional information includes the container carbon filter identification number, the TRUCON code, the date the container was closed, and the waste profile form (WPF) number. This form is completed by Plutonium Facility waste management personnel and reviewed and approved by LANL Waste Management Facility personnel. The waste management technician completing the TWSR signs and dates it. The container is then surveyed for surface contamination and dose rates at the surface, 30 cm, and 1 m. This information, along with the survey instrument identification number and calibration void date, is recorded on the TWSR. The radiological control technician (RCT) signs and dates this portion of the TWSR.

The completed data package is copied by the data package coordinator, who then sends the package for review and approval. The coordinator takes the package to each reviewer sequentially and tracks the progress of the package through the review cycle using a dedicated database. The data package is reviewed, signed, and dated by the TRU waste Operations Team Leader, the on-site quality assurance (QA) representative, the nuclear material accountability representative, the LANL Waste Management Facility acceptance personnel (who also prepare the shipping manifests), and LANL Safeguards and Security personnel. Any problems identified during the review cycle are corrected immediately by the person responsible.

The Plutonium Facility waste shipment coordinator then receives the data packages (including the shipping manifests) and prepares a shipment. This entails coordinating a shipping date and vehicle; setting up a road closure (the containers travel on a public road); reviewing and signing the shipping manifests; marking and labeling the containers; setting up the final formal container inspection prior to shipment; and working with the waste management technicians to load the containers on the shipping date. The original data package and the waste manifests accompany the containers to the LANL Waste Management Facility, where the containers and official paperwork are stored.

After the containers leave the facility, the copy of the data package is given to a data clerk at the Plutonium Facility to input the information from the DWLS and TWSR into a dedicated TRU waste database. These data serve only as local information and are not subjected to extensive QA. The copy of the data package, as well as copies of the signed waste manifests, are kept on-site. Supporting documentation (e.g., assay results, CWS, and CFDS) are stored by the operational personnel.

When the containers are received at the LANL Waste Management Facility, the information on the data packages is entered into the official LANL waste database. The quality of the data entry is checked extensively under a system called double data entry to ensure accuracy.

THE COMPUTER SYSTEM

Background Information

The WMS mirrors the paper TRU waste data package system described above. During beta testing and implementation, use of the system required the buy-in and extensive testing and input from all of the different organizations that were involved in providing and verifying information for waste certification. Through the WMS programmer's daily interactions with these personnel, many improvements were and are still being made in the way the process is handled to take advantage of the automated capabilities of the computer. The product of the WMS is easier to interpret and only contains relevant information. One programmer has worked on the WMS since its inception and into the production model to control the system. Therefore, the programmer had an intimate knowledge both of the computer program and the process. During the phased implementation of the system, the programmer was able to recognize inconsistencies between the program and the process and make changes as appropriate to ensure a smoothly running operation.

The WMS data are stored in a Sybase database, which resides on a Sun Workstation. It is accessed throughout the facility using a graphical user interface (GUI), which was written in Omnis7, a client/server development tool. Client/server computing breaks programs into two parts: one part on the local workstation, the client that requests data; and the remainder on one or more server machines that supply the data. This program can be run using Windows 3.1, Windows 95, Windows NT, or Macintosh operating systems. The following paragraphs describe the pertinent details of the process for certification and packaging using the WMS.

Most information is selected from dropdown lists, check boxes, or radio buttons. A dropdown list is a field on the window, which may be expanded to a list of choices by using the mouse. A check box is a field that indicates a yes or no selection. A radio button allows the selection of options that are mutually exclusive. One primary requirement of the system was that it be easy to learn and use.

Initially, network connections and computers were not available in many rooms of the Plutonium Facility, so the originators had to go to the waste management operations room to input information. Waste management technicians were available to assist the originators in logging onto the network; and completing the form electronically.

The implementation of the WMS required that upgrades to networking capabilities be made throughout the Plutonium Facility so that originators would have the ability to log on to the system in their own processing room and input the waste item information. This included adding new network lines and ports in the rooms and purchasing new hardware and software. Waste management personnel purchased portable laptop computers, which are used to travel to the originators location, plug into a network port, and input waste item data.

Two major hurdles to overcome in the implementation of this system were the QA requirements for signatures of the various individuals who input information to the system and for an auditable trail of changes made to the data. This required setting up a list of authorities, identifying who could change data that has been entered into the system. It also required setting up record tables to track changes made to an item. An example of the way the list of authorities works is that the TRU waste team leader who is reviewing the data package can only review the package and request the waste management team member who entered the data to make changes or corrections, if needed. If a change is made in a data item at the level of the waste management team member, for example, all prior approvals on the data package are revoked and the package has to be reviewed a second time with the corrected data.

During all test phases, paper forms were completed and used to conduct parallel testing of the WMS. The purpose of the parallel testing was to confirm the accuracy and usability of all aspects of the system by allowing all levels of users to compare the information, calculations, and process handling to the actual paper system. All final documents were reviewed to determine accuracy at the conclusion of each implementation phase, and a log was maintained to document and address errors when located. The paper form remained the official form until parallel testing of this phase was completed. Errors identified during the parallel testing phase were tracked and used to correct the computer program and to re design the process to include only essential information. When the tracking statistics proved that the confidence level in the data was very high, the paper forms were deleted as a confirmatory step, and the data in the WMS became the official waste record. The TRU Waste data package can be viewed on-line at any time during processing. All approvals are listed so that viewers can determine the current stage in processing for a given container.

