TRANSURANIC WASTE MANAGEMENT PROGRAM AND FACILITIES[a]

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ABSTRACT

Since 1954, defense-generated transuranic (TRU) waste has been received at the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering Laboratory (INEL). Prior to 1970, approximately 2.2 million cubic feet of transuranic waste were buried in shallow-land trenches and pits at the RWMC. Since 1970, an additional 2.1 million cubic feet of waste have been retrievably stored in aboveground engineered confinement.

A major objective of the Department of Energy (DOE) Nuclear Waste Management Program is the proper management of defense-generated transuranic waste. Strategies have been developed for managing INEL stored and buried transuranic waste. These strategies have been incorporated in the Defense Waste Management Plan[1] and are currently being implemented with logistical coordination of transportation systems and schedules for the Waste Isolation Pilot Plant (WIPP). The Stored Waste Examination Pilot Plant (SWEPP) is providing nondestructive examination and assay of retrievably stored, contact-handled TRU waste. Construction of the Process Experimental Pilot Plant (PREPP) was recently completed, and PREPP is currently undergoing system checkout. The PREPP will provide processing capabilities for contact-handled waste not meeting WIPP-Waste Acceptance Criteria (WAC). In addition, ongoing studies and technology development efforts for managing the TRU waste such as remote-handled and buried TRU waste, are being conducted.

INTRODUCTION

The Idaho National Engineering Laboratory (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), which encompasses 58 ha in the southwestern corner of the INEL, serves as a major storage site for defense transuranic (TRU) wastes generated by operations conducted for the U.S. Atomic Energy Commission and its successor agencies, now the U.S. Department of Energy (DOE). Transuranic waste is currently defined as material that has negligible economic value, and is "contaminated with alpha-emitting transuranic radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g.[2] The RWMC was established in 1952 as a controlled area for burial of solid radioactive waste generated by INEL operations. In 1954, the burial ground was also designated as a solid TRU waste disposal site. Until 1970, all TRU waste was buried below grade at the RWMC. In November 1970, the Transuranic Storage Area (TSA) was established within the RWMC for 20-year retrievable storage of contact-handled (<200 mrem/h at the container surface) TRU waste. The Intermediate Level Transuranic Storage Facility (ILTSF) was established in 1976, within the TSA, to provide a 20-year retrievable storage of remote-handled (>200 mrem/h at the container surface) TRU waste.

A major objective of the U.S. DOE Nuclear Waste Management Program is the proper management of defense-generated transuranic waste. Strategies have been developed for managing INEL stored and buried TRU waste. Retrievable stored TRU waste will be processed and certified for shipment and disposal at the WIPP near Carlsbad, New Mexico. The WIPP, now under construction, will be a research and development facility for demonstrating the safe disposal of defense-generated TRU waste. Before shipping waste to WIPP, the waste must be certified as complying with the WIPP-WAC.[3] These criteria delineate the requirements by which the waste will be accepted for disposal. These criteria include limits on the amount of respirable and dispersible fines. In a waste package, absence of free liquids, fissile inventory, and labeling requirements. The purpose of these criteria is to ensure safe disposal of the waste.

The Stored Waste Examination Pilot Plant (SWEPP) and the Process Experimental Pilot Plant (PREPP) are INEL facilities used to process and certify contact-handled stored TRU waste. The purpose of SWEPP is to provide capabilities for nondestructive examination (NDE), nondestructive assay (NDA), and certification of the waste without waste container opening or processing. The purpose of PREPP is to demonstrate processing selected uncertifiable TRU waste into an acceptable waste form for disposal at WIPP. The SWEPP-II PREPP-II facilities will provide processing and certification capabilities for remote-handled (RH) and special-case (SC) TRU waste. Studies are currently being conducted toward technology development, evaluation, and selection of a management alternative for buried TRU waste.

