A MULTIPLE WASTE RECEIPT AND PACKAGING FACILITY FOR A SALT REPOSITORY

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ABSTRACT

Present programmatic planning by the Department of Energy's National Waste Terminal Storage Program is directed toward the receipt and emplacement of a variety of waste types and forms in a mined geological repository. The repository would accept spent fuel (SF), reprocessed commercial high-level waste (CHLW) including West Valley waste (WVW), contact- and remote-handled commercial transuranic (TRU) waste, and defense high-level waste (DHLW). This paper presents the results of a conceptual design study for a multiwaste receiving and packaging facility located at a salt repository site.

INTRODUCTION

During 1982, baselining activities by DOE's National Waste Terminal Storage Program began to define the types and quantities of nuclear wastes to be disposed of in a salt geologic repository, and their rate of receipt. The repository would receive and dispose of spent fuel (SF), reprocessed commercial high-level waste (CHLW), defense high-level waste (DHLW), West Valley waste (WVW), and commercial TRU waste including that in existence and that which would be generated from reprocessing activities. Quantities, throughputs, and receipt parameters (dimensions, weights, etc.) are presented in Tables I and II.

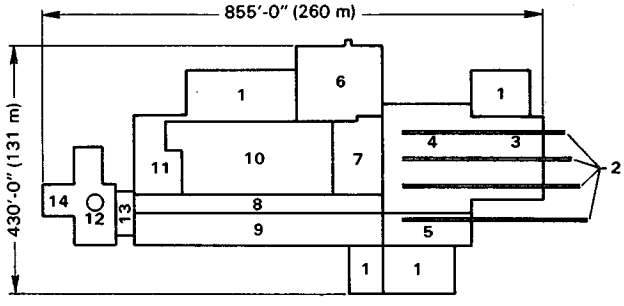
Previous salt repository concept[2] and waste receiving and packaging facilities[3] did not consider multiple waste types nor did they consider long-lived waste package designs of the kind developed during package conceptual design activities. This paper presents the results of a design conceptualization activity for such a multiwaste receiving and packaging facility located at the salt repository site.

FACILITY DESCRIPTION

The Waste Receiving and Packaging Facility is the largest building on the repository site. The building is located adjacent to the waste shaft headframe and is served by both nuclear and nonnuclear supply roads and rail. Figure 1 is a simplified plan view of the facility. The building consists of approximately 200,000 square feet (18,600

Table I. Waste Types and Quantities to be Received at the Salt Repository.

Waste Type	Total Quantity	Design Rate Per Year
Spent fuel assemblies	24,000 metric tons of uranium (MTU)	1,000 MTU
Boxed spent fuel pins	12,000 MTU	500 MTU
CHLW	36,000 MTU	1,500 MTU
WVW	300 canisters	50 canisters
DHLW	6,720 canisters	500 canisters
Remote-handled TRU	43,250 m^3	1,800 m^3
Contact-handled TRU	36,000 m^3	1,500 m^3



1 HVAC
2 Rail Lines
3 Shipping Cask Cleaning and Decon
4 Shipping Cask Offloading
5 Contact TRU Offloading
6 Office and Personnel Support
7 Shipping Cask Handling
8 Transfer Cask Loading Corridor
9 Contact TRU Handling
10 Hot Cells
11 Maintenance and Storage
12 Shaft
13 Ventilation Control
14 Waste Headframe

Fig. 1. Waste Packaging Facility Layout.

Table II. Estimated Waste Receipt and Packaging Quantities, 26-Year Operating Period.