The final TWSR includes the SNM measurement information and the uncertainty. The WMS includes this information on each waste item in the form of a measurement of material type amounts. The waste item information has to be manipulated by the computer program to calculate the isotopic information required on the TWSR. On the paper system, this was accomplished by a spreadsheet program run for each container, which also calculated the Curie values. The calculation results from the spreadsheet were then transferred to the paper TWSR. This spreadsheet step has been eliminated using the WMS since the computer program now performs the calculations. Isotopic values are available on the WMS in either gram or Curie amounts.

Computer Trail for Treatment and Packaging of TRU Waste

The first phase of the WMS was introduced in the Plutonium Facility in August 1995, with the requirement that originators input the same information on the computer that they were submitting to waste management personnel on a paper WODF. The waste originator logs on to the system and characterizes the waste. The waste item is assigned a unique identifier, which contains an abbreviation of the process that originated the waste and of the waste matrix, as well as a sequential waste item number for that process and matrix.

The new item is visually inspected and approved on-line by waste management personnel. At the time of approval, rigorous checks are in place to ensure that all information is complete. After approval, the generator may no longer modify the data that describe the item. Modifications require reapproval.

An approved waste item is eligible for assay, which was the next phase implemented for the WMS. For solid waste and particulate waste items, the waste originator requests an assay on line. The item then appears on the list of items ready for assay to personnel in the NDA Laboratory. NDA personnel ready to receive an item, notify the waste originator, and the item is bagged out of the glove box line and brought to the NDA Laboratory to be measured. After measuring the item, NDA personnel enter the results of the assay into the system.

For a liquid waste item, the originator samples the item and submits the sample for radiochemical analysis. Upon receiving the assay results, the originator contacts a waste management technician, who enters the assay results into the system. The system compares the assay results to the discard limits for the item being measured and displays the two values. If the item exceeds the discard limit, NDA Laboratory or waste management personnel are asked to confirm the information. If the information is confirmed and the item is above the discard limit, approval is removed from that item. This then allows the item to be reinspected to determine whether there are errors or if it should be converted to a nondiscardable item. If the item does not exceed the discard limit, it then becomes available for treatment or packaging into a waste container. Waste management personnel notify the waste originator(s) when they are ready to package or treat an item.

As each solid waste item arrives, waste management personnel use the system to locate the appropriate container—either a partially filled container with the same matrix (the system keeps a rough account of how full a container is), or an empty container; and electronically place the item in the container. The system calculates the resultant weight and SNM of the container. The item is then physically placed next to the container into which it will be packaged. When personnel confirm that none of the containers will exceed the SNM limits and that all containers are ready to be packaged, they don respirators for the actual packing operation. One person operates the computer terminal while the others do the packing. The containers are opened and each new item is weighed and the final package weight of the item is provided to the individual at the terminal. This final measurement allows the completion of all calculations required for the individual waste items. The waste is then physically placed into the container.

For a waste item that will be cemented, the waste management technician opens the cement processing screen; and enters the target volume of the drum, the scale used, and the pH calibration data. The technician then opens a planning screen that shows items that are ready for cementation. The technician selects items to be added to the drum. Depending on the item, the system calculates the volume of the item and any additional chemicals needed to treat the item and subtract the volumes from the targeted volume for the drum. The technician opens the processing screen where the items selected and the evaporator bottoms will appear. The technician electronically packs any off normal solutions or any soluble particulates into the drum. The WMS calculates the volumes, SNM, and twice the SNM uncertainty for the drum and displays the amounts on the screen. The system will not allow an item to be packed if, by doing so, it will exceed the drum's limits. The technician then selects an evaporator bottom to be treated and packed into the drum. If an item has been previously treated, the system will display the water, caustic, values, and ratios, and calculate the amount of the evaporator bottom that can be added to the drum based on the ratios so as not to exceed the drum limits.

If the item has not been previously treated, the system will display blank values where the technician can enter the values. The values are obtained by taking a sample of the solution from the tank and treating the sample, thereby obtaining the values. After obtaining and entering the values, the WMS system will calculate the volumes, ratios, SNM, and SNM uncertainty for the item that can be added to the drum. Only after the system has calculated the values and determined that the drum limits will not be exceeded can the technician continue to treat and physically package the item into the drum. When the items are added to the drum, the technician opens the water/NaOH screen and the system displays the amount of water and NaOH that still needs to be added to the drum. The technician adds the amount of water, and while monitoring the pH, adds NaOH until the pH is within the pH range. The technician enters into the WMS the volume of water added and the final pH of the drum.. The technician is then prompted to open the cementation screen to enter the volume and weight of the drum.

