EQUIPMENT FOR EMPLACEMENT OF REMOTE HANDLED TRU WASTE IN DEEP GEOLOGIC DISPOSAL IN WIPP

V. F. LIKAR AND J. W. SADLER, WESTINGHOUSE ELECTRIC CORP.
ADVANCED ENERGY SYSTEMS DIVISION, WIPP PROJECT
P.O. BOX 40039, ALBUQUERQUE, NM 87196

ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is planned for construction in Southeast New Mexico. Remote handled transuranic waste will be retrievably stored at WIPP in horizontal, steel sleeved holes, in the pillars of the rooms excavated for storage of contact handled transuranic waste. The remote handled waste is contained in standardized canisters nominally 0.6m in diameter and 3.1m in overall length. An emplacement machine is preplaced at each storage location, and when mated with the facility cask, provides necessary shielding, support, and alignment, for the transfer of the waste canister to the storage location. The emplacement machine can also be used for retrieval of previously stored waste should that be necessary.

GENERAL

The Waste Isolation Pilot Plant (WIPP) is planned to be constructed in bedded salt formations in Southeast New Mexico at a site approximately 25 miles east of Carlsbad. Construction of the full facility is scheduled to begin in mid-1983 following completion of the Site and Preliminary Design Validation (SPDV) Phase and formal validation of the site. The SPDV construction has been in progress since April 1981.

WIPP MISSION

The WIPP mission is to provide a research and development facility to demonstrate the safe disposal of radioactive wastes resulting from defense activities and programs of the United States. The WIPP is being designed to handle transuranic (TRU) waste in two classifications for deep geologic disposal, specifically, Contact Handled (CH) and Remote Handled (RH) TRU waste. In this regard, a significant consideration in satisfying a WIPP mission requirement is that pending designation as a TRU repository, each type of emplaced TRU waste shall be retrievable during the initial five year WIPP operating period with that waste type. If at the end of this initial period it is determined that retrieval is not required, retrievability will no longer be a factor in emplacing future waste. WIPP will also conduct experiments with defense high level waste, and all of this waste will be retrieved and removed from the site at the completion of the experiments.

INTRODUCTION

This paper discusses the equipment and methods used for handling and emplacing the Remote Handled (RH) transuranic waste in the underground facility. Other WIPP waste handling systems are not discussed. The receipt, handling, movement of the RH waste on the surface and transfer to the underground facility is covered by a separate paper at this conference titled "Nuclear Waste Handling Technology for Underground Storage in WIPP[1]."

RH TRU WASTE HANDLING SYSTEM

The RH TRU waste canister for WIPP is a smooth sided cylinder nominally 0.6 m in diameter by 3.1m in overall length. It includes an integral pintle of a design specified by WIPP to insure compatibility with WIPP facility handling grapples. The maximum allowable weight is 3180 kg, and the maximum surface dose rate is 100 Rem/hr. Other requirements applicable to the waste form and waste package are specified in the WIPP Waste Acceptance Criteria[2]. The size, weight, and radiation levels as specified here have been established for approximately three years. There is an effort underway at this time to revise these values to some extent, thereby increasing the effectiveness of the standardized canister for the storage of RH TRU waste. With regard to the WIPP facility, i.e., neglecting the transportation interface, the maximum envelope, weight and radiation level of the canister are primarily a function of the facility cask, the waste shaft size, and waste hoist capacity. The facility cask is used to handle and provide shielding for the RH canister from the surface hot cell to its emplaced position, and an increase in RH canister size and radiation levels causes corresponding increases in facility-cask size and weight. The facility cask, with the RH TRU canister inside, must be handled on the waste cage in the waste shaft, which establishes further limits, and total weight must be within the capacity of the waste hoist. Shaft size, cage size, and hoist capacity are not absolute limits, but must be evaluated and established from a systems and cost effectiveness standpoint to achieve a reasonable design. This shaft cage and hoist also function to transport the Contact Handled (CH) waste.

Reflecting the relationship between canister envelope, weight and surface dose rate and the resulting impact on the waste hoist system requirements, the conceptual design studies for WIPP resulted in the selection of a concept whereby the functions of the RH TRU waste handling system are accomplished by separate hardware elements. The RH TRU waste handling system consists of three primary elements: the facility cask, which is used to contain and transfer the canister from the hot cell on the surface to the underground storage location; an emplacement machine, which is kept underground and used in conjunction with the facility cask to emplace the canister in the underground storage location, and a shield plug housing which similarly functions with the emplacement machine to emplace the final shield plug at the storage location. This concept minimizes the size and total weight of equipment which must be handled through the waste shaft, thereby maximizing the size and weight of the RH TRU waste canister that can be accommodated by a given hoist system.