Waste Type, Waste Form	Receipt Units	Number of Packages (Total/Per Year)
SF, whole assemblies	34,700 pressurized water reactors (PWR)[1]	3,500/145
	49,300 boiling water reactors (BWR)	1,750/73
SF, boxed pins	8,700 PWR boxes	1,750/73
	12,300 BWR boxes	890/37
CHLW, canistered glass	3,700 canisters	3,700/154
WVW, canistered glass	300 canisters	300/50
DHLW, canistered glass	6,720 canisters	6,720/500
Remote TRU, canisters	32,500 canisters	32,500/1,540
Contact TRU, 55-gallon drums	190,000 drums	15,800/660 pallets
Site-generated waste:		
Remote-handled	-	2,688/112
Contact-handled	-	900/37

square meters) of ground floor area. The parts of this building which contain radioactive materials are designed to be tornado- and earthquake-resistant. The building is roughly 855 feet (260 meters) long, 430 feet (131 meters) wide, and 70 feet (21 meters) high at the highest point. The central portion of the building complex is founded on a 5-foot (1.5-meter) thick concrete mat. Outlying parts of the building are founded on spread footings. The tornado- and earthquake-resistant sections of the buildings have walls and roofs of approximately 1-foot (30-centimeter) thick reinforced concrete. All other areas of the building are either structural steel or concrete block construction.

All the functions required to receive shipping casks from trucks or rail vehicles, and to prepare the waste for underground disposal, up to and including the loading of the waste hoist at the surface, are performed within the confines of the facility. Significant waste processing operations are carried out as well. An overall functional schematic for the facility is presented in Fig. 2.

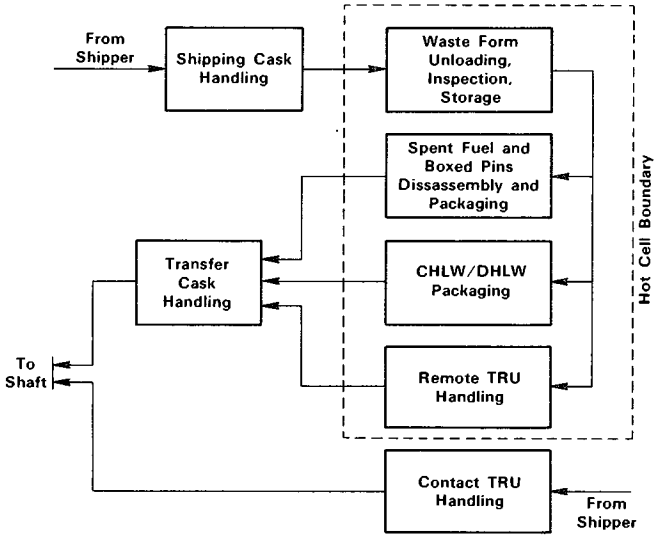


Fig. 2. Waste Packaging Facility Functional Diagram.

The waste packaging operations begin with the receipt of shipping casks by rail or truck. Shipping casks are inspected, cleaned, decontaminated, offloaded, and positioned in preparation for unloading their radioactive waste forms. With the exception of contact TRU, all the waste forms are unloaded from the shipping casks into the hot cell where they are inspected, sorted, and stored. The functions performed within the hot cell depend on the waste form. Spent fuel assemblies and boxed spent fuel pins are disassembled and repackaged into large waste packages. Canisters of commercial and defense high-level waste are simply repackaged. Remote TRU is inspected and passed through the hot cell without repackaging. All the waste packages are passed out of the hot cell into transfer casks, in which the highly radioactive materials are moved from the facility down the shaft and through the underground workings to the emplacement location. Contact TRU is handled directly from the incoming rail shipping container through the inspection and palletizing functions to the shaft for disposal underground.

SHIPPING CASK HANDLING AREA

The Shipping Cask Handling area is designed to receive 1,200 casks per year of spent fuel, CHLW, DHLW, and remote TRU--about five casks per day, five days per week for fifty weeks.

Casks arriving at the facility are positioned in the cask cleaning and decontamination area, where they are inspected, steam cleaned, and decontaminated if necessary. They are then moved by positioners to the shipping cask offloading area. A bridge crane with a yoke hook erects each cask to a vertical position and offloads it to a surface effect vehicle. The surface effect vehicle transports the cask to the entry vestibule where the structural lid fasteners are removed. Then the cask is moved to the lid removal vestibule where the structural lid is lifted off and stored. The cask is then removed underneath the hot cell loading port in the unloading room where it is mated with the contamination control seal.

Because of radiation streaming during the waste unloading operation, personnel are cleared from the unloading room while the shipping cask is unloaded. The unloaded shipping cask is reassembled, inspected, internally decontaminated as necessary, reloaded onto a railcar or truck, and returned to the shipper.

