ADEQUACY OF A SMALL QUANTITY SITE RH-TRU WASTE PROGRAM IN MEETING PROPOSED WIPP CHARACTERIZATION OBJECTIVES

J. Biedscheid, S. Stahl, M. Devarakonda,
IT Corporation
5301 Central Ave., NE, Suite 700, Albuquerque, NM 87108-1513 USA

K. Peters
Wastren
1333 West 120th Ave., Suite 300, Westminster, CO 80234 USA

J. Eide
Battelle Columbus Laboratories
505 King Ave., Columbus, OH 43201-2693 USA

ABSTRACT

The first remote-handled transuranic (RH-TRU) waste is expected to be permanently disposed of at the Waste Isolation Pilot Plant (WIPP) during Fiscal Year (FY) 2003. The first RH-TRU waste shipments are scheduled from the Battelle Columbus Laboratories (BCL) to WIPP in order to facilitate compliance with BCL Decommissioning Project (BCLDP) milestones. Milestones requiring RH-TRU waste containerization and removal from the site by 2004 in order to meet a 2006 site closure goal, established by Congress in the Defense Facilities Closure Projects account, necessitated the establishment and implementation of a site-specific program to direct the packaging of BCLDP RH-TRU waste prior to the finalization of WIPP RH-TRU waste characterization requirements. The program was designed to collect waste data, including audio and videotape records of waste packaging, such that upon completion of waste packaging, comprehensive data records exist from which compliance with final WIPP RH-TRU waste characterization requirements can be demonstrated. With the BCLDP data records generated to date and the development by the U.S. Department of Energy (DOE)-Carlsbad Field Office (CBFO) of preliminary documents proposing the WIPP RH-TRU waste characterization program, it is possible to evaluate the adequacy of the BCLDP program with respect to meeting proposed characterization objectives.

The BCLDP characterization program uses primarily acceptable knowledge (AK) and visual examination (VE) during waste packaging to characterize RH-TRU waste. These methods are used to estimate physical waste parameters, including weight percentages of metals, cellulosics, plastics, and rubber in the waste, and to determine the absence of prohibited items, including free liquids. AK combined with computer modeling is used to estimate radiological waste parameters, including total activity on a waste container basis, for the majority of BCLDP RH-TRU waste. AK combined with direct analysis is used to characterize radiological parameters for the small populations of the RH-TRU waste generated by the BCLDP. All characterization based on AK is verified. Per its design for comprehensive waste data collection, the BCLDP characterization program using AK and waste packaging procedures, including VE during packaging, meets the proposed WIPP RH-TRU waste characterization objectives. The

conservative program design implemented generates certification data that will be adequate to meet any additional program requirements that may be imposed by the CBFO.

BACKGROUND

The BCLDP is an initiative of Battelle Memorial Institute (BMI) and the DOE-Columbus Environmental Management Project (CEMP) to decontaminate and decommission buildings and associated grounds at BMI's Columbus King Avenue facility and West Jefferson North campus. These buildings became radioactively contaminated as a result of atomic energy research performed by BMI for clients including the DOE and its predecessor agencies. The BCLDP is generating defense RH-TRU wastes that will be shipped to the WIPP for disposal. As directed by Congress in the Defense Facilities Closure Projects account, the BCLDP site closure deadline of 2006 requires the containerization and off-site shipment of all TRU waste by 2004. The first RH-TRU waste is expected to be permanently disposed of at WIPP during FY 2003 (1). The first RH-TRU waste shipments are scheduled from BCL to the WIPP in order to facilitate compliance with BCLDP milestones. The BCLDP is classified as a small quantity shipper site.

BCLDP milestones requiring RH-TRU waste removal from the site by 2002 in order to meet a 2006 decontamination and decommissioning completion date necessitated the establishment of a site-specific program to direct the packaging of BCLDP RH-TRU waste prior to the finalization of WIPP RH-TRU waste characterization requirements. As such, the BCLDP RH-TRU waste characterization program has been conservatively designed to collect waste data, including complete audio and videotape records of all waste packaging, such that upon completion of waste packaging, comprehensive data records exist from which to demonstrate compliance with final WIPP RH-TRU waste characterization requirements.

The BCLDP RH-TRU waste characterization program was developed using current WIPP characterization requirements established for contact-handled (CH) TRU waste. As such, BCLDP program documents required to direct RH-TRU waste certification and characterization activities have been prepared to document compliance with the current revisions of the WIPP Waste Acceptance Criteria (2) and the CH-TRU Waste Analysis Plan (CH-WAP) of the Hazardous Waste Facility Permit (3), which address only CH-TRU waste certification and characterization, respectively. These BCLDP documents will be revised following the finalization and issuance of the WIPP RH-TRU waste certification and characterization program documents. Because the WIPP program for RH-TRU waste transportation using the 72-B Cask (4) is established and the RH-TRU waste quality assurance (QA) program is not anticipated to differ significantly from the current CH-TRU waste QA program (5), BCLDP program documents that have been prepared to direct RH-TRU waste transportation and QA activities should not require major revision to address final WIPP RH-TRU waste program requirements. The DOE-CBFO has conditionally approved the BCLDP plans contingent upon the finalization of the RH-TRU waste requirements. As of October 2001, the BCLDP program has been implemented for the packaging of approximately 74 55-gallon drums of the anticipated 132 55-gallon drums (approximately 25 cubic meters) total RH-TRU waste inventory. Because it was developed using current WIPP characterization requirements established for CH-TRU waste, the implementation of the BCLDP characterization program has resulted in the generation of waste data that exceed many of the data requirements of the proposed WIPP RH-TRU waste characterization objectives, as presented in the draft version of Remote-Handled TRU Waste

