LA-UR- 00-3363

Approved for public release;
distribution is unlimited.

Title: TRANSURANIC WASTE MANAGEMENT AT LOS ALAMOS
NATIONAL LABORATORY

Author(s): JAMES J. BALKEY, NMT-DO
RONALD E. WIENEKE, NMT-7

Submitted to: RADIOACTIVE WASTE MANAGEMENT 2000

Unclassified Not UCM

JUL 24 2000

LANL Class. Group

date

Los Alamos

NATIONAL LABORATORY

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the U.S. Department of Energy under contract W-7405-ENG-36. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Transuranic Waste Management at Los Alamos National Laboratory

James J Balkey and Ronald E. Wieneke, Nuclear Materials Technology Division,
Los Alamos National Laboratory, P.O. Box 1663, Los Alamos
New Mexico 87545

Abstract

Los Alamos National Laboratory (LANL) was the first to ship transuranic (TRU) waste for deep geologic disposal in the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. This was the culmination of a tremendous effort on the part of personnel at the Plutonium Facility (TA-55) where the waste was generated and of Laboratory waste management personnel. The Plutonium Facility provides a wide variety of actinide research and development capabilities in support of national defense needs. Many of these operations produce a wide variety of waste forms including transuranic waste from activities in the glove-box lines throughout the facility. Critical to the success of this shipment was the integrity of the waste management program at TA-55. A group of dedicated waste management professionals worked intimately with actinide processing operations personnel to assure that all waste packages met the WIPP Waste Acceptance Criteria (WAC) and were documented and packaged in accordance with all applicable regulations. Records are largely computerized, eliminating paper forms and improving the integrity of data packages and expediting the review and approval process. Research into waste minimization has succeeded in identifying processes to reduce the volumes of transuranic waste produced and has resulted in the implementation of decontamination and waste avoidance techniques in the facility. This paper provides a broad overview of current waste management activities in the TA-55 Plutonium Facility.

Introduction

On March 26, 1999, the first transuranic waste to be shipped to WIPP for disposal left LANL by truck, enclosed in the Transuranic Package Transporter Model 2 (TRUPACT-II) designed to meet Department of Transportation (DOT) standards for over-the-road shipments of radioactive materials. This paper focuses on the management of transuranic waste by the Nuclear Materials Technology (NMT) Division at LANL that operates two nonreactor nuclear facilities; the TA-55 Plutonium Facility (PF-4) and the TA-3 Chemical and Metallurgical Research (CMR) Facility. Actinide processing operations at these two facilities generate a substantial quantity of waste that must be segregated, assayed, documented, packaged, labeled and staged prior to off-site shipment for disposal.

Los Alamos National Laboratory

Los Alamos is one of America's National Laboratories owned by the United States Department of Energy (DOE) and operated by the University of California (UC). The laboratory is one of the original Nuclear Weapons Complex Laboratories dating back to Project Y of the Manhattan Engineering District during World War II. Consequently, research with radioactive materials has been conducted at Los Alamos for over half a century and remains one of the primary responsibilities of this institution. NMT's PF-4 and CMR are essential in the accomplishment of one of the Laboratory's core missions of Stockpile Stewardship of America's nuclear arsenal.

RECEIVED

OCT 26 2000

OS 11

The Laboratory occupies about 43 square miles in north-central New Mexico, about 25 miles northwest of Santa Fe. It is located at an elevation of approximately 7,200 feet on the Pajarito plateau on the east flank of the Jemez Mountains.

Nuclear Materials Technology Division

The Nuclear Materials Technology Division is one of the Laboratory's organizational units responsible for the operation of two nonreactor nuclear facilities at Technical Areas (TA) 3 and 55 which are about a mile and a half apart. These two nuclear facilities are the Plutonium Facility (PF-4) at TA-55 and the Chemistry and Metallurgy Research (CMR) Building at TA-3. They are distinctly different facilities from the standpoint of age, design, size and the nature of operations conducted within them although both sites generate transuranic waste.

