PROCESSING OF TRANSURANIC WASTE AT THE SAVANNAH RIVER PLANT

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ABSTRACT

The Department of Energy (DOE) has instituted a national program to isolate defense TRU waste in a deep geological repository, the Waste Isolation Pilot Plant (WIPP), in Calsbad, New Mexico. Since 1972, the highly toxic and long half-life transuranic (TRU) waste at the Savannah River Plant (SRP) has been stored on above-grade concrete pads in 55-gallon drums, large carbon steel boxes, and concrete culverts. As part of the national program, a major project is planned at SRP to retrieve and process this waste. This project, the TRU Waste Facility (TWF), will provide equipment and processes to retrieve TRU waste from 20-year retrievable storage and prepare it for permanent disposal at the WIPP. This project is an integral part of the SRP Long Range TRU Waste Management Program to reduce the amount of TRU waste stored at SRP. The TWF is designed to process 15,000 cubic feet of retrieved waste and 6,200 cubic feet of newly generated waste each year of operation. This facility is designed to minimize direct personnel contact with the waste using state-of-the-art, remotely operated equipment. In support of the TWF, a remote size-reduction and material handling process is being cold-tested at the Savannah River Laboratory. The process consists of a large, low-speed shredder and material handling system, a remote worktable, bagless transfer system, and a robotically controlled manipulator.

BACKGROUND

TRU waste has been generated at SRP since plant startup in early 1953. From 1953 through 1964, TRU waste was disposed of nonretrievably in shallow land burial trenches. Beginning in 1965, TRU waste was stored both nonretrievably and retrievably. Packages containing less than 0.1 Ci of TRU isotopes were disposed of nonretrievably in shallow land burial trenches. Waste packages containing greater than 0.1 Ci per package were placed in retrievable concrete containers or encapsulated in concrete monoliths in shallow land burial trenches.

Since 1974, all TRU waste suspected of containing greater than 10 nCi/g of TRU contaminants has been stored retrievably on aboveground concrete pads under a soil mound. Solid waste contaminated with 10 nCi/g to 0.5 Ci per container is stored in 55-gallon galvanized steel drums with 90-mil polyethylene liners. Solid waste contaminated to greater than 0.5 Ci per container is also stored in 55-gallon galvanized steel drums with 90-mil liners, however, these drums are also enclosed in concrete culverts. The concrete culverts are seven feet in diameter and seven feet high with six-inch-thick walls and can contain up to fourteen 55-gallon drums. Bulky TRU waste is placed in carbon steel, polyethylene, or concrete boxes, which can be as large as 12' wide x 18' long x 7' high.

The drums, filled concrete culverts, and boxes are stored on one-foot-thick concrete pads. When the pads are full, three feet of soil is mounded over the containers, a moisture barrier is placed on top of the soil, and an additional foot of soil is placed on top of the moisture barrier. Shallow-rooted grasses are then planted on the mound for erosion control.

GENERAL DESIGN BASIS

The primary mission of the TRU Waste Facility is to safely retrieve and process stored waste for disposal at WIPP while minimizing occupational radiation exposure and environmental effects.

The design life of the TWF will be 30 years. The TWF design will meet the General Design Criteria of DOE Order 6430.1 for new DOE facilities and DOE Manual 5480.1A, Chapter XI, "Standards for Radiation Protection." Plutonium processing facility standards for fire resistance and protection, ventilation, and radiation protection will apply to the design.

Because process inventory will be controlled so that exposures to offsite and near-in personnel resulting from a design basis accident will not exceed plant exposure limits, the building loading design criteria for seismic and tornado activity for plutonium processing facilities have not been applied.

For contamination control, all regulated area and radiation zone floors, walls, and ceilings will be smooth and free of obstructions and coated with a material designed for ease of decontamination.

Regulated areas outside the process areas and airlocks will have suspended, removable panel ceilings with piping, ductwork, cable trays, and conduit located above the ceiling.

The equipment installed in the radiation zones has been specifically designed for remote operation and maintenance. Where possible, equipment motors have been installed outside of contaminated cell areas to reduce exposure during maintenance. All radiation zone lighting will also be accessed from outside the process areas for ease of changing the lamps without breaking containment seals.

Several areas of the TWF will be designed to withstand forces generated by a hydrogen gas explosion within a waste drum. Hydrogen gas is a product of radiolysis that can occur in the sealed waste drums. To identify specific areas of risk and to determine measures for eliminating personnel exposure to these risks, a study was conducted in which several drums containing a mixture of hydrogen in air were detonated. These tests provided a technical basis for the design of areas where there will be potential for drum explosions.