Acceptance Criteria for the Waste Isolation Pilot Plant (6). Complete data records have been generated under the BCLDP RH-TRU waste characterization program and the conservative program design produces waste data that will be adequate to meet any additional requirements that may be established with the finalization of the WIPP RH-TRU waste characterization program.

PROPOSED WIPP RH-TRU WASTE CHARACTERIZATION PROGRAM

The DOE is proposing a program for the characterization of RH-TRU waste destined for permanent disposal at the WIPP. Characterization requirements that are specific to RH-TRU waste are currently being developed by the DOE-CBFO to meet U.S. Environmental Protection Agency (EPA) characterization objectives per Title 40, Code of Federal Regulations (CFR), Section 194.24 (40 CFR 194.24) (7) and the WIPP Land Withdrawal Act (8).

The proposed RH-TRU waste characterization program takes into consideration the nature of the waste and carefully weighs the safety concerns relating to RH-TRU waste measurements and the technical implications of measurements against the needs of the waste component information and the importance they have on the WIPP repository performance. Characterization of each RH-TRU waste stream will rely primarily on the use of AK to provide adequate characterization information. The use of AK refers to applying knowledge of the waste in light of the materials or processes used to generate the waste. It is envisioned that significant reliance will be placed on AK for RH-TRU waste characterization so that physical handling of the waste and personnel exposure can be minimized. Measurements are proposed only to confirm AK or when AK is insufficient to meet the program objectives. Table I summarizes the proposed RH-TRU waste characterization objectives for WIPP disposal and associated characterization methods.

Table I. Proposed RH-TRU Waste Characterization Objectives and Methods

Parameter	Proposed Characterization Objective	Proposed Characterization Method
Metals	Account for metals in the disposed inventory	Metals will be tracked and controlled to the minimum limits by counting the number of containers emplaced in the repository.
Free Water	Limit the total residual liquid inventory emplaced with remote-handled (RH-) transuranic (TRU) waste to less than 71 cubic meters	Free water will be controlled to the maximum limit using one of the following methods: • Use acceptable knowledge (AK) to show that a waste stream contains <1% residual liquid • When AK is not available, use nondestructive examination (NDE) on a sampling basis to show that a waste stream contains <1% residual liquid • When AK and a sampling program are insufficient, use NDE and conservative assumptions to estimate the amount of residual liquid in each container in a waste stream.

Parameter	Proposed Characterization Objective	Proposed Characterization Method
Cellulosics, Plastic, Rubber (CPR)	Control the total RH-TRU waste CPR mass such that contact-handled TRU waste emplacement is not severely impacted	CPR will be tracked and controlled by determining the Summary Category Group of each waste stream. For every emplaced canister from an S5000 (debris) waste stream, the Waste Isolation Pilot Plant (WIPP) Waste Information System (WWIS) will calculate 50% of the net weight and enter that value as CPR.
Surface Dose Rate	Determine if the surface dose rate for a container is greater than 100 roentgen equivalent man per hour (rem/hr) or greater than 1,000 rem/hr	The surface dose rate of each container will be measured. If the dose rate exceeds 1,000 rem/hr, the container is not eligible for receipt at WIPP. If the dose rate exceeds 100 rem/hr (and is less than 1,000 rem/hr), a notation will be made in data submitted to WWIS.
Activity	Demonstrate, with sufficient confidence, that the total activity of emplaced RH-TRU waste is less than 5.1 million curies	Total RH-TRU waste activity will be quantified with 95% confidence that the value is within a factor of five of the true value ($0.2Value_{true} < Value_{data} < 5.0Value_{true}$ [95% confidence level]) using one of the following methods: • Use AK on a waste stream basis • When AK is not available, use radiological measurements on a sampling basis to determine a waste stream total activity value • When AK and a sampling program are insufficient, measure the total activity in each container in a waste stream.

Reference: (9)

PROPOSED BCLDP RH-TRU WASTE CHARACTERIZATION

The BCLDP program uses primarily AK and VE during waste packaging to characterize RH-TRU waste. These methods are used to estimate physical waste parameters, including weight percentages of metals and CPR in the waste, and to determine the absence of prohibited items, including free liquids. AK combined with computer modeling is used to estimate radiological waste parameters, including total activity on a waste container basis, for the majority of BCLDP RH-TRU waste. AK combined with direct analysis is used to characterize radiological parameters for a small population of the RH-TRU waste generated by the BCLDP. The determination of isotopic inventory is verified through confirmatory testing as required by 40 CFR 194.22(b) (7).

