THE STORED WASTE EXAMINATION PILOT PLANT PROGRAM AT THE INEL

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ABSTRACT

Since 1970, defense transuranic waste has been placed into 20-year retrievable storage at the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory (INEL). A major objective of the U.S. Department of Energy (DOE) Nuclear Waste Management Program is to remove all retrievably stored transuranic waste from the INEL. The January 1981 DOE Record of Decision on the Waste Isolation Pilot Plant (WIPP) stated, "The WIPP facility will dispose of defense transuranic waste stored retrievably at the Idaho National Engineering Laboratory."

After retrieval and before shipment, processing may be necessary to prepare the waste for acceptance, handling, and enhanced long-term isolation in the WIPP. However, some of the waste is certifiable to the WIPP waste acceptance criteria without container opening or waste processing. To minimize costs, the Stored Waste Examination Pilot Plant (SWEPP) is being developed to certify INEL stored transuranic waste without container opening or waste processing. The SWEPP certification concept is based on records assessment, nondestructive examination techniques, assay techniques, health physics examinations, and limited opening of containers at another facility for quality control.

INTRODUCTION

The INEL covers 2305 km^2 of semiarid land in southeast Idaho near the center of the eastern Snake River Plain. The Radioactive Waste Management Complex (RWMC) encompasses approximately 58 ha in the southwestern corner of the INEL. The RWMC was established in 1952 as a controlled area for burial of solid radioactive wastes generated by INEL operations. In 1954, the burial ground was also designated as a solid transuranic (TRU) waste disposal site for waste generated offsite. Until 1970, all TRU waste was buried below grade at the RWMC. In November 1970, the Transuranic Storage Area (TSA) was established for 20-yr retrievable storage of contact-handled TRU waste (>10 nCi/g and <200 mrem/h at the container surface; the 10 nCi/g definition has since been changed to 100 nCi/g).[1] The waste is stored aboveground on asphalt pads within the TSA.

TRU waste stored at the TSA is generated by operations conducted for the U.S. Atomic Energy Commission and its successor agencies, now the U.S. Department of Energy (DOE). The following facilities have generated the majority of TRU waste placed in storage at the TSA: Mound Laboratory, Miamisburg, OH; Battelle Columbus Laboratories, Columbus, OH; Bettis Atomic Power Laboratory, West Mifflin, PA; Argonne National Laboratory-East, Argonne, IL; and the Rocky Flats Plant, Golden, CO. Small volumes of TRU waste have also been generated by INEL operations. In addition, the INEL Initial Drum Retrieval (IDR) and Early Waste Retrieval (EWR) projects have contributed formerly buried waste for storage at the TSA.

The TSA consists of three surface storage pads. TSA-1 was filled and closed in 1975. A portion of TSA-2 is filled and closed. The remainder of TSA-2 is active and being filled with TRU waste under an air support weather shield which provides environmental protection. The third pad (TSA-R) was used to store waste retrieved from the IDR and EWR projects.

Stored waste is currently packaged in DOT 7A fiberglass reinforced polyester-coated plywood boxes, DOT 7A steel (M-III) bins, and DOT 6M and 17C 208-L steel drums. Stored waste has also been packaged in DOT 7A wood boxes and 17H steel drums. The bins and boxes are placed around the perimeter of an area called a "cell," which serves as a boundary, retaining wall, and load-bearing surface. Each cell on the pad is isolated from the adjacent cell by an earth firewall. The steel drums occupy the space within the cell boundary and are stacked five high. After a cell is filled with waste, it is covered with plywood, nylon-reinforced polyvinyl sheeting, and soil which is seeded with sod-building grass to provide drainage and structural integrity.

Approximately 34 000 m^3 of TRU waste is stored at the RWMC. By 1989, this volume is expected to reach about 57 000 m^3.

The January 1981 DOE Record of Decision[2] on the WIPP stated, "The WIPP facility will dispose of defense transuranic waste stored retrievably at the Idaho National Engineering Laboratory." Before the stored waste can be removed from the INEL, the waste must be certified to meet the WIPP waste acceptance criteria (WAC).[3] Some of the waste must be processed to meet the WIPP-WAC. However, much of the waste is certifiable without waste processing. To minimize opening and processing costs, a concept was developed to certify INEL stored TRU waste without container opening or waste processing. The concept is based on certifying waste forms in sealed waste containers based on the results of records assessment, nondestructive examination (NDE) techniques, assay techniques, health physics (HP) examinations, and limited opening of containers in another facility for quality control. These activities will take place within the SWEPP facility, which will be the pilot plant for demonstrating certification of TRU waste stored at other DOE sites.