RH TRU waste canisters will be stored in steel sleeves in horizontal holes in the walls of the waste storage rooms. The waste storage rooms are also used for the storage of Contact Handled (CH) waste, which, after the RH waste is emplaced in the walls, is stacked in boxes and drums in the room. The waste storage room size is as large as possible for emplacement of a maximum amount of CH waste, while limited to a size and configuration that will be geologically stable and remain open over the WIPP operating life, i.e., it will accommodate projected salt creep. The underground configuration for the WIPP is 7 storage rooms, each 10m wide by 4m high by 91m long, comprising a storage panel. The storage rooms are separated by salt pillars that are 30m wide; there are eight storage panels and the panels are separated by salt pillars that are 60m wide. This arrangement is shown in Fig. 1. The RH TRU waste will be placed in the storage room pillars which measure 30m by 91m. Emplacement is performed from the storage rooms into the sides of the pillar or from the access entries into the ends of the pillar. The general arrangement for RH waste storage is shown schematically in Fig. 2.

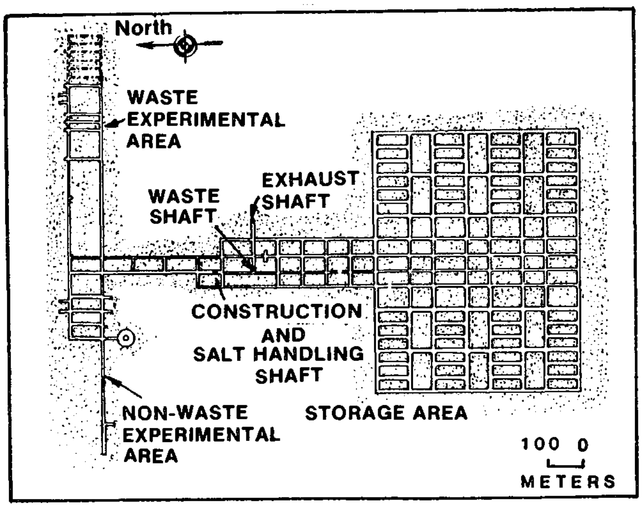

Fig. 1 Storage Horizon

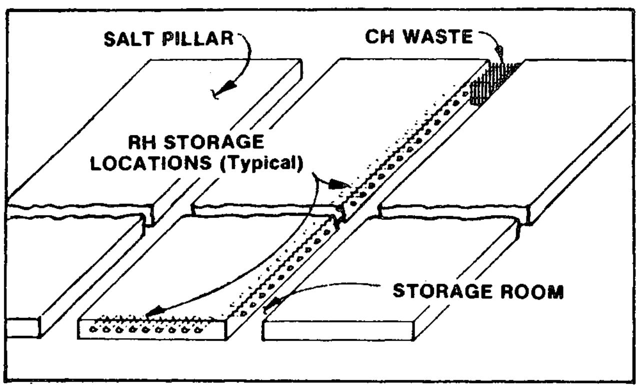

Fig. 2 RH Waste Storage Arrangement

RH EMPLACEMENT CONSIDERATIONS

The horizontal emplacement of RH TRU waste in the pillars provides several advantages. The major advantage is that mining of separate storage areas for RH and CH wastes is not required. The areas mined for CH waste will provide more than enough space for the projected quantities of RH TRU waste, with presently planned RH TRU waste volumes requiring less than a quarter of the CH waste areas. The horizontal emplacement also allows roomy access (because of the wide room configuration) for emplacement equipment and personnel required to conduct these operations. In contrast, there are several distinct disadvantages associated with vertical emplacement of RH TRU. Although there need not be an increase in total excavated volume, vertical emplacement requires a higher room to accommodate the emplacement system overall length, which includes the vertical facility cask plus any adaptors and lifting or grappling equipment. Excavation is complicated in that: multi-pass mining must be employed to establish the required room height; the underground design is further complicated in that, particularly with respect to bedded salt, increased room height means that additional geologic discontinuities, i.e., clay seams, anhydrite layers, polyhalite layers, etc., are intercepted, and CH waste storage operations are complicated in that the height of the stack of waste containers starts to become unwieldy.

The emplacement of the RH TRU waste horizontally in the pillars at WIPP is feasible because of the large pillar size, which is dictated by mine design considerations, and because of the very low thermal output of the RH TRU waste. The low thermal output avoids significant heating of the salt pillars and the accompanying higher salt creep rates. The calculated maximum thermal output from an RH TRU waste canister is less than 60 watts. The steel sleeves are sized to accommodate salt creep and the resulting lithostatic load thereby assuring easy access to the emplaced RH TRU canister should retrieval be required. The storage holes are spaced at a reasonable distance from the floor and from each other. This spacing provides easy access for equipment and personnel. A nominal 3m horizontal spacing between storage holes is employed.