Acceptable Knowledge Program

The BCLDP has implemented an approach for a logical sequence of AK development progressing from the description of historical facility operation and TRU waste stream descriptions through AK confirmation conducted during TRU waste packaging operations of

Building Jefferson North (JN)-1 Hot Cell Laboratory waste materials. Fig. 1 illustrates the BCLDP methodology used to construct the documentation necessary to present a defensible and auditable record to certify the characterization for each TRU waste stream destined for disposal at WIPP.

During the initial planning of the AK development program, it was critical to first identify the location of relevant historical information. The primary sources of AK were determined to be historical files maintained in numerous project and personal file cabinets at the West Jefferson site. Several hundred files and documents were assessed at these locations to collect relevant AK information sources. These sources were then thoroughly reviewed to determine their utility and limitations. The resulting AK Source Files consist of a variety of published documents, unpublished data, and other historical communications and correspondence. AK Source Files are also created for reports and letters generated by the program to supplement and clarify the AK record. Specifically, Discrepancy Reports are generated to document the resolution of inconsistencies identified between AK sources or between AK sources and confirmation data generated during packaging.

The information contained in the AK Source Files was then compiled into a report (10) to present the TRU waste management program information and provide a roadmap to the original source of the information. Specifically, the Building JN-1 Hot Cell Laboratory AK Document (10) provides:

- Maps of the West Jefferson North site and Building JN-1 Hot Cell Laboratory facility
- Summaries of the history and mission for the site and laboratory
- Descriptions of the historical laboratory operations and waste management practices
- Type and quantity of potential TRU waste contained in JN-1.

Potential TRU waste materials were identified and grouped into categories based primarily on the matrix of the waste. The waste was then characterized as it existed in the building knowing that many of the materials (hydraulic oil, liquids, etc.) would require further processing to be eligible for disposal at the WIPP. This materials assessment and the supporting AK source documentation were used as the basis for subsequent TRU waste stream segregation and characterization activities.

The Building JN-1 Hot Cell Laboratory AK Document (10) also provides the basis for the defense waste justification, spent nuclear fuel (SNF) and high level waste (HLW) discussions, and the JN-1 Hot Cell Laboratory radionuclide distribution (Standard Isotope Mix or another mix).