The Plutonium Facility is a concrete reinforced structure designed in accordance with DOE general design criteria for plutonium processing and handling facilities and was completed in 1978. It has a floor area of 150,000 square feet consisting of a service floor and operations floor that is divided into two independent halves and organized into four operating areas. The 100 and 200 areas contain plutonium research and development laboratories, reactor fuels laboratories, plutonium-238 heat-source fabrication operations, analytical chemistry and personnel decontamination areas. The 300 and 400 areas contain actinide processes (both wet chemistry and pyrochemistry), metallurgical operations, parts machining, waste operations and nondestructive assay laboratories. Diverse activities and a rapidly changing project base present a challenge to waste operations.

The Chemistry and Metallurgy Research Facility was completed in 1952 and designed in accordance with the 1949 Universal Building Code at that time. It has a floor area of 550,000 square feet and is divided into eight wings arranged around a spinal corridor. Each operations' wing has a basement, attic, operation floor and filter tower at the end of the wing, opposite the spinal corridor. Utilities run through the attic and basement: the air intake, air conditioning equipment, supply fans and ventilation distribution ductwork run throughout the attic; the exhaust ductwork, ventilation dampers and duct wash-down system are in the basement; the filter plenums, exhaust fans and exhaust stacks are in the filter towers. One wing (Wing 9) was added in 1959 and has two blocks of hot cells with remote manipulators to conduct high radiation dose rate activities. The operations conducted in the CMR are basically support functions of radiochemistry and metallurgical analysis. Other activities include nuclear materials safeguards training, nondestructive assay, waste management, gas generation studies and neutron source storage. The main challenges to waste operations in this facility revolve mainly around legacy waste and obsolete equipment and instrumentation.

Transuranic Waste

The Department of Energy defines transuranic waste as waste contaminated with greater than 100 nano-curies per gram of radioisotopes with atomic numbers greater than 92. TRU radioisotopes are further defined as alpha emitters with half-lives greater than 20 years. This waste is principally generated from defense activities and does not contain fission products. TRU waste is typically generated inside of glovebox lines from actinide processing operations.

The Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico has been designated as the national deep geologic (2250 feet underground in salt beds) repository for the disposal of waste of this type. The waste is

emplaced in rooms mined in the salt beds that are sealed when full. The eventual collapse of the burial chambers completes the isolation process.

There are two suitable containers for transuranic waste: the 55-gallon drum and the 82.5 cubic foot Standard Waste Box (SWB). Both containers must be enclosed in the TRUPACT-II in order to be transported by truck to the repository. This packaging is in compliance with Department of Transportation regulations for the shipment of radioactive materials.

Control must be exercised over the waste from the standpoint of Nuclear Material Control & Accountability (NMC&A) which is accomplished by nondestructive assay and the use of tamper indication devices on the packages. Any waste containing hazardous materials as defined by the Resource Conservation and Recovery Act (RCRA) is also subject to regulation by the State of New Mexico. Radiological hazards, chemical hazards in the case of mixed waste (radioactive and RCRA hazardous) and mechanical and ergonomic hazards must be defined and mitigated in NMT waste operations.

Waste Management

Waste management at LANL is conducted in the Facilities and Waste Operations Group (FWO). This paper presents waste management from the viewpoint of the waste generator. In this case NMT Division recognized the impact of waste management and regulatory compliance on their operations and established a group within the organization to provide a responsive interface for both waste generators and the Laboratory waste management organization. NMT waste management has the latitude to tailor their operations to provide optimum support for operations and to protest unreasonable or unrealistic regulation and propose compromises.

The management of TRU waste is a cooperative effort by both the generator and waste management personnel. This is necessary in order to optimize the process and minimize the costs associated with waste handling and disposal. The researcher whose process generates the waste is most qualified to provide characterization information on it. Basic information on waste composition and content from the generator is essential in determining the isotopic composition and to avoid comprehensive (and expensive) sampling and analysis. The role of the generator is also pivotal in maintaining proper segregation of waste and in working actively to reduce waste volumes.