STORED WASTE EXAMINATION PILOT PLANT (SWEPP)

Capabilities for certifying INEL stored waste containers include weighing, real-time radiographic examination, assay examination, container integrity examination, radiological surveys, and labeling of waste containers. Other support capabilities, which will not be addressed in this paper, include providing facilities and equipment for retrieval of waste containers, venting pressurized containers, overpacking damaged waste containers, storing certified and uncertifiable waste packages, and preparing and shipping certified waste to WIPP.

Waste certification in SWEPP is based on a combination of information obtained from:

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1. Waste Records: This information is available from the computerized Transuranic Contaminated Waste Container Information System (TCWCIS), which was developed in 1971. This system contains specific information for each waste container that is used to initially screen waste containers for identification of container contents prior to examination in SWEPP.

2. Waste Content Code Assessment: Each waste content code, which describes the physical contents of a waste container, was evaluated to determine waste form, packaging information, and compliance with the waste form requirements of the WIPP-WAC. This information is used to assist NDE equipment operators in evaluating waste container contents.

3. Nondestructive Examination Data: Nondestructive examination (NDE) techniques are used in SWEPP to ensure the waste meets the WIPP-WAC. These techniques are discussed later in this paper.

4. Sampling Program: A sampling program was conducted to open, examine, and evaluate INEL stored TRU waste for compliance with the WIPP-WAC and determine the capabilities of the NDE equipment for certifying waste. A similar sampling program will be conducted throughout SWEPP's operational phase to ensure quality control of the certification process.

Within SWEPP, waste packages are nondestructively examined, and classified, based on the NDE results, as to ultimate disposition. Packages that meet the WIPP-WAC are certified accordingly and stored for future shipment to WIPP. Packages that can be processed to a certifiable state are identified for processing in PREPP, and those that cannot are classified as "special-case" and held in interim storage pending development of enhanced examination and processing capabilities. Packages containing less than 100 nCi/g TRU activity are designated as low-level waste and treated as such.

The NDE techniques used to certify and classify waste in SWEPP are real-time radiography (RTR), assay, and container integrity examination.

Real-Time Radiography

The RTR system is a commercially available x-ray system that permits internal examination of waste packages and avoids the need for opening. It is used primarily to determine whether the physical contents meet the WIPP or PREPP-WAC. Specifically, it is used to identify such materials as free liquids, respirable fines, and pressurized containers that would make the packages unacceptable for WIPP storage. Similarly, it permits identification of large quantities of liquid, unshreddable objects or other items that cannot be processed in PREPP.

The RTR system consists of a 420-KvP constant-potential x-ray head, imaging system, video processor, monitors, and a recorder. The x-ray source and imaging system are housed in lead-shielded, light-tight enclosures. A cart is used to transport waste packages into and out of the enclosure.

Controls are provided to enable adjustment of x-ray head and package position and selection of one of several camera lenses by the operator. Monitors display both the direct imaging system and the video processor outputs. The recorder permits documentation of all examinations on video tape.

Assay System

The SWEPP assay system, developed by the Los Alamos National Laboratory, measures fissile material content, thermal power density, and total TRU content. A drum counter is presently installed, and a box/bin assay system will be added in the fall of 1986. Both counters use a differential die-away, active neutron interrogation technique (DDT) and passive neutron counting. In DDT, a pulse of fast (14-MeV) neutrons is introduced into a polyethylene- and graphite-lined chamber and thermalized. These neutrons have a characteristic lifetime, called the system die-away time. If fissile material is present in the chamber, some of the neutrons cause fissions. Prompt neutrons from these fissions are detected in specially designed neutron detectors that are sensitive only to fast neutrons.

The fissile content of a waste drum is determined by active neutron interrogation (DDT) as well as passive neutron counting. The active assay provides the greatest accuracy for low fissile inventories; the passive assay is more accurate for the higher ones. Hence, data from the two are used accordingly. The thermal power density and total TRU content is derived by counting nonfission (single) neutrons. These neutrons are produced by (α, n) reactions with elements such as O-18 or F-19 within the waste matrix and serve as an indication of the total alpha-activity. Since the average energy deposited per alpha-decay is known, the thermal power can be calculated based on the total alpha-activity. The total TRU content is determined using the same (α, n) reaction. For non-alpha-emitting isotopes, such as Pu 241, the amount of these isotopes present is calculated using isotopic ratios. The total TRU content measurement is used to identify waste containers with less than 100 nCi/g TRU activity.