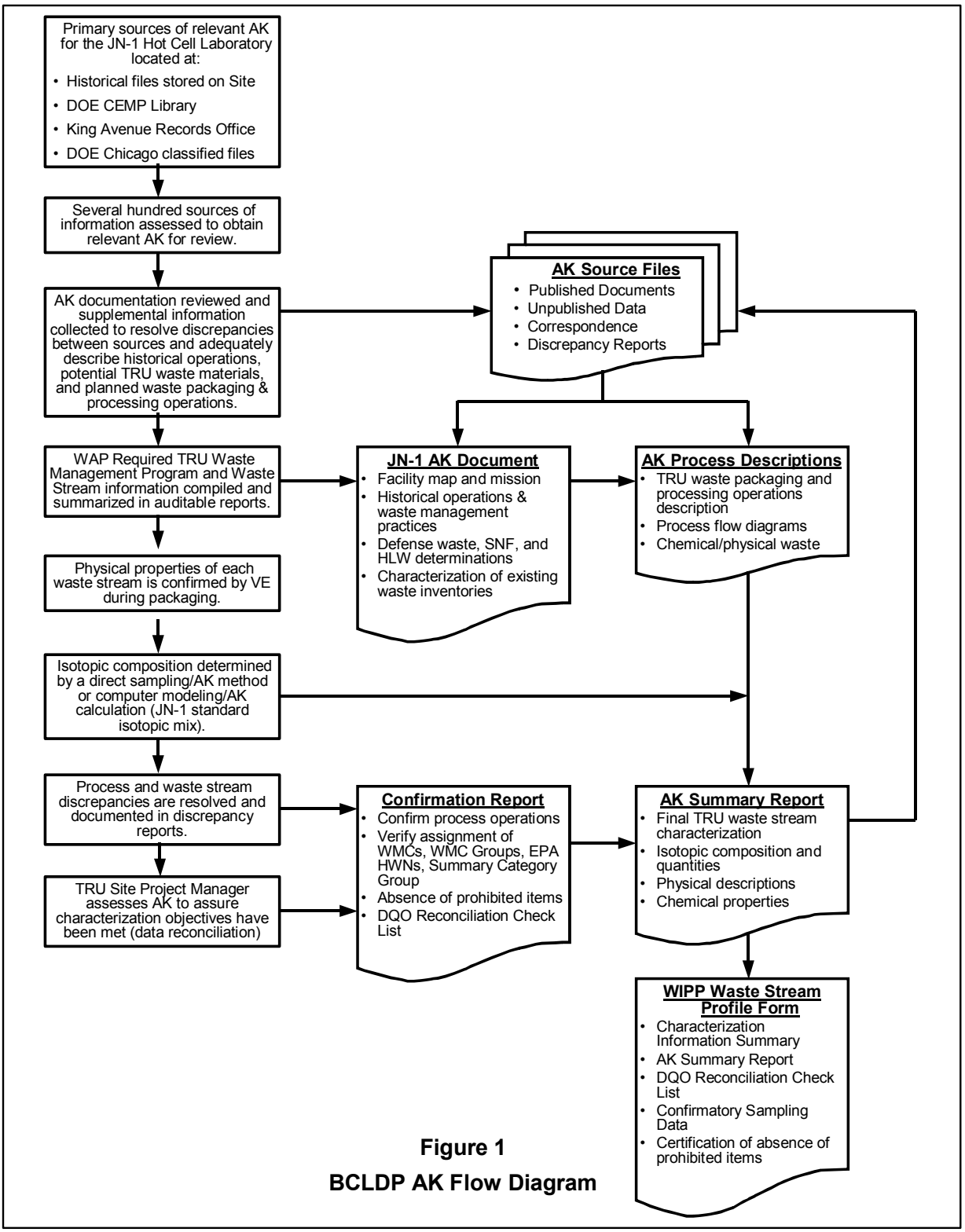

Fig. 1. BCLDLP AK Flow Diagram.

The BCLDP TRU waste packaging and processing operations are summarized in AK Process Descriptions created for each operation. These reports include the TRU waste stream information required by WIPP for waste acceptance. These reports are prepared prior to TRU waste processing to describe the waste inventory to be processed, process inputs, and TRU waste stream characterization. Each process waste stream is described in detail including:

- Description of the waste matrix
- Process flow diagrams
- Waste stream identification number
- Generation area
- Projected waste stream volume and generation dates
- Radionuclide distribution
- EPA Hazardous Waste Codes
- TRU waste content codes
- Summary Category and Waste Matrix Code (WMC), and Waste Matrix Code Group
- Waste Material Parameters and weight ranges
- Resource Conservation and Recovery Act characterization rationale
- Toxic Substance Control Act waste determination.

Physical and Chemical Characterization and Verification

BCLDP visually examines the contents of every waste container as it is generated to confirm the physical content as characterized during the AK process. Per the current WIPP CH-TRU waste program requirements, generators choosing this option are required to document the examination on audio and videotape and on waste inventory sheets. In addition, two visual examination experts independently perform the confirmation of AK characterization by observing the packaging of waste items into a 55-gallon drum. The primary objective of the BCLDP program is to ensure that the resulting confirmation documentation is sufficient to meet the developing RH-TRU waste program requirements.

In addition to documenting every item placed in each container, the BCLDP uses an audio and videotape system during waste packaging to meet the WIPP requirements for visually examining and documenting the physical contents. The system creates an audio and videotape record that can be easily reviewed, if any questions arise about a container or a specific waste item in a container. The videotape will allow for future visual re-inspection of packaged items, if necessary, and minimize personnel exposure associated with re-handling of waste materials. Specifically, the BCLDP VE system confirms the following certification criteria:

- Verification that the correct Summary Category Group (and WMC) has been applied to the waste being packaged
- Verification that the proper TRU waste stream has been applied to the container
- Verification of the EPA Hazardous Waste Numbers applied to the waste being packaged
- Verification that no prohibited item has been placed into the container, such as
  - Free liquids in amounts greater than the CH-WAP (3) allows
  - Compressed gas containers

  - Unvented containers greater than 4 liters (L) (nominal) in size
  - Non-radionuclide pyrophoric materials greater than or equal to 1% (weight)
  - Non-radionuclide hazardous/non-hazardous waste
  - Ignitable, reactive, or corrosive wastes
- Confirmation of the number of confinement layers
- Confirmation of the installation of filter vents, both on the drum and any confinement layers, which require a vent
- Demonstration that the container is empty at the beginning of the process, thereby negating aspiration requirements, and confirming that the material is newly generated
- Application of a custody seal and the recording of the seal number.

The videotape system records TRU waste packaging from the time the container is empty (prior to waste loading) until the container has been loaded and sealed with a custody seal. BCLDP RH-TRU waste is directly loaded into a liner (steel or polyethylene) prior to placement in a 55-gallon drum. In some instances, the internal container liner may be sealed with a custody seal so it can be stored until it is placed into the drum for shipment. This sealing of the liner is required if the storage is to take place out of camera range. Once the TRU waste is in the drum and the drum is sealed, no video recording is required until the loading process when drums are put into shipping containers to be shipped offsite. Recording of the loading process for shipment will be accomplished with a handheld recorder.