RH EMPLACEMENT MACHINE

In the storage room, the RH emplacement machine which emplaces and retrieves the canister is delivered to the sleeved hole by the RH fork lift truck. The primary parts of the emplacement machine are shown in Fig. 3. The machine includes a frame, which is the primary support for the emplacement machine and the facility cask, and a bed. A shield valve is located at one end while a housing which contains a grapple and hydraulic push-pull mechanism is located at the other end. The area between the shield valve and the housing is termed the cask table and accommodates the facility cask, Fig. 4. It should be noted that the facility cask includes integral shield valves at each end.

The emplacement machine is set in place by a fork lift in a position that is accurate with respect to the sleeve centerline within ± 15 cm and within 8 to 23 cm of the face of the sleeve. Further adjustments required to precisely align the canister with the sleeve are accomplished by adjustment features incorporated into the RH emplacement machine itself. It is anticipated that optically related tooling will be used to indicate off of the bottom of the sleeve or the sleeve face (depending on whether the operation is emplacement or retrieval) to project guiding marks on the drift floor or wall. These marks will provide a reference to the fork lift operator.

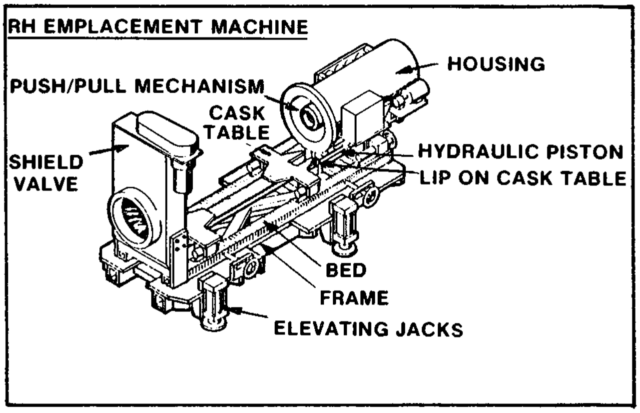

Fig. 3 RH Emplacement Machine

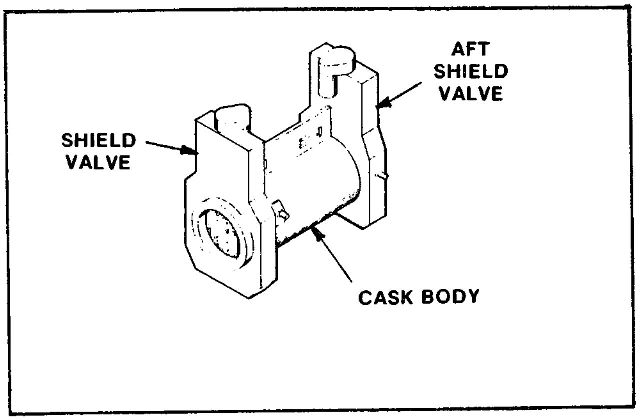

Fig. 4 WIPP Facility Cask for RH TRU

Once the emplacement machine has been set in place, the proper elevation is achieved by extending hydraulically operated jacks located on the emplacement machine frame. These jacks are individually adjustable and provide an adjustment capability which is sufficient to offset the tolerance associated with drilling the storage hole in the salt, as well as the expected roughness of the drift floor. Transverse adjustment of the bed relative to the frame (parallel to the pillar face) is made through a pair of jackscrews which are hand operated. Each jackscrew can adjust independently through ± 20 cm, giving, in addition to straight side to side adjustment, angular adjustment capability of about 6 degrees. This horizontal angular adjustment, in conjunction with the vertical angular adjustment achievable through the floor jacks, insures that the canister axis can be properly aligned with the sleeve axis.

When the bed of the emplacement machine has been brought into proper alignment with the sleeve, the bed is manually advanced toward the sleeve by a jackscrew until its shield valve engages (overlaps) the sleeve. This step insures radiation shielding integrity at this interface during subsequent operations when the canister is passed through the shield valve into the sleeve.