Container Integrity System

The container integrity system, developed by EG&G Idaho, Inc., ultrasonically measures metal wall thickness of waste drums to ensure that U.S. Department of Transportation requirements are met. With this system, a waste drum is rotated, in a holding fixture, past stationary ultrasonic search units, which are positioned in representative locations including those where experience has shown corrosion caused thinning to occur. Signals from the transducers are inputted to on-line data processing equipment, and the output data are recorded in engineering units. Containers that fail the container integrity examination must be overpacked in new containers prior to shipment to WIPP.

Other Certification Equipment

Other equipment important to the certification process are the data management system, which processes and stores data and produces a certification data package for each waste package; scales, which provide accurate measurement of container weight; radiological survey instruments; and computer-driven container labeling equipment.

PROCESS EXPERIMENTAL PILOT PLANT (PREPP)

Noncertifiable waste will be sent to PREPP for processing. PREPP will demonstrate different experimental approaches for processing TRU waste into a form acceptable for disposal. Processed waste will be returned to SWEPP for certification and shipment to WIPP.

PREPP's processing methods consist of low-speed shredding of the waste and container, incineration in a rotary kiln incinerator, separation of the incinerated waste, and waste immobilization by cementing. On the average, nine drums of waste will be processed per 8-hour shift. However, this number is highly dependent on the particular waste composition being processed.

Boxes and drums are transported by truck from SWEPP to PREPP. The incoming containers are logged in and temporarily stored in the Shipping and Receiving Area. The waste containers are moved through two airlocks, up the elevator enclosure, and transferred by two chain conveyors and a monorail crane to the Shredder Enclosure. The low-speed shredder is powered by two 75-hp electric motors, which turn two shredding shafts. The floor of the enclosure slopes 14 degrees toward the shafts, acting as a hopper for the shredder. The shredder feed rate is dependent upon the type of material being shredded; but, for average waste compositions, it is estimated that the shredder will operate only 5 min. of every hour. The shredder is capable of shredding up to 1/2-in. thick stainless steel plate. In general, however, waste to be processed will be restricted to less than 1/4-in. thick.

When large, difficult-to-shred items are encountered, an overload condition is sensed by increased electrical current to the motors. When the preset limit is reached, the motors automatically stop, reverse direction momentarily, then proceed forward again. This action is repeated until the waste is shredded or until the operator turns the shredder off. Unshreddable items are removed from the shredder by a grapple and then removed from the Shredder Enclosure.

The shredded pieces drop from the bottom of the shredder to the Incinerator Feed Conveyor for transfer to the incinerator. This horizontally vibrating inertial-drive conveyor moves the shredded waste along with a relatively slow forward stroke and a quick return reverse stroke. Shredded waste is transported by the conveyor through two feed conveyor gates to a shuttle-hopper assembly. Waste falls from the conveyor into the hopper and is then batch fed into the rotary kiln incinerator.

Incineration of waste results in volume reduction of combustibles and burning or drying of any liquids contained in the waste. The rotary kiln incinerator is 8 ft in diameter and 24.5 ft long. It is slightly inclined downward in the direction of waste flow. Inside the kiln, waste is subjected to temperatures of 1500-1800°F. Heat is added to the incinerator by propane-fired burners. Waste is retained in the kiln for approximately 90 min. to ensure complete waste combustion. Gases pass from the incinerator to the Secondary Combustion Chamber where complete burning of waste gases is assured. Off-gases are cooled, scrubbed, and filtered prior to release from the stack.