The role of waste management personnel is to provide program definition and control and to furnish guidance to the generator. Waste management technicians work with the generator to provide the proper documentation, to file and track records, to package, mark and label, and arrange transportation off-site for waste packages that are properly documented and meet all of the required criteria.

Waste management is organized by function with two TRU waste operations teams (solid and immobilization) at the Plutonium Facility and one composite team (TRU, low-level, recycle and salvage) at CMR. In addition to the waste management technicians and their supervisors, there are various support personnel that provide specialized assistance in quality assurance, regulatory compliance, clerical, administrative, computer support, budgeting and planning.

Requirements

A number of requirements, many carrying the force of law, control the way in which waste is managed. Of primary concern is the Waste Acceptance Criteria (WAC) provided by the repository that addresses many

aspects of transportation, handling and disposal. Many requirements in the WAC are driven by the performance expectations of the repository, established during the performance assessment, which are required for licensing. Other mandates are based upon requirements set by the state for the disposal of RCRA hazardous (mixed transuranic) waste. These limitations assure that the hazardous constituents of the waste will never migrate beyond the site boundary to contaminate the environment. Other requirements are driven by transportation regulations, various acts such as the Atomic Energy Act or DOE Orders. All of these requirements must be consolidated and tracked from their originating legislation, down through institutional documents to the procedures by which waste operations are conducted in NMT Division.

DOE regulations, title 10 of the Code of Federal Regulations (CFR), part 835.120 "Quality Assurance", and the disposal facility quality requirements document, CAO-94-1012 "Quality Assurance Program Document", set the quality standards for the NMT transuranic waste management program. These very prescriptive requirements make NMT waste operations a focus of auditors and assessors. Waste management operations have an integral quality assurance program for this reason. Two full time quality assurance personnel are actively involved in the waste management program. They continually review program documentation to assure that the requirements of the repository and regulators are being met. They regularly conduct assessments in the field, observing operations to assure that the program is operating as designed. These internal assessments are documented and reported to management on a monthly basis. Key components of the program are monitored for indications of systemic weakness. Significant variances are investigated, the root causes are determined and any identified deficiencies corrected.

Two, full-time regulatory compliance specialists also work in NMT waste operations. Their job is to assure that state environmental regulations regarding the proper marking, labeling and storage of hazardous and mixed waste are being met. They provide input to the Laboratory's operating permit, specifically that part which describes permitted activities at NMT Facilities. They also provide guidance to operations personnel in designing their activities in compliance with regulations and assist in applying for permitting of new activities when necessary. They conduct monthly inspections of waste storage areas and report findings to the storage areas custodians for correction and to management.

Waste Disposal

Waste management work areas and personnel reside in the facilities alongside the operations and research activities that they support. This results in the expedient and cost effective handling of transuranic waste. Waste management personnel are able to establish close working relationships with operations personnel and become familiar with the processes that generate the waste. They visually inspect waste items and provide guidance to the generator in writing the originating documentation and preparing the items for transfer. The waste must be assayed for SNM content in balancing the process account from which they originate (standard NMC&A practice). This information is also used to verify the waste activity (transuranic or low-level) and to provide SNM content information to the disposal site.

Items that meet the WIPP WAC are segregated by waste matrix and isotopic composition and placed directly into the waste container. Information on the waste item, its composition and characteristics, is entered into the Waste Management System (WMS), a computerized database which tracks waste items and records vital information. Items that do not meet the WIPP WAC (i.e., liquids) go to the immobilization process where they are fixed in gypsum cement. The WMS also tracks package limits; fissile content and weight are checked to

make sure that they are not exceeded. Packages that are not full are kept locked to control waste that is placed in them.

Once the packages are full, they are closed in accordance with DOT requirements and the data packages are completed on the WMS. The final data packages are then routed for the review and approval necessary to ship them to an on-site staging area. Any additional testing that is necessary; head space gas sampling for volatile organic compounds, real time radiography to verify conformance with the WAC and nondestructive analysis by tomographic segmented gamma scanning or passive active neutron interrogation, is conducted prior to final staging and packaging into the TRUPACT-II at another on-site waste facility.