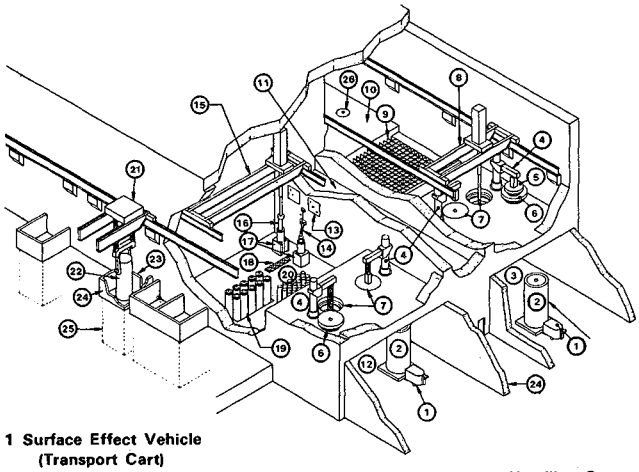
FACILITY HOT CELLS

A total of six separate hot cells are contained within the facility in two separate functional areas. The first area contains a single hot cell which handles all of the canistered waste forms including CHLW, DHLW, and remote TRU. The second area handles spent fuel either as whole assemblies or as boxed spent fuel pins.

In order to handle the specified spent fuel throughput rate, there are two identical spent fuel disassembly hot cells and one very similar boxed fuel pin disassembly hot cell. Another hot cell is provided for compaction and packaging of radioactive scrap materials generated during this disassembly process, including fuel element skeletons and empty fuel pin boxes. Finally, an additional hot cell, designated a "special function" cell, is provided to deal with damaged fuel assemblies and other remedial repair actions for both spent fuel and canistered waste packages.

The canistered waste hot cell and the spent fuel unloading and storage areas are shown in Fig. 3. The canistered waste hot cell in the foreground shows a canister being lowered into a waste package by the overhead canister-handling crane [15], similar to a fuel-handling bridge. This hot cell has space for storing incoming waste canisters, empty waste packages, and filled waste packages. In the background the spent fuel offloading and storage area shows the spent fuel handling crane [8] reaching down into a shipping cask to remove either a spent fuel assembly or a box of spent fuel pins. These items are placed in the spent fuel storage area [9] until they are required to be delivered to the processing hot cells through the corridor in the background [10].

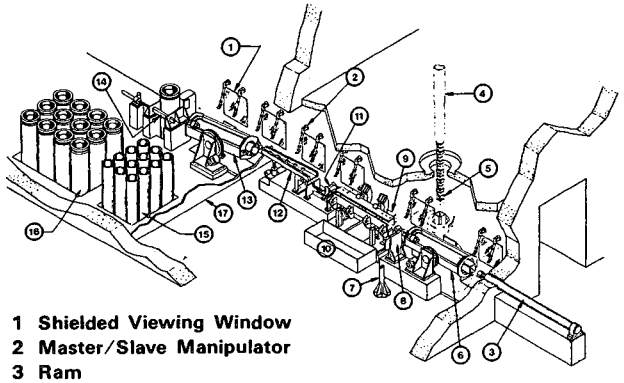
The fuel disassembly and packaging hot cell is shown in Fig. 4. The hot cell contains all machinery necessary to remotely disassemble the spent fuel element. The fuel element is shown being delivered by the fuel assembly handler [4] at the top right. The fuel assembly is received vertically and then



1 Surface Effect Vehicle (Transport Cart)
2 Shipping Cask
3 Spent Fuel Unloading Dock
4 Plug Handling Crane
5 Shipping Cask Shield Plug
6 Unloading Port Plug
7 Unloading Port
8 Fuel Handling Crane (2 Required)
9 Spent Fuel Storage Area
10 Waste Packaging Lines Receiving Aisle
11 Personnel Observation Area
12 Packaged Waste Unloading Dock
13 Shielded Viewing Windows
14 Lid Handling Jib Crane
15 Packaged Waste Handling Crane (2 Required)
16 Packaged Waste Form
17 Waste Package Holder
18 Lid Positioner
19 Waste Package Storage
20 Packaged Waste Storage Area
21 Transfer Cask Handling Crane (2 Required)
22 Transfer Cask
23 Power Operated Cover
24 Shield Wall (Typical)
25 Transfer Cell (Typical)
26 Delivery Point