The system calculates the amount of cement to be added to the drum based on the solution volume in the drum and calculates the time for the cement delivery system to be set to deliver the amount of cement based on the previous cement delivery rate. The technician sets the timer on the cement delivery system and adds the cement to the drum while mixing the drum. After the set time has expired, mixing is stopped, the props are raised from the drum, and the weight is taken and entered into the WMS. The system calculates the cement-to-liquid ratio and displays a new or additional time for cement addition if the cement-to-liquid ratio is lower than a predetermined ratio. The cemented drum is allowed to cure, then removed from the glove box system, and closed.

When packing is complete, the final gross weight of the container is entered (the tare weight of the container has been previously entered). The calculated weight of a solid waste container has been created by the computer and is displayed for comparison. The packed container is then closed electronically, at which time final calculations are performed as required.

When a solid waste container is closed and sealed, the container undergoes a confirmation assay by the NDA Laboratory. The computer performs calculations to determine whether the container confirms, based on any difference between the container assay and the sum of the assays of the items in the container. These calculations are quite extensive for containers that contain multiple material types (material types are combinations of several isotopes in different percentages).

The closed and sealed container is swiped and surveyed by a WIPP-certified RCT. The RCT enters his or her swipe and survey data and identifies the instruments he or she used with pull-down menus. To help the RCT and to eliminate potential transcription errors, the calibration information from the instruments and the instrument identification numbers are present in the database tables and are kept up to date. The WMS then presents the RCT with allowable instrument numbers and automatically alerts him or her when an instrument is out of calibration. The system verifies measurement limits and prevents containers whose contents exceed those limits from being released.

Using the manual system, only about one-half of the paperwork would be completed at this time. Using the computer system, all paperwork in the data package, except the review and approval traveler, is finished now. The data package forms are created by the system only, and no paper is transferred outside of the radiation controlled area. Each reviewer logs on to the system and issues the approval. Reviewers are notified electronically when the data package is ready for each level of review and approval.

When all approvals have been given, the waste shipping coordinator prints the data package. To ensure control of the printed data package, the coordinator is the only person authorized to print the data package. This package accompanies the container when it leaves the facility.

BENEFITS OF THE WMS REALIZED TO DATE

Numerous benefits have already been realized using the WMS. The most obvious benefits are that transcription errors and calculational errors have been eliminated; mistaken entries on paperwork have decreased; and there are no longer mistakes where decisions need to be made based on numerical comparisons. The need for a data clerk to enter the final data into a separate database has been eliminated. There is no longer a need to transfer hard copies of the data packages from a radiological controlled area to an uncontrolled area. Documents are no longer misplaced. Reviewers do not have to check calculations or check for transcription errors. One reviewer has been eliminated from the cycle.

Personnel who participated in the phased testing of the system and provided feedback to the programmer became partners in the development and improvement of the WMS. This integration resulted in a vastly improved product that enhanced the WMS and, in many cases, caused personnel to re-think the way they had been performing work. Personnel who use the WMS frequently say that this part of their job has become a lot easier, less time consuming, and has freed time for them to do other tasks. For example, in the past, at the end of a full-facility cleanup for the annual SNM inventory, waste management technicians frequently had a two-foot stack of paper to process. Now, when the cleanup is done, 99 percent of the "paperwork" for TRU waste items is also done.

Waste management personnel are frequently asked to provide information to upper management on waste production. With the previous archival database system, the retrieval of information, such as the monthly production of a certain waste matrix in the facility for a number of years, was difficult because the waste originators assigned item identification numbers with little consistency across processes. A secondary reason was that data entry into the archival database was subjected to QA. Therefore, an identification number may have been entered incorrectly or a volume may have been entered as a weight, for example. With the WMS requirement that waste item identification be consistent across the facility, complete with standardized data entry, this difficulty has disappeared.

FUTURE PLANS TO ENHANCE THIS SYSTEM

Enhancements to the WMS, which are being considered for implementation at a future date, include the following:

- Electronic interface will be made to NDA laboratory measurement instruments. This would allow the NDA Laboratory to upload assay results stored in the instruments directly to the computer system and, when multiple results are obtained, select the measurement determined to be correct. This selection would then be logged as the official assay for the item. This, of course, eliminates the transposition of numbers and other errors that can occur during manual data entry.

- Electronic transfer of data will be made to the LANL Waste Management Facility. This move is particularly desirable because it would eliminate the additional steps of transporting the paperwork to and from the Waste Management Facility, as well as their double data entry into the official LANL waste management database.

- Wattage and other WIPP limits will be incorporated into the WMS to inform waste management personnel proactively whether a drum will comply with WIPP requirements.

- Waste items will be bar coded to eliminate errors resulting from similar item identifiers.

- The physical location of waste containers will be tracked through the use of bar code readers. Bar code readers are anticipated as the first implementation, with a costly, but more reliable, implementation, to come later.

CONCLUSION

To date, implementation of this system has resulted in a 50-percent time reduction in manually performing calculations and documenting the paperwork trail of TRU waste at the LANL Plutonium Facility. Transcription errors and calculational errors have been eliminated. Mistaken entries on paperwork have decreased. The need for a data clerk to enter the final data into a separate database has been eliminated.