Ashes and noncombustibles exit the kiln and drop onto a discharge conveyor of a design similar to the feed conveyor. Two pneumatically operated gates contain a batch of waste on the discharge conveyor for a period of time sufficient to cool the waste from the kiln operating temperature to approximately 160°F. Water cooling jackets are mounted on the four outside surfaces of the discharge conveyor and two transvectors inject air into the conveyor to improve convective heat transfer. After cooling, the downstream gate is opened and the conveyor transports the waste to a rotating cylindrical screen trommel.

The trommel separates the fine ash (less than 1/4 in.) from the coarse material. Two rotating drums allow the fine waste material to fall through the holes in the trommel and into the hopper below. The fines are pneumatically conveyed to blenders and then to a weigh tank.

The larger pieces move on through the trommel and into a glove box table in the Drum Fill Enclosure. Glove ports, manual rakes, and a small hanging grapple are used to move the waste into the final storage drum. A grout mixer, also located inside the Drum Fill Enclosure, is suspended from the ceiling above the drum loading hole. Sand, cement, fines, sludge from the off-gas system, and water are added to the grout mixer. As coarse material is placed into a double-plastic-lined drum, wet grout is discharged through a downspout to the drum being filled. During the filling process, an operator puts the grout and coarse material into the drum in layers. A vibrator is used to settle the contents and fill the voids.

After the drum is filled, it is sealed and transferred to the drum curing room by way of a roller conveyor, drum lift, and handtruck. After curing for at least three days, the drums of cemented wastes are transported back to SWEPP for assay, final certification, and shipment to WIPP.

SWEPP II/PREPP II

The objective of the SWEPP II/PREPP II project is to provide capabilities for processing and certifying remote-handled (RH) and special-case (SC) TRU waste. Special-case waste is defined as waste that can not be processed or certified in SWEPP or PREPP. Remote-handled waste exceeds 200 mrem/h at the container surface. Management alternatives are currently being evaluated. The alternatives include: (1) modify the existing SWEPP and PREPP, (2) modify an existing facility (e.g., hot cell), (3) design and construct new facilities or (4) ship the waste to another site. SWEPP II/PREPP II is scheduled to be operational in FY-1993.

BURIED TRU WASTE STUDIES

Studies are currently being conducted at the INEL to evaluate alternatives for long-term management of TRU waste buried prior to 1970. These alternatives include: (1) leaving the waste in place and providing environmental monitoring; (2) leaving the waste in place, but providing improved confinement, or (3) retrieving, processing and certifying the waste for disposal at a federal repository.

In-situ grouting is the improved-confinement technology being evaluated at the INEL. This two-year program will demonstrate the applicability of grouting technology in arid, unsaturated soil zones found at the INEL. Grout is forced, as a fluid, into the buried waste/soil matrix of a buried waste pit. The fluid grout either fills the voids in the matrix or displaces and compacts the host soil. The grout solidifies around the waste containers, inside breeched containers, and around loose waste. The waste is immobilized in place and becomes a cohesive mass with lower permeability than the host soil. With lower permeability, leaching of transuranic radionuclides from the waste pit is minimized. In addition, pit subsidence problems and site maintenance are minimized.

In FY-1986, three simulated waste pits will be loaded with simulated TRU waste. Two of the pits will include instrumentation and hydrological tracers to detect water movement. One pit will be grouted, the other pit will not be grouted and will serve as a control pit. The third pit will be grouted and destructively examined to determine grout penetration characteristics. The instrumented pits will be monitored for moisture movement for an eight-year period.

CONCLUSION

The above facilities and studies are an integral part of the long-term strategy for managing INEL stored and buried TRU waste. In addition, the concepts and experimental data obtained from these programs will make valuable contributions to the U.S. DOE Nuclear Waste Management Program.

REFERENCES

1. U.S. Department of Energy, The Defense Waste Management Plan, DOE/DP-0015, June 1983.
2. U.S. Department of Energy, Radioactive Waste Management, DOE Order 5820.2, February 6, 1984.
3. U.S. Department of Energy, TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant, WIPP-DOE-069, Revision 2, September 1985.