Fig. 3. Waste Packaging Facility Receiving and Packaging Areas.

clamped and rotated to the horizontal position, where one or both of the end caps are cut off [8]. The fuel assembly is then pushed to the next station where it is again clamped. In this position the fuel pins are removed and conveyed by a powered roller [12] into the waste package liner held horizontally [13] at the end of the line. When the liner is filled with fuel pins it is rotated to the vertical position, the top is sealed in place, and the liner is lifted and set into the waste package. The waste package lid is then permanently attached. There is also room in the hot cell for storage of empty waste package liners and waste packages as well as filled waste packages. The contamination-generating

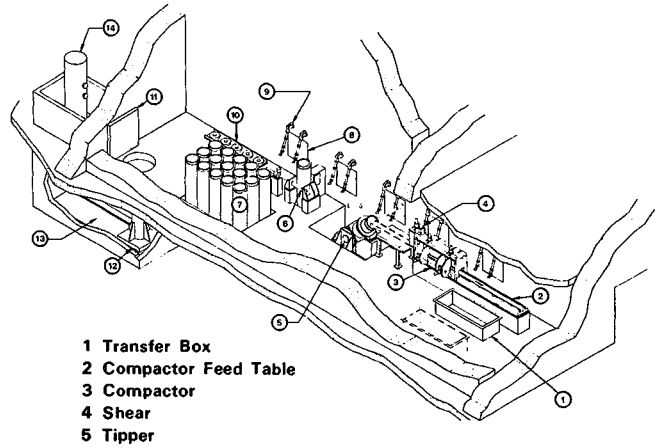


1 Shielded Viewing Window
2 Master/Slave Manipulator
3 Ram
4 Fuel Assembly Handler
5 Fuel Assembly
6 Fuel Assembly Tipper & Positioner
7 Jib Crane
8 Head Cut Off Saw
9 Clamp & Dump Mechanism
10 Skeleton Tote Box
11 Fuel Pin Puller
12 Roller Guide
13 Waste Package Tipper & End Sealer
14 Waste Package Holder
15 Waste Package Liner Storage
16 Waste Package Storage
17 Contamination Barrier

Fig. 4. Fuel Disassembly and Packaging Hot Cell.

operations of the fuel disassembly are separated from the waste package operations by a contamination barrier through which only spent fuel pins pass. Fuel element end caps and skeletons accumulate temporarily in the hot cell and then are removed to the scrap compaction and packaging hot cell. Extensive observation and manipulation capability is built into the cell to handle operating and maintenance requirements. The hot cell for opening and unloading boxed spent fuel pins is similar to the fuel disassembly and packaging hot cell.

The machinery for compaction and packaging of fuel element skeletons and boxes is shown in Fig. 5. Skeletons and boxes are brought into this hot cell in transfer boxes from the spent fuel and boxed pin disassembly hot cells. Here the skeletons and boxes are flattened to reduce volume and loaded into canisters similar to the remote TRU canisters. These materials are not enclosed in long-lived waste packages. This figure also shows the transfer cell through which completed canisters are lowered below the hot cell floor level into a transfer cart which moves over underneath the transfer cask to permit the transfer cask to be loaded from the bottom. This transfer cell is typical of all the hot cells.



1 Transfer Box
2 Compactor Feed Table
3 Compactor
4 Shear
5 Tipper
6 Waste Package Holder
7 Waste Package Storage
8 Shielded Viewing Window
9 Master/Slave Manipulator
10 Lid Positioner
11 Power Operated Cover
12 Transfer Cart
13 Transfer Cell
14 Transfer Cask

Fig. 5. Radioactive Scrap Compaction and Packaging Line.