WASTE CERTIFICATION APPROACH

The approach to certify stored TRU waste in the SWEPP is based on information from the following sources:

1. Waste Records Received from the Waste Generator. This information is available from the computerized Transuranic-Contaminated Waste Container Information System (TCWCIS) developed in 1974 for input, storage, analysis, and presentation of data for each container of TRU waste stored at the RWMC. This system is in the NOMAD language; the data can be obtained on an interactive basis.

2. Waste Content Code Assessment. Each waste content code in the TCWCIS, identifying the contents of waste containers, was evaluated to determine waste form and packaging information. The assessment for each content code is used to determine if the content code meets the WIPP-WAC.

3. NDE Data. NDE techniques, described later, will be used to examine waste packages.

4. Sampling Program. Until SWEPP is operational, a sampling program will be established at the Rocky Flats Plant to examine and evaluate newly-generated TRU waste to provide evidence that a content code meets the WIPP-WAC. After SWEPP experiments begin, the sampling will be performed at another INEL facility, having the capability to open containers and examine the contents.

Each content code used by the waste generators has been evaluated to determine waste form, any variations in the waste form, and packaging methods. This information was obtained by contacting or visiting each waste generator shipping TRU waste to the INEL for storage, interviewing personnel, and reviewing available records, including the TCWCIS. The assessment for each content code was used to identify the presence, or potential presence, of free liquids, sludges, pyrophoric materials, explosives, compressed gases, respirable or dispersible fines, toxics, and corrosive materials in the waste package. Each of these items would cause the waste not to be certifiable to the WIPP-WAC. Based on this assessment, an initial determination was made as to whether the content code meets the WIPP-WAC. Based on the content code assessment, about 30% of the total waste volume can be directly certified in the SWEPP. About 20% of the waste has a TRU content of less than 100 nCi/g. This waste will be assayed in the SWEPP and reclassified as low-level waste. The remaining 50% will require processing. During certification, the content code assessment will be used to supplement the NDE of the waste container contents.

During FY-1983 and FY-1984, the Rocky Flats Plant is scheduled to sample and evaluate newly-generated TRU waste which is similar to waste stored at the INEL. The results will help determine if a waste form complies with the WIPP-WAC.

The information gained from the content code assessments and the sampling program is also being used in the preparation of mock-up waste packages simulating actual waste. The mock-up packages are being used to demonstrate and verify the capability of the NDE techniques and will be used as a quality control standard during SWEPP operations.

The NDE techniques being developed--assay, real-time radiography, and container integrity--will be incorporated into the SWEPP. Other NDE techniques available for waste certification include weighing and HP instrumentation.

Based on the records and content code assessments, sampling program, and NDE technology development, certification procedures are being prepared.

The certification procedure for each waste form will provide a brief description of how each criterion of the WIPP-WAC is being met. Certification procedures for each waste form will be submitted to the WIPP certification committee for approval before SWEPP experiments begin. These certification procedures implement the Certification Program Plan, which is being developed. Quality assurance for the waste certification will be administered through the SWEPP Quality Program Plan.

Waste certification will be based on the above approaches and on administrative controls. The administrative controls ensure that DOT Type A containers are used and are properly labeled and color-coded. Administrative controls will be used to ensure that a complete data package is prepared for each container. A summary of the certification approach is given in Table I.

SWEPP

The purpose of the SWEPP is to provide capabilities for the NDE and certification of INEL stored TRU waste containers. These capabilities include overpacking damaged and nonmetal waste containers, container integrity examination, weighing, radiographic examination, assay examination, radiological surveys, painting, color-coding, and labeling waste containers. If a waste package meets all the WIPP-WAC, the package will be stored until it can be shipped to the WIPP. Waste packages not meeting the WIPP-WAC will be processed in the INEL Processing Experimental Pilot Plant (PREPP) or placed in storage until the waste can be processed or otherwise certified. Containers with less than 100 nCi/g TRU will be segregated and disposed of as low-level waste.