The building ventilation system design will meet the requirements of DOE 5480.1A Chapter 1, 8.a.(1)(h); ERDA 76-21, Nuclear Air Cleaning Handbook. Facility design will provide safeguards to prevent uptakes and ventilation system reversals, which could cause contamination of clean areas. Building exhausts will be discharged to a sand filter prior to release to the atmosphere. Regulated exhaust air from the process cells will be passed through DOP-testable high-efficiency particulate air (HEPA) filters before being introduced to the sand filter. In-cell HEPA filters will also be provided in areas of high contamination potential as an added protection. This type of ventilation ensures that the population at SRP and in the surrounding communities will be protected in the unlikely event of a process upset. For the purpose of maintaining facility nuclear safety limits for plutonium inventory, all process area regulated duct work will be accessible for HP fissile material monitoring and cleaning.

An automatic fire detection and alarm system is to be provided in all building areas, including the glovebox enclosures. Local process equipment fire suppression systems will be provided where necessary.

PROCESS DESCRIPTION

General

The TWF process will handle approximately 15,000 cubic feet of retrieved waste and 6,200 cubic feet of newly generated waste each year of operation.

The primary wasteforms received at the TWF will be 55-gallon drums and carbon steel boxes. Stored waste drums contain a mixture of combustible and non-combustible waste. The carbon steel boxes contain large, bulky waste wrapped in plastic and packed into plywood boxes. Waste processing through the TWF is shown in Fig. 1.

Waste Retrieval Operations

To retrieve TRU waste, the four-foot soil cover over the stored waste will be removed using earth-moving equipment to within approximately six inches of the waste containers. The remaining soil will be removed with a remotely operated, HEPA-filtered soil vacuum truck. Due to the potential for drum explosions due to radiolytically generated hydrogen, 55-gallon drums will be removed from storage using a specially designed and shielded lifting canister. This canister will fit over the drum to protect personnel in the event of an explosion and will control any contamination released. Drums will be placed from the lifting device into an explosion-resistant cask for transportation to the TWF. Larger containers will be lifted from the pads and placed directly on a low-boy trailer for shipment to the TWF building. All equipment used in the retrieval operation will be radiation and explosion shielded.

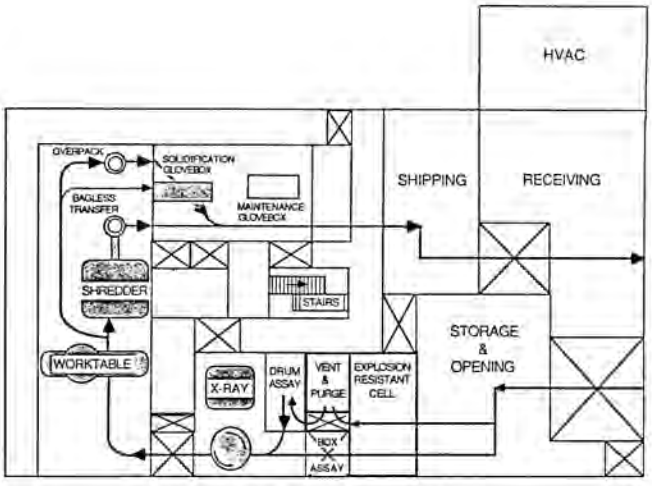

Fig. 1. TWF Process Flow.

Storage and Opening Area

Waste containers will be received into the TWF through an airlock into the Storage and Opening Area. Steel boxes will be opened in the high bay area, and the plywood boxes will be removed to be processed through the facility. The shielded drum transportation cask and the culverts will be placed directly into an adjacent explosion-resistant room. In this area, the culverts will be remotely opened using a system of wedges to break the grout seal at the culvert lid.

Using an overhead crane, drums will be removed individually from the shipping containers and placed in a cell where the drums can be vented, purged with an inert gas, and fitted with a carbon composite filter vent before being introduced into the Verification Area. These vents allow gases to diffuse, preventing the buildup of radiolytically generated hydrogen in waste drums while they await processing.

Verification Area

In the Verification Area both drums and boxes will be assayed using neutron interrogation to determine the waste container curie content for inventory control and record purposes. Each waste container will then be x-rayed to identify any objects that do not meet the WIPP Waste Acceptance Criteria.