RH WASTE EMPLACEMENT

The emplacement machine is now ready to receive the facility cask which is brought from the waste hoist to the emplacement machine by a forklift. The cask is positioned over the cask table of the emplacement machine. Transverse position adjustment is by forward and reverse travel of the fork lift, while longitudinal adjustment (axial motion of the cask) is made through a fork side shift mechanism. Final positioning is achieved as channeled corners on the cask engage guide rollers located on the cask table. Once the cask is properly positioned, the push/pull mechanism housing is advanced axially until it engages the shield valve on the aft (pintle) end of the cask. The push/pull mechanism housing in addition to providing mechanical support for the hydraulic cylinder which pushes the canister into the sleeve, also provides the protective shielding required when the cask's aft shield valve is subsequently opened. Once engaged with the cask, the push/pull mechanism housing continues to advance, pushing the cask and cask table along its guide rails until the forward end of the cask engages the bed emplacement machine shield valve. The cask is now confined on both ends and shielded on both ends. To effect the transfer of the canister from cask to sleeved hole, the three shield valves (two on the cask and one on the bed of the emplacement machine) are opened. The push/pull cylinder extends until the grapple, attached to the end of the piston rod, engages and locks onto the canister pintle. The cylinder then continues its extension, pushing the canister through the cask and into the sleeve. After the grapple is disengaged, the cylinder is retracted and the valves are closed. The push/pull mechanism housing retracts, separating it from the aft end of the cask until it engages a lip on the cask table. As the push/pull mechanism housing completes its motion, it pulls the cask table and thus the cask, away from the shield valve on the bed of the emplacement machine. The cask may now be removed by the fork lift and transported back to the facility cask car in the transfer area for return to the surface. The general arrangement of the facility cask emplacement machine and storage location is shown in Fig. 5.

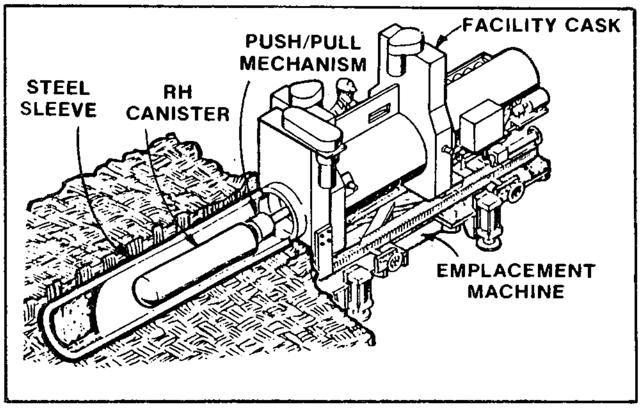

Fig. 5 RH Waste Emplacement Operation

In order to complete the emplacement, the sleeve must be plugged with a radiation shield. The sleeve plug, contained in its own housing, is delivered to the emplacement machine by the fork lift and, in a procedure that is virtually identical to canister emplacement, is placed into the mouth of the sleeve. The push/pull mechanism is withdrawn, and the sleeve plug housing is removed from the emplacement machine by the fork lift. The emplacement machine may now be moved by the fork lift to another sleeved hole for emplacement of the next canister.

ADDITIONAL CONSIDERATIONS

In general terms, emplacement of RH TRU in a given storage room would precede emplacement of CH waste. However, during the initial five year retrievability period only limited quantities of RH TRU will be emplaced and CH waste emplacement will not interfere with retrieval of the RH TRU canisters should that be necessary.

The WIPP facility is sized for a thruput of 2 canisters per shift. Each canister would contain approximately 0.7 cubic meters of transuranic waste. Disposal is presently planned for 1000 canisters, although this number could be easily increased because of the small amount of the available CH storage area which will be used for storage of RH waste.

The RH waste handling system at WIPP includes provisions to overpack the normal canister if it should have excessive surface contamination or be damaged. This overpacking operation would be performed in the hot cell of the Waste Handling Building on the surface. The facility cask and emplacement machine are capable of handling the larger size of the overpacked canister. These overpacked canisters would be stored in the same manner, but in larger diameter steel sleeves provided specifically for storage of the overpacked canisters. It is estimated that only a very small number of canisters (less than 2 percent) would require overpacking.

SYSTEM TESTING

The RH waste handling equipment, systems, and procedures will be tested thoroughly before use in full scale operations with simulated and actual waste. This will consist of not only the normal testing done during manufacture and upon receipt, but also a full scale handling demonstration. The handling demonstration will use mock-up (non-radioactive) waste canisters to demonstrate the receipt, processing, handling, emplacement and retrieval operations. This demonstration will debug the equipment and procedures, check all interfaces, provide personnel training, and optimize the operations for performance with minimum radiation dose to operating personnel. The demonstration will be performed as part of the WIPP experimental program, and will occur after the facility is completed but prior to receipt of the first actual RH waste.

ACKNOWLEDGEMENT

This work was performed under Contract DE-AC04-78AL05346 with the U.S. Department of Energy.

REFERENCES

1. Z. Stachon and R. L. Brunnenmeyer, "Nuclear Waste Handling Technology for Underground Storage at WIPP," Proceedings of the Symposium on Waste Management, Tucson, AZ, February 27-March 3, 1983.

2. WIPP-DOE-069, Rev. 1, "TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant," September 1981.