Support facilities and equipment for retrieving stored waste packages from the storage area, venting pressurized containers, storing certified and noncertified waste, and preparing and shipping certified waste to the WIPP are not addressed in this paper.

The Title I and II designs of the SWEPP are underway. SWEPP construction will begin in FY-1984 and be completed in FY-1985. SWEPP experiments will begin in the fourth quarter of FY-1985.

Real-Time Radiography

Radiographic examinations will be used with the TCWCIS and content code assessments to identify waste forms and verify compliance with the WIPP-WAC. Table II summarizes the waste form certification capabilities of radiographic techniques.

The contents of a waste container will be identified from size, shape, and relative density. This identification will be compared to the TCWCIS content code. The radiography system operator will then judge whether the radiographic information is consistent with the TCWCIS content code for that container or with any other certifiable content code. (For a small fraction of the containers, sampling programs have shown that the listed content codes are incorrect.)

TABLE I. SWEPP CERTIFICATION APPROACH

WIPP-WAC	CERTIFICATION METHOD: Container Integrity	Weighing	Radiography	Fissile Inventory	Sampling/ Analysis	Administrative Controls	Records (TCWCIS)	Content Code Assessments
WASTE CONTAINER REQUIREMENTS								
Waste Containers	X					X		
Waste Size						X		
Waste Package Handling	X					X		
WASTE FORM REQUIREMENTS								
Immobilization			X		X		X	X
Free Liquids			X				X	X
Sludges	X		X				X	X
Pyrophoric Materials					X		X	X
Explosives and Compressed Gases			X		X		X	X
Toxic and Corrosive Materials	X				X			
WASTE PACKAGE REQUIREMENTS								
Waste Package Weight		X						
Nuclear Criticality				X				
Surface Dose Rate					X			
Surface Contamination					X			
Thermal Power				X				
Combustibility			X					
Gas Generation		X	X					
Color-Coding						X		
Labeling						X		
Data Package/Certification						X	X	

If this determination cannot be made, the waste package will be processed by the PREPP. If the radiographic information is consistent with the TCWCIS content code, the package will proceed to the next certification examination.

Radiography system operators will be trained to identify various waste forms in INEL stored TRU waste. An operator training program will be developed prior to the beginning of the SWEPP experiments. An operator qualification program will also be developed.

The radiography will be performed using a real-time x-ray system. This system was designed and is being developed by EG&G Idaho, Inc., Waste Programs and NDE Engineering Branches. This system was assembled by Real-Time X-Ray Imaging Corporation. This system has a power supply (420 kV at 10 mA), a detector made of a fluorescent screen which produces light photons under x-ray bombardment, a fiber-optics-coupled image intensifier to boost light levels, and a low light level TV camera to produce signals for a TV monitor. The components are fitted into a portable, light-tight, shielded box.

The x-ray beam passes through the object being examined. The attenuated beam is picked up by the detector, which converts the transmitted x-rays to light for the TV camera. The containers are rotated through the beam, which makes the image on the TV monitor appear to be three-dimensional. With this system, images of objects in motion can be produced. Low-voltage x-rays (up to 420 kV) are useful to inspect waste container contents when the waste does not highly attenuate x-rays. For sludge-filled drums or larger containers, it may be necessary to use a higher energy x-ray source or improve the efficiency of the image-processing equipment to obtain an adequate image of the container contents. These alternatives are being investigated.

The prototype real-time x-ray radiography system is being operated at the RWMC. The technology development will be completed in FY-1984. The radiography system will be installed in SWEPP in FY-1985.

Container Integrity

The container integrity examination will be used to certify the physical condition of the steel drums and bins is adequate to meet the 15-year life criterion in the WIPP-WAC. This examination will determine: (a) if the wall thickness of the waste container still meets DOT Type A specifications, (b) if the internal surface of the container is corroding significantly, and (c) if the container lifting lugs have deteriorated.