Waste Processing Cell

After x-ray, containers pass through an airlock onto the Waste Preparation Area. Design of the airlock will incorporate balloon seals to prevent potential backflow of contamination into the Verification Area. In this cell, contaminated equipment will be removed from its plywood box. The equipment can then be size-reduced using a heavy-duty, electromechanical manipulator (telerobot) in conjunction with master-slave manipulators as illustrated in Fig. 2. The telerobot is capable of handling several tools, including a plasma arc torch for size-reduction of large equipment contained within the plywood boxes. The telerobot will also be utilized to remove any objects identified in the x-ray process as requiring further processing prior to WIPP disposal. An electric worktable, which has been custom designed for use with the telerobot will be provided. It has the capability to hold large, bulky objects in place in any position while they are being operated upon by the robot. The worktable has also been designed to facilitate remote maintenance by the telerobot.

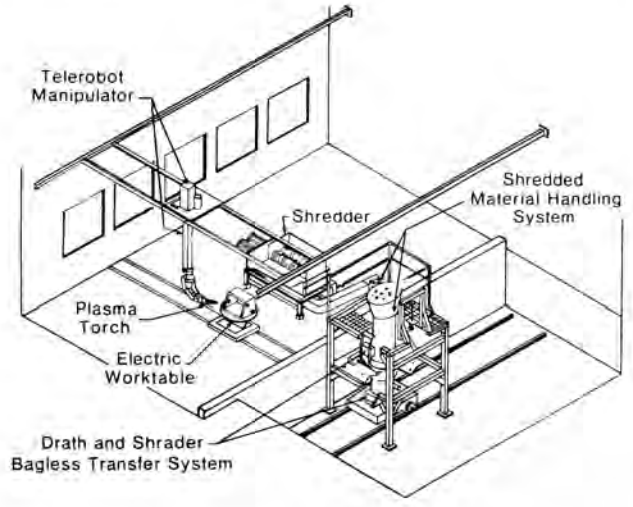

Fig. 2. Waste Preparation Cell.

Drums and other equipment can then be placed into a low-speed, high-torque shredder or directly in a drum overpack for removal from the Waste Processing Cell. Waste from the cell will be removed using Drath and Schrader bagless transfer systems, which allow waste to be removed without the use of traditional bagout operations. With this system, waste is placed directly in special drums designed to prevent contamination of the drum lid and the exterior surface of the drum.

The wasteforms segregated as requiring additional processing, such as respirable fines and items containing free liquids (sludges and resins), will be stabilized in the TWF to meet the WIPP-WAC.

Respirable fines, sludges, and resins will be transferred from the Waste Preparation Area into a glovebox containing a small-scale solidification process. In the glovebox, the waste will be placed in a small container, mixed with cement, sand, and water, and allowed to harden. Once set, the solidified matrix is returned to the Waste Preparation Area and placed in the bagless transfer system for disposal.

The Waste Processing Cell will also contain a glovebox for changing tool tips and an in-cell vacuum cleaning system to remove dust and contamination. Operations in this cell will be completely remote and can be viewed from the telerobot operating console corridor through lead-shielded windows. A closed-circuit television system will provide localized viewing of individual equipment operations. All cameras will be fitted with cerium-stabilized lenses to prevent radiation damage and will be accessible to the telerobot for in-cell maintenance.

Shipping and Receiving Area

Drums of processed waste removed from the waste preparation cell using the bagless transfer system are transported to the shipping area where they are prepared for shipment to the Waste Certification Facility (WCF) for classification as low level waste, WIPP intended waste, or as noncertifiable waste.

Regulated Maintenance Facilities

Regulated maintenance facilities include a regulated maintenance shop and a master-slave manipulator repair glovebox. The regulated maintenance shop will be located on the second floor of the TWF between the Storage and Opening Area and the Waste Processing Cell. Maintenance access to the overhead cranes and monorails in these areas will be incorporated into the facility design through the use of service decks accessed from this regulated maintenance shop. Lead-shielded windows will be provided in the shop to view repair operations in the Waste Processing Cell.

The master-slave manipulator repair glovebox will be located adjacent to the Waste Preparation Cell for easy access from the cell area using the telerobot. This glovebox provides 360 degrees access for repair of the contaminated "slave" end of the manipulator.

CONCLUSION

With the construction of the TWF, interim storage of all TRU waste can be ended. The placement of TRU waste in a deep geological repository will provide a single disposal site for the long-lived TRU isotopes now stored at the Savannah River Plant.

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