As shown in Fig. 3, all the transfer casks are moved with a pair of overhead bridge cranes. The transfer cask is placed in a small shield cubicle to protect personnel from radiation during the cask-loading operation. When loaded, the cask is lifted and transported down the passageway through the ventilation control area and onto the hoist cage. The hoist cage is loaded by a hydraulically operated transfer yoke similar to the one in Fig. 6. The transfer yoke in the headframe takes the transfer cask from the bridge crane and sets it onto the hoist cage. A more complex operation is performed by the transfer yoke at the underground shaft station, as shown in Fig. 6.

CONTACT-HANDLED TRU

The TRU waste facility has three major operational areas:

- The receiving, offloading, and shipping area.
- The waste container unloading, decontamination, and overpack area.
- The waste container weighing and palleting area.

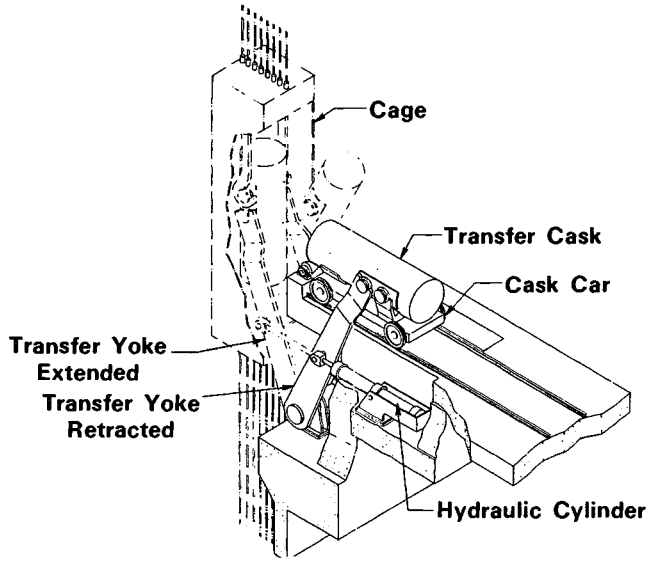


Fig. 6. Waste Shaft Loading Area.

The railcar receiving, offloading, and shipping area has a loading dock which can also handle trucks. It is serviced by the overhead bridge cranes which operate across the full width of the shipping cask offloading area and also service the air pallet transfer loading-offloading bay. Railcars which are contaminated on their exterior may be decontaminated at the receiving dock. The surface effect pallets are used to transfer groups of waste containers through the air lock to the unloading dock.

The waste container unloading dock and air lock lead to and from the receiving, offloading, and shipping area. The unloading dock is serviced by 4,000-pound (1800-kilogram) capacity forklifts. These forklifts have specially designed lifting heads on specially sized lift masts which enable the fork lift to unload the cargo carrier by three 55-gallon (280-liter) drums per trip. The waste drums are laid down on an interim storage area where they are inspected for surface contamination, radiation surface dose level, and physical damage. Physically damaged drums are transferred to the overpack machine. Drums having a higher than 100 mR/hr surface dose rate are transferred to a shielded shipping container and sent to the hot cells for processing. Sound drums with surface contamination only are decontaminated with water. Those that cannot be decontaminated are sent to overpack. Sound, decontaminated, and overpacked drums are moved by the fork lift to the weighing and assaying area.

Waste containers arriving at the weighing and palleting station are weighed and then moved to the palleting station, where all drums are placed on pallets and securely strapped in a two-by-three array, two tiers high. The palleted waste containers are then moved through the air lock by a large capacity fork lift and are placed on the waste hoist cage.

SUPPORT FACILITIES

The facility has several support areas not directly involved in the handling of waste. Most significant of these in size are the heating, ventilation, and air-conditioning (HVAC) system which is capable of moving up to 130,000 cubic feet per minute (3,679 cubic meters) of air through the hot cells and double HEPA (high-efficiency particulate air) filters with 100 percent flow and filtering redundancy. Separate ventilation systems are provided for other major functional areas such as the shipping cask handling area, personnel area, and the contact TRU handling area. Each system is designed to its own specific criteria.

REFERENCES

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3. RHO-CO-506, Draft Spent Fuel Receiving and Packaging Facility Conceptual Design Report, September 1978, Rockwell Hanford Operation.