TABLE II. REAL-TIME RADIOGRAPHY CERTIFICATION CAPABILITIES

WIPP-WAC	Discussion
Gas Generation	Estimate volume of gas-generating waste material based on shape and relative density of contents. Then, using package weight, or weight of various standard components common in waste packages, estimate the weight of gas-generating material in the waste package.
Combustibility	Estimate volume of combustible material in the waste package based on shape and relative density of contents.
Immobilization	Estimate the quantity and type of particulates based on shape and relative density. Use sampling program data to qualify more exactly the percent less than 10 microns and less than 200 microns. Then, with the package weight, determine whether it meets the WIPP-WAC. The capability of the system for measuring the quantity of particulate material in this manner will be determined during development work.
Sludges	Verify content code assessment and examine for free liquids. Verify, based on shape and relative density of waste contents.
Free Liquids	Draw conclusions based on shape, relative density, and fluid motion.
Explosives and Compressed Gases	Explosives cannot be identified except when related to specific shape. Compressed gases can be identified based on imaging of gas cylinders, aerosol containers, etc.
Pyrophoric Materials	Identification is not feasible, except verification of content code assessment.
Toxic and Corrosive Materials	Identification is not feasible, except verification of content code assessment.

An ultrasonic system will be used to measure the metal thickness and internal corrosion of a steel drum or bin. The system will use a single transducer for sending and receiving sound waves. Since the sound velocity in the material is known, the thickness of a given container can be determined by measuring the time the sound takes to travel from the outer surface of the material to the inner surface.

Immersion in water may be required to test the drum material where the bottom is joined to the side wall. A bubbler appears to be the desired method to couple the ultrasonic system to the other areas of the drum. The specific design is being established. Ultrasonic testing with a water bubbler as a coupler has been demonstrated to be viable.

An automated system will be used to measure drums. A prototype drum-rotating assembly is currently being fabricated. This assembly will be used as the base to position ultrasonic probes and devices to remove loose paint, rust, and other materials that affect the measurement.

Specific measurement points on drums have been tentatively identified, based on where the most moisture would collect. The crevice between the sidewall and the bottom has the highest potential for moisture collection, and the bottom surface the next highest potential. The lower surfaces of the hoops on the sides of the drums are being measured, since they are used in handling and also should retain the most moisture on the sidewall. One measurement on the top is considered adequate, since corrosion on this surface should be external and readily visible.

Similar logic was applied to measuring M-III bins. The bottom, the joint between the bottom and sidewall, and random locations on the side and top are proposed measurement points.

Criteria will be established to assess whether container dents are significant enough to warrant overpacking. Small dents or those caused by a blunt surface may be considered acceptable. Overpacking would only be required if the dent has sharply creased or stretched the metal.

The lifting lugs on the M-III bins will be visually inspected for integrity at the time of retrieval. If rusting is observed, the diameter of the lifting lug will be measured to verify that sufficient metal remains.

The initial container integrity technology was developed in FY-1982 by the Hanford Engineering Development Laboratory. The container integrity system is being designed and built during FY-1983. In FY-1984, the system will be tested and upgraded, as required. In FY-1985, the system will be moved into the SWEPP. The FY-1983 through FY-1985 tasks are being performed by EG&G Idaho, Inc., Waste Programs and NDE Engineering Branches.

<u>Assay</u>

An assay system will be developed for the SWEPP to determine: (a) fissile inventory, (b) thermal power density, and (c) TRU content in waste packages. These objectives will be met by: (a) using a drum counter recently developed to assay 208-L drums, and (b) applying this drum counter technology to produce a box/bin counter that can assay the stored boxes, bins, and 314-L drums. These devices will be developed by the Los Alamos National Laboratory (LANL). Both systems will use the differential dieaway technique (DDT, which is an active neutron interrogation technique) and passive neutron counting. In DDT, a pulse of fast (14-MeV) neutrons is introduced into an assay chamber. The chamber is made of polyethylene and lined with graphite to thermalize the neutrons. These neutrons have a characteristic lifetime, called the system dieaway time. If fissile material is present in the chamber, some of the neutrons will cause fissions. Prompt neutrons from these fissions are detected in specially designed neutron detectors, which are sensitive only to fast neutrons.

The fissile inventory, thermal power density, and the content will be measured by the assay system as follows:

1. <u>Fissile Inventory</u>. The actual quantities of the fissile isotopes ^{239}Pu, ^{233}U, and ^{235}U will be determined by active neutron interrogation. In the active phase, the

prompt and delayed neutrons from fissions induced by interrogating thermal neutrons will be counted. The number of observed prompt neutrons is directly related to the mass of fissile material present. The ratio of prompt to delayed neutrons will indicate which fissile isotopes are present.