Characterization

Both the repository WAC and state RCRA regulations require full characterization of transuranic waste. Sampling and analysis can accomplish the required characterization but is very expensive. An alternative to analytical methods is Acceptable Knowledge (AK). AK is built using existing documentation surrounding the process that generates the waste. These documents consist of process design information, engineering flow diagrams, mass balance equations and chemical reactions, chemical and material purchase orders, analysis of feed materials, operating procedures and operating logs, verified by occasional sampling and analysis. Nuclear material control and accountability practices require that the radio-isotopic compositions of nuclear materials be known accurately. These compositions are organized into standard Material Types (MT) which are used to track SNM in feed, product and waste streams on the Materials Accounting and Safeguards System (MASS). Operations, generally, do not mix materials of differing isotopic compositions. NMC&A in this instance can be used to determine the isotopic composition of SNM in the waste items accurately without resorting to a full spectral analysis.

Although all parties (LANL, DOE, WIPP & NMED) agree upon the use of acceptable knowledge; there is disagreement over what constitutes adequate AK. The first waste that was shipped to WIPP from LANL was very well documented by virtue of the quality assurance program inherent in the process. This was plutonium-238 waste from radio-isotopic thermoelectric generator fuel production. Despite extensive records, the State of New Mexico required that sampling and analysis be done to verify the AK. The results proved, as expected, that the AK was correct but was very expensive and time consuming.

The current approach to AK at the Plutonium Facility focuses on seven process streams: nitrate operations, chloride operations, metal preparation, pyrochemical operations, plutonium-238 operations, special isotope operations and a miscellaneous category. TA-55 is fortunate that extensive waste tracking has been the practice for a number of years as part of the NMC&A System. Operations in the plutonium facility are organized into Process Status (PS) that are used as accounts in tracking SNM in the facility. By utilizing this data, detailed AK is being assembled for waste generated in the Plutonium Facility back to the end of the 1980s.

These process streams are cross referenced to waste streams (waste with similar characteristics) that correspond with Transuranic Content (TRUCON) Codes set up to address transportation requirements. In this manner, characterization information is shown to track from the processes that produce the waste to the final waste package. Waste is certified as meeting the WAC by demonstrating compliance with and verifying the integrity of the waste management program, not by the certification of each individual waste package.

This AK methodology is for debris or non-homogenous waste streams. Waste streams that are processed to meet the WAC (cemented or vitrified waste) must be randomly sampled to demonstrate compliance. This is most conveniently accomplished by sampling during the immobilization process. Legacy waste monoliths from these processes must be sampled by coring in a manner that guarantees a representative sample of waste from the package. This procedure is complicated and is currently in the development stage.

The key to meeting the AK criteria is documentation and traceability of waste items back to the processes that resulted in their generation and in capturing as much information on the waste as possible. Meticulous archives of historical operation documentation have been invaluable.

Waste Minimization and Avoidance

Effective waste management begins in the conceptual design phase of a project. Facility procedures require that waste issues be evaluated at the onset of activity planning. In this manner, problem waste types or expensive disposal requirements can be evaluated and steps taken in the design to eliminate or reduce the cost of waste management with minimal impact to the project. At the very least, design life-cycle costs associated with waste disposal and decommissioning can be identified and planned for at the onset. In some cases, substitution can be made for hazardous substances and the necessary changes made to the process so that quality or efficiency is not sacrificed. Where the use of hazardous substances cannot be avoided, the necessary permits must be procured and steps may be taken to minimize the resulting waste.

Several technologies have been developed at Los Alamos to reduce the generation of transuranic or mixed waste. One way of reducing costs is to reduce the activity of the waste. It is much less expensive to dispose of low-level waste onsite than to ship transuranic waste to Carlsbad for disposal. An Electrolytic Decontamination technique has been developed and implemented on a pilot basis for the successful decontamination of decommissioned gloveboxes. Another method for reducing waste activity is the Salt Distillation Process by which chloride salts from pyrochemical processes are distilled to the point where they may be recycled back into the process. This has the effect of reducing the waste volume from this process by an order of magnitude.