Radiological Characterization

For the purposes of radiological characterization, BCLDP RH-TRU wastes are classified as two waste populations based on whether the waste was contaminated by the isotopes associated with routine operations in the laboratory (Standard Isotope Mix) or another mix of isotopes associated with non-routine activities or processes. The Standard Isotope Mix is determined for waste materials from specific facility areas through the use of AK combined with software modeling. For any waste population that cannot be included in the Standard Isotope Mix, radiological characterization is accomplished by AK combined with direct waste analysis.

The Standard Isotope Mix may be applied to the majority of BCLDP RH-TRU waste as determined according to the methodology described in the site document DD-98-04, Waste Characterization, Classification, and Shipping Support Technical Basis Document (11). Under this methodology (Methodology 1), the RH-TRU isotopic content is determined by a combination of knowledge of the processes generating the waste, materials historically examined in the laboratory, representative waste stream sample analyses, application of Oak Ridge Isotope Generation and Depletion (ORIGEN2.1) code values for expected isotopes, and external radiation field measurements. Methodology 1 is summarized below and illustrated in Fig. 2. Methodology 2 (AK combined with direct analysis) is used to determine the radiological characterization for any population that cannot be included in the Standard Isotope Mix.

Methodology 1, AK Combined with Computer Modeling

Based on knowledge of the processes documented as AK (10), the contamination of the Controlled Access Area (CAA) of Building JN-1 has been determined to be representative of

contamination in the building as a whole. The CAA supported operations conducted in the Building JN-1. During Building JN-1 operations, the CAA was in constant use and was repeatedly contaminated by numerous projects conducted in all Building JN-1 hot cells. Although the CAA has been cleaned many times, the floors and other surfaces remain contaminated with radionuclides from these projects.

An evaluation of samples collected from various locations of the CAA resulted in the selection of 69 samples that are documented in the AK record as being representative samples. The 69 samples analyzed were smear samples compositing the contamination of the CAA in Building JN-1.

The 69 CAA smear samples were analyzed by gamma spectroscopy before radiochemical isotopic separation analyses were performed. After gamma spectroscopy results were evaluated, the smears were processed by acid dissolution methods, diluted, and specific methods were used to perform the isotopic separations. The alpha isotopic samples were analyzed by alpha spectroscopy. Strontium-90 samples were analyzed by beta gas flow proportional counting. The sample results revealed the presence of Co-60, Cs-134, Cs-137, Eu-154, Am-241, Cm-244, Pu-238, Pu-239/240, U-234, U-238, Np-237, Sb-125, and Sr-90 in measurable quantities in at least one sample, with Cs-137 being dominant. Only significant isotopes were retained in the Standard Isotope Mix.

Using the measured distribution determined through sampling as a base, the remaining isotopes are scaled according to the distribution generated by the ORIGEN2.1 computer code, which models the production and decay of fission and activation products of commercial nuclear power plant fuel. The ORIGEN2.1 input parameters are as follows:

- Enrichment (atom % U-235)
- Burn-up (Megawatt-days per metric ton of uranium)
- Decay (years post-irradiation).

As described in DD-98-04 (11), these parameters were assigned associated value ranges that are representative of the JN-1 waste. Four replicates of a five-sample statistical (Latin hypercube) design were developed to provide 20 representative analysis runs. The distribution of each parameter was divided into five partitions of equal probability. Latin hypercube sampling ensured the inclusion of a random value of each partition in each of the four replicated designs. Because Cs-137 is also the dominant isotope in the ORIGEN2.1 output, it is used as the basis for the Standard Isotope Mix. Ratios for all isotopes included in the Standard Isotope Mix, but not identified in the samples, are based on the ORIGEN2.1 calculations. The mean result across the 20 ORIGEN2.1 runs for each studied isotope represents its normalized activity ratio (to Cs-137) in the Standard Isotope Mix. A direct comparison between measured activities from the analytical results for the 69 samples and theoretical results from the ORIGEN2.1 analyses was performed. Five of the isotopes, Am-241, Pu-238, Pu-239, Pu-240, and Cm-244, were detected in every sample and show good agreement with the ORIGEN2.1 analyses. Pu-239/240 sample results were split according to the calculated values for each from ORIGEN2.1.

The primary contributors to the gamma field external to a shipping container containing spent fuel contaminated materials are the decay of Cs-137 and Co-60. The estimation of the TRU waste isotopic content relies on the measurement of the radiation exposure rate (roentgen per hour) from these and other gamma emitters in the waste. To model the gamma source term, the relative contribution of each isotope's emitted gamma rays was evaluated. The multi-group gamma source spectrum used in the ORIGEN2.1 code was selected. The GAMMA2 computer program was written by BCLDP to generate the source spectrum and gamma flux-to-exposure rate conversion factors for this multi-group format.