2. Thermal Power Density. A conservative estimate of the total α activity within the container and, hence, the thermal power generation can be obtained by counting non-fission (single) neutrons. These single neutrons are produced by α, n reactions with certain elements such as ^{18}O or ^{19}F in the waste matrix. Experiments have shown that the α, n reaction in TRU waste will produce at least two neutrons per second (nps) per mCi, regardless of which TRU isotopes are present. For example, if the observed singles count rate is 2 nps, then the total α activity is known to be at least 1 mCi. Once the total α activity is known, it can easily be converted to thermal power by using the average energy deposited within the matrix with each α decay, approximately 5 MeV. The estimate for thermal power obtained in this way will be checked against the value calculated using the fissile inventory. If there is a discrepancy, the higher value will be used.

3. TRU Content. According to the definition of TRU in DOE Order 5820.1,[1] nearly 30 isotopes can be classified as TRU. Most of these isotopes emit energetic α particles and can therefore be detected by the same α, n reaction that is used to estimate the thermal power generation. Certain isotopes, such as ^{241}Pu, do not emit α particles, but decay into α-emitting daughters. The amount of these isotopes present will be calculated using isotopic ratios. For example, 0.325% by weight of weapons-grade plutonium is ^{241}Pu. For the α-emitters, the conservative assumption is again made that 1 mCi of α activity will always produce at least 2 nps. For a drum that weighs 100 kg, 100 nCi/g will produce at least 20 nps. Thus, if only 10 nps were measured, the total TRU activity in that drum would be less than 50 nCi/g. That particular drum would then be disposed of as low-level waste.

The drum counter is presently being built by LANL and will be shipped to the INEL in FY-1984. It will be installed in the SWEPP in FY-1985. The box/bin counter will be built by LANL in FY-1985 and FY-1986, and installed in the SWEPP in FY-1987.

Other Certification Equipment

Waste containers will be weighed on a flexure-base-type platform scale. In a flexure-base scale, thin high-strength steel plates (flexures) in tension replace the pivots and bearings. The flexure plates never wear out, are always aligned, and will not fail unless the platform is loaded well beyond the capacity of the scale.

Each waste package will be surveyed for direct ionizing radiation by using an instrument similar to an Eberline Model RO-3A. The survey probe will be hand-held at approximately 1 cm from the waste package surface. If the survey indicates that the radiation level exceeds 200 mrem/h at contact, corrective actions will be taken, such as shielding.

The surface contamination survey of a waste container will be performed using established HP survey techniques. The survey will be performed with large area smears of the container surface. If contamination is detected from these smears, a detailed survey will be performed and the individual smears counted with a standard α/β proportional counter to quantify the contamination level. If the survey exceeds contamination limits, the container will be decontaminated until verified as radiologically clean. If the source of the contamination is from a breached waste container, the container will be overpacked.

All waste packages determined to have met the WIPP-WAC will be color-coded and labeled in accordance with the WIPP-WAC. Color-coding the waste containers will identify: (a) surface dose rates exceeding 100 mR/h and less than 200 mR/h, (b) waste packages exceeding 25% combustibles by volume, and (3) reportable quantities of toxic materials.

The color code will be applied as a band or stripe with metal tape to meet the 15-year WIPP storage life requirement.

A Data/Certification Package will be transmitted to the WIPP prior to shipment of the waste. The information in the Package will be available from the Data Management System in the SWEPP. The contents of the data package will be as required by the WIPP-WAC and/or by the specific requirements being defined by the Mound Laboratory.

CONCLUSIONS

The SWEPP will experimentally demonstrate that stored TRU waste can be certified to the WIPP-WAC without opening the waste container or processing the waste. The SWEPP will accomplish this certification in a cost-effective manner. This technology can be transferred to other DOE sites where TRU waste is stored or buried. This technology can also be transferred to ensure that packages of low-level waste meet shallow-land burial criteria.

REFERENCES

1. Department of Energy, "Management of Transuranic Containment Material," DOE Order 5820.1, September 30, 1982.

2. Department of Energy, "Waste Isolation Pilot Plant (WIPP); Record of Decision," Federal Register, 46, No. 18, January 28, 1981.

3. Department of Energy, "TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant," WIPP-DOE-609, Revision 1, September 1981.