Another area for both reducing the volume of waste sent for disposal and in eliminating the RCRA hazardous component of the waste is to address the combustible portion of the transuranic waste stream which consists of plastics from containers, packaging and wipes used for cleaning in the glovebox lines. The techniques of Supercritical Water Oxidation and Molten Salt Oxidation have been developed to reduce these waste volumes through the use of pyrolysis. They have been demonstrated successfully and funding is being sought to implement them in NMT Division.

Recent reductions in allowable nitrates released to the environment in aqueous effluent from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) has required a dramatic reduction in spent nitrate solutions from anion exchange operations at the Plutonium Facility and the curtailment of processing. A Nitric Acid Recycle System was developed to reduce the quantity of these solutions that are sent to the evaporator and on to the RLWTF. This system recently completed cold testing and is ready for operation upon completion of its formal readiness review.

The restrictive limitation in SNM loading of waste containers due to radiolytic hydrogen gas generation and transportation limits has also been addressed. This limit is especially important when dealing with plutonium-238 waste from heat source fabrication. The higher specific activity of this isotope severely limits the efficiency

of loading waste packages. A Vitrification System has been developed and is in the final stages of cold testing before installation in the Plutonium Facility. This will significantly increase the waste loading limit for waste solutions generated from nitrate operations (reduce the number of waste packages by an order of magnitude) and take the place of the transuranic waste immobilization process.

Computerized Data Management

The key to a successful waste management program lies in the integrity of waste documentation and the ability to track waste back to the generating process. Concepts such as AK have placed an additional burden on systems that track and compile waste documentation. Directly charging programs for the waste that they generate is expected to promote the waste minimization effort, but it requires an extensive accounting system and associated paperwork. All of these concepts have contributed to a proliferation in waste data requirements that quickly overburdened paper systems.

Two major projects were undertaken to take advantage of electronic data handling. The first was the development of a computerized Waste Management System (WMS). This had the impact of eliminating the flow of paper waste documentation out of radiological control areas and significantly reduced calculation and transcription errors, making the quality review process much easier. The process of review and approval was also improved and data could be transferred electronically, instead of relying upon the mail system. This system was implemented for transuranic waste in 1995. The second system is an inventory and tracking system (Waste Inventory Tracking System; WITS) that employs bar codes and hand-held palm pilots with built-in scanners. This takes the portability of using a computerized data management system a step beyond notebook computers and severs the network connection by providing data storage in the hand held unit. The palm pilot also has the ability to capture signatures, providing legal backing to the characterization process since the President of the United States signed into law legislation to make electronic signatures legally binding effective January 1, 2001.

The WITS system is currently in the implementation phase with initial deployment of barcodes and palm pilots in waste operations. Data is being collected in databases set up for the room trash operation. In this manner, the minor problems expected during implementation can be corrected on this pilot scale activity before it is implemented division-wide at both nuclear facilities.

Synopsis

Waste management in NMT Division is a cooperative process requiring the partnership of both generators and waste management personnel to be efficient and successful. Waste processes must be robust in order to withstand the rigors of audit, but flexible enough to change readily in response to regulatory drivers. Waste certification is demanding an increasing amount of information in order to demonstrate compliance with waste characterization requirements. This same information is also useful in assigning disposal costs and demonstrating waste minimization. The cost of acquiring and compiling this information (the development of new software applications is typically very expensive and carries a high element of risk) must be balanced with the benefits to be gained. Waste minimization technologies can be easily evaluated for effectiveness but the challenge is in funding their implementation. Unless a comprehensive waste management program is supported, both the quantity and cost of waste disposal will spiral out of control and can effectively cripple operations as special interest and activist groups have discovered. The effective management of waste from actinide processing operations is a challenging activity and will continue to present complex issues into the foreseeable future.