The QAD-Combinatorial Geometry/Geometric Progression (CGGP)-A model is used to calculate the dose rate at 1 meter from 1 millicurie (mCi) of Standard Isotope Mix placed into a 55-gallon drum of a given weight (TRU Waste Container Model). The waste matrix is assumed to be iron with waste densities yielding a waste mass range from 34.7 to 347.4 pounds. The QAD-CGGP-A uses the point kernel technique to calculate the dose rate at a selected location from a distributed, multi-group source. The QAD-CGGP-A calculations result in the generations of external gamma ray interaction rates-to-weight conversion equations for the TRU Waste Container Model packaging various waste densities. Using the relationship between the dose rate calculated by QAD-CGGP-A for the TRU Waste Container Model and the actual measured dose rate from a 55-gallon drum, the total activity of the drum may be calculated. The drum total activity may be multiplied by the fractional composition of the Standard Isotope Mix to quantify individual isotopic contributors. Using the Standard Isotope Mix fractional composition, a total activity of 3.2 Curie (Ci) equals 1 Ci TRU isotopic content.

In summary, the general process for characterizing the radiological content of a waste container as the Standard Isotope Mix is as follows (11):

1. The Standard Isotope Mix is a combination of isotopes measured in 69 representative samples and modeled using ORIGEN2.1
2. A known quantity of the Standard Isotope Mix is modeled by QAD-CGGP-A for a 55-gallon drum
3. The computer model (QAD-CGGP-A) produces a measured dose rate for a modeled 55-gallon drum of a given weight at a specified measurement point
4. The external gamma dose rate and weight of an actual waste drum is measured
5. The measured dose rate is compared to that of a known activity for the modeled drum
6. By setting the ratios of dose-to-activity equal for the waste drum and the modeled drum, the total activity within the waste drum is calculated.
7. The total activity within the waste drum is then divided into constituent isotopes by multiplying the total activity by the isotopic ratios established by the Standard Isotope Mix.

Methodology 1 includes the conservative estimation of measurement errors and assumptions used to determine a total uncertainty that is bounding for the methodology. The contribution of the following six sources of uncertainty were combined statistically to determine a bounding total uncertainty:

- Uncertainty in measuring the exposure rate emanating from the container
- Variability in the distribution of mass within a container

- Variability in the distribution of source within a container
- Uncertainty in the weight of the container being characterized
- Uncertainty in the calculated isotopic fractions in the Standard Isotope Mix
- Uncertainty in the ability of the QAD-CGGP-A computer code methodology to accurately predict dose rate for the drum configuration.

The uncertainty calculation associated with Methodology 1 will comply with the final data quality objectives.

Methodology 2, AK Combined with Direct Analysis

AK combined with direct analysis (Methodology 2) is used to determine the radiological characterization for any waste stream that cannot be included in the Standard Isotope Mix. For example, the Standard Isotope Mix could not be applied to filters used to clean the storage and transfer pool at the laboratory based on AK information supporting the fact that exposure to the pool water alters the ratios of the isotopes due to differences in the solubility of the elements. Cesium, upon which Methodology 1 modeling depends, is highly soluble, while TRU isotopes and others tend to be largely insoluble. This inconsistency rendered cesium-based modeling unsuitable for any waste stream in which solubility is a major concern. For this reason, radiological characterization for this stream is based on direct sampling and data ratioed from sampling and/or modeling based on AK. AK is combined with radiological measurements collected on a sampling basis to determine a waste stream total activity.

Initially, data included in the analysis were compiled to determine only the TRU content of the waste rather than all potential radionuclides present. Continued evaluation of the radiological data collected during packaging of six drums resulted in a data set where results for Pu-240 were split out from the alpha spectroscopy results for Pu-239 assuming the Standard Isotope Mix. Since analyses were not conducted for Sr-90, U-233, U-234, U-235, U-236, and U-238, values for these isotopes were estimated based on previously observed ratios of Eu-154 and Am-241 compared to the measured values from the waste samples.

Verification of Radiological Characterization

The assignment of either the Standard Isotope Mix (Methodology 1) or another mix (Methodology 2) is verified through confirmatory testing. The BCLDP confirmatory testing process is currently being developed. The process will include a sampling plan that will define the applicability of any sampling data collected for other purposes (e.g., health physics samples collected for the purpose of disposing of the empty storage casks that contained the waste prior to sorting/segregating and packaging into 55-gallon drums) and the collection of additional samples as necessary to ensure that smear samples are collected from locations that are representative of the waste population. For example, the sample plan for confirmation of a waste population that, based on AK information, cannot be included in the Standard Isotope Mix will direct the collection of samples directly from that waste population. The sampling and analysis reports are evaluated for confirmation of the Standard Isotope Mix or another mix established by AK.

Specifically, the BCLDP radiological sampling and analysis confirms the appropriate assignment of the Standard Isotope Mix or another mix, which is then used in the verification of the following characterization criteria:

- Verification that the waste contains greater than 100 nanocuries per gram (nCi/g) TRU alpha-emitting isotopes with half-lives exceeding 20 years.
- Verification that total curies is calculated for each container.
- Verification that a curies per liter value is calculated for each container.
- Verification that total curies of plutonium is calculated for each container.

A report documenting the confirmation report is prepared in conjunction with the WIPP waste stream profile to verify AK, resolve discrepancies identified during confirmation, and ensure that the proposed characterization objectives have been achieved based on the evaluation of each waste container. The AK collection process is ongoing in that the Building JN-1 Hot Cell Laboratory AK Document (10) and AK Process Descriptions are revised, as necessary, to reflect the most current information observed during the BCLDP waste processing operations.

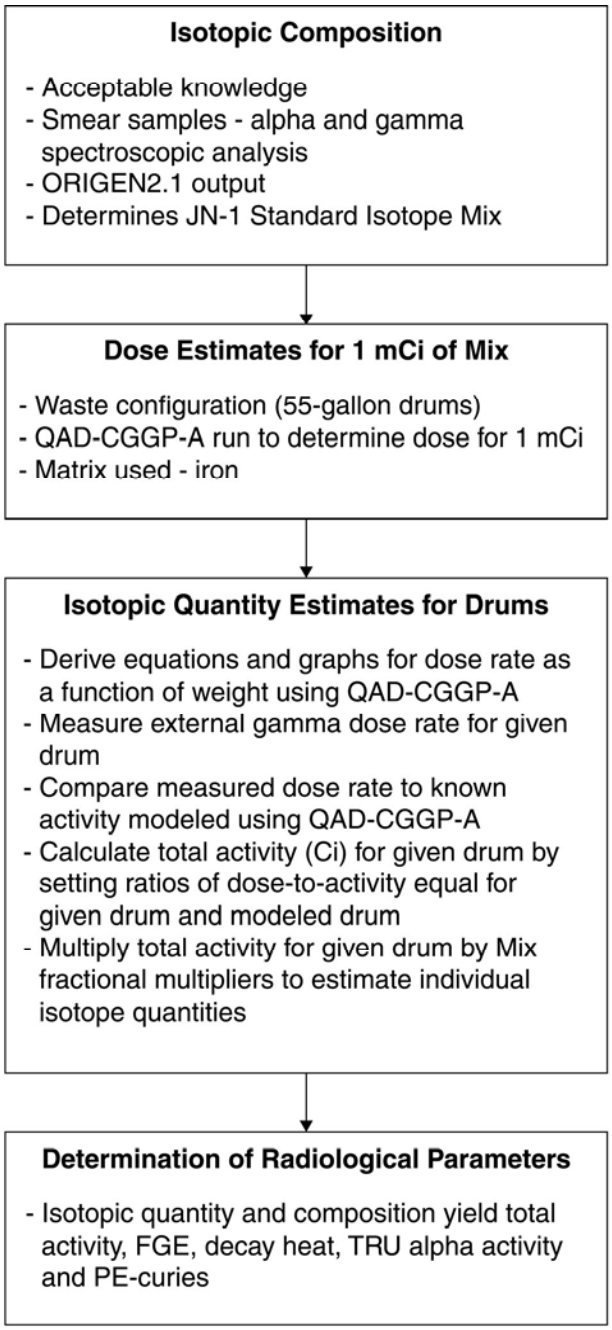

Fig. 2. BCLDP Radiological Characterization Using Acceptable Knowledge Combined with Computer Modeling.

ADEQUACY OF PROPOSED BCLDP RH-TRU WASTE CHARACTERIZATION

Per its design for comprehensive waste data collection, the BCLDP characterization program using AK and waste packaging procedures, including VE during packaging, meets the proposed WIPP RH-TRU waste characterization objectives. Because it was developed using current WIPP characterization requirements established for CH-TRU waste and proposed RH-TRU waste requirements are different, the implementation of the BCLDP characterization program has resulted in the generation of waste data that exceed the data requirements in the proposed WIPP RH-TRU waste characterization objectives. Complete data records have been generated under the BCLDP RH-TRU waste characterization program and the conservative program design produces waste data that will be comprehensive enough to meet any additional WIPP program requirements.

Determination of Physical Waste Parameters (Characterization Objectives: Metals, Free Water, and CPR)

Because the BCLDP RH-TRU waste characterization program development has been initiated prior to the finalization of the WIPP RH-TRU waste program, the BCLDP AK program has been conservatively designed to determine the physical waste parameters required by the WIPP CH-TRU waste program. During the research for the Building JN-1 Hot Cell Laboratory AK Document (10), the potential TRU waste materials were segregated into populations as defined by the CH-TRU waste program for WIPP disposal. The AK Process Descriptions describe the processing and packaging of these populations into the appropriate BCLDP TRU waste streams. The physical contents of each container are confirmed during VE during final waste packaging. Confirmation ensures that the appropriate Waste Summary Category, WMC, and waste material parameter weights have been assigned to the container and contents, and that the following physical waste parameters have been characterized:

- Prohibited Items - During packaging and VE operations, the absence of prohibited items is ensured. Prohibited items include free liquids, sharp or heavy objects, sealed containers, explosives, corrosives, and compressed gases. During packaging, each waste item is inspected and logged as it is placed into the drum liner. Any prohibited item identified during the waste sorting process is segregated from the waste being packaged. As such, BCLDP demonstrates compliance with the restriction on prohibited items on a container basis using VE and packaging procedures.

- Metals - AK is collected to estimate the waste material parameter distributions for waste materials including metals. These AK data are summarized in the AK Process Description for the applicable waste stream. VE confirms the weight estimates for observed ferrous and non-ferrous metals in the waste materials and of the metal liners and drums. Because the WIPP will track and control metals in the disposed inventory by counting the number of containers emplaced in the repository and entering data into the WWIS, no action for site characterization will be proposed to account for metals in the waste. As such, the AK that BCLDP is collecting to estimate waste metal weights exceeds the data requirements proposed for RH-TRU waste characterization.

- Free Water - Potential sources of liquids in the wastes were identified during the development of the Building JN-1 Hot Cell Laboratory AK Document. The AK Process Descriptions identify the methodology to be implemented to identify, segregate, and/or process potential liquid in waste materials. During packaging and VE operations, the absence of free liquids is ensured. During packaging, all waste items are drained prior to placement in the payload container and any identified liquid is segregated for solidification. Additionally, absorbents are added to every container to assure that free liquid will not form due to condensation or dewatering of the waste matrices. As such, BCLDP demonstrates compliance with the <1% residual liquid limit on a container basis using VE and packaging procedures.

- CPR - AK is collected to estimate the waste material parameter distributions for waste materials including CPR. These AK data are summarized in the AK Process Description for the applicable waste stream. VE is used to confirm the assignment of the Summary Category Group (and WMC) and to estimate the weight of the observed CPR in the waste materials and of the packaging materials. Because the WIPP will track and control the total emplaced RH-TRU waste CPR mass by assuming 50% of the net weight of each canister assigned to Summary Category Group S5000 (debris waste) is CPR, required site characterization consists only of Summary Category Group assignment. The BCLDP uses AK and VE to assign Summary Category Groups. The additional assignment of the more matrix-specific WMC exceeds data requirements proposed for RH-TRU waste characterization.

Determination of Surface Dose Rate (Characterization Objective: Surface Dose Rate)

By definition, the surface dose rate of RH-TRU waste containers will exceed 200 millirem per hour. However, if the surface dose rate exceeds 1,000 rem/hr, the container will not be eligible for receipt at the WIPP. If the dose rate exceeds 100 rem/hr (and is less than 1,000 rem/hr), notification to the WIPP in the WWIS data input will be required. The surface dose rate of each container (e.g., 55-gallon drum or RH-TRU waste canister) and the loaded transportation package must be quantified.

The BCLDP measures the surface dose rate of each loaded waste container. In accordance with a written and approved work instruction, the waste container is positioned to allow for the remote determination of the dose rate. Two surface dose rates, as well as 30 centimeter or 1 meter dose rates, are taken for each waste container. These dose rates are recorded on the TRU Waste Loading Record and the TRU Waste Payload Container Nuclear Properties Data Sheet. These dose rates are also used in the radiological characterization methodology.

Determination of Radiological Waste Parameters (Characterization Objective: Activity)

For the purposes of radiological characterization, BCLDP RH-TRU wastes are classified as two waste populations based on whether the waste is described by the Standard Isotope Mix or another mix. As previously described, the two methodologies associated with the assignment of the Standard Isotope Mix or another mix are used by the BCLDP to characterized the radiological properties of RH-TRU waste, including the following:

- TRU Alpha Activity - For classification as TRU, waste containers must contain >100 nCi/g alpha-emitting TRU radionuclides. Using the radiological characterization methodologies previously described, the TRU alpha activity concentrations for are determined.

- Determination of Total Curie Content - The total curies per drum must be determined and reported to WIPP for use in tracking compliance with the 5.1-million-curie limit for RH-TRU waste emplaced at WIPP. Using the methodologies previously described, total curies for drums are determined.

- Determination of Maximum Activity Level - Depending on the transportation cask used, RH-TRU waste containers must comply with the maximum activity level of 23 curies per liter averaged over the volume of the 72-B Cask RH-TRU waste canister (three 55-gallon drums), or 20 Ci total plutonium per 10-160B Cask payload (10 55-gallon drums). Using the methodologies previously described, the total activity levels for selected drums are determined.

CONCLUSION

Per its design for comprehensive waste data collection, the BCLDP characterization program using AK and direct examination of waste items during packaging, meets the proposed WIPP RH-TRU waste characterization objectives. Because it was developed using current WIPP characterization requirements established for CH-TRU waste, the implementation of the BCLDP characterization program has resulted in the generation of waste data that exceed the data requirements of the proposed WIPP RH-TRU waste characterization objectives. The conservative program design implemented generates defensible waste characterization documentation adequate to address any WIPP requirements imposed on the BCLDP program in the future.

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