AN ANALYSIS OF THE WIPP WASTE HANDLING DEMONSTRATIONS

E. K. Hunter, U.S. Department of Energy
W. R. Chiquelin, Westinghouse Electric Corporation
WIPP Project

ABSTRACT

As part of a comprehensive Startup Program to ensure safe and efficient handling of transuranic waste at the Waste Isolation Pilot Plant (WIPP), a succession of waste handling demonstrations have occurred. To quantify system performance, operator proficiency and projected radiation dose to workers, WIPP conducted four major waste handling preoperational demonstration checkouts (two each for contact-handled (CH) waste and remote-handled (RH) waste). These preoperational demonstrations began with underground CH and RH mock retrievability demonstrations performed for the state of New Mexico to verify WIPP's ability to safely retrieve waste. Additionally, these demonstrations assessed waste handling equipment, processes, procedures, and personnel capabilities.

Following these underground retrievability demonstrations, WIPP performed complete "end-to-end" CH and RH preoperational checkouts (also witnessed by the state of New Mexico). These integrated checkouts not only validated system operation and personnel qualifications, but, using numerous video tapes of the checkout as time elapsed references, also allowed accurate worker radiation dose projections to be made.

The WIPP succession of waste handling preoperational demonstration checkouts proved that WIPP safely and efficiently handles transuranic defense waste at a flow rate consistent with the design basis of the facility. Indeed, the state of New Mexico environmental evaluation group, which oversees WIPP, stated that the waste handlers should be given a "top drum award" for superior performance. All objectives of these demonstrations were met or exceeded.

INTRODUCTION

WIPP has been designed and constructed to applicable nuclear and industrial standards and requirements utilizing extensive experience from the nuclear industry. Plant start-up and eventual full scale operations are to be conducted with the same rigorous discipline. Facility and equipment acceptance testing has proceeded concurrently with procedural development and technician training. Final confirmation of readiness to operate for both hardware and personnel is achieved through an extensive readiness review process in conjunction with system end-to-end tests, integrated systems checkouts, and preoperational demonstrations.

The first demonstrations were intended to validate WIPP procedures and operational systems, as well as to complete milestones contained in the agreement for Consultation and Cooperation with the state of New Mexico. This required the in-situ demonstrations of retrievability of RH TRU waste, and CH TRU waste. The results of these demonstrations were documented in reports which were submitted to the state of New Mexico for review and comments. The in-situ underground retrievability demonstrations were followed by RH and CH TRU waste preoperational checkout demonstrations. These demonstrations addressed the balance of the RH and CH waste handling processes. The scope of these demonstration was from waste receipt through emplacement. Successful completion of all the demonstrations using mock (nonradioactive) waste, is a prerequisite to the receipt of actual waste.

All four demonstrations utilized actual canisters and containers loaded to representative weights anticipated during normal operations. To satisfy the demonstration objectives, each demonstration was recorded on video tape and the resulting time line data was utilized in conjunction with calculated radiation fields related to the various source configurations representative of actual operations. These time-annotated video tapes allowed for an accurate analysis to be performed of the WIPP Waste Handling Operations, both CH and RH. Additionally, these demonstrations also comprised an important part of WIPP readiness reviews, and were witnessed by both Department of Energy and New Mexico State officials as they were performed.

OVERVIEW OF RH TRU WASTE PROCESS

RH TRU Waste consists of transuranic waste with radiation levels on contact of over 200 mRem per hour and below 100 Rem per hour, and therefore requires shielding or remote handling. RH TRU waste will be shipped to the WIPP in a shipping cask containing a single canister. The RH TRU cask will be designed and certified as a DOT Type B container, and licensed by the NRC. Trucks bearing the RH TRU casks enter the WIPP site and are spotted within the WIPP yard where Health Physics Technicians survey each shipment for external contamination. Trailers and casks are taken into the cask receiving area inside the Waste Handling Building. Health Physics Technicians again survey the casks for contamination and for damage.

The shipment's date and arrival time are entered into the Waste Information System database. In the Waste Handling Building the cask is uprighted from a horizontal to a vertical position for transfer to the transporter. On the transporter the cask outer lid is removed; the cask is then moved through the open shield door and into the cask unloading room where it is positioned under the hot cell unloading port.

To prevent any potential contamination spread, the cask is mated to the bottom of the hot cell using the cask seal collar. The shield door is then closed. Using the hot cell crane the Waste Handling Technician removes the shield plug from the floor of the hot cell. Next the cask

inner closure lid is removed, the canister is then taken from the cask and moved to the inspection station in the hot cell. There it is inspected and remote swipes are taken to test for surface contamination. Should the canister be faulty, the Waste Handling Technician moves it to the overpack station. The damaged canister is placed in an overpack canister, and the closure lid is remotely placed on the overpack container and welded.

The canister, regular or overpack, is next lowered into the canister shuttle car located in the transfer cell under the hot cell. The shuttle car positions the canister under the port shield valve of the facility cask loading room. With the facility cask in a vertical position above the port, the telescoping port shield is raised to interface with the cask. The shield bell is positioned on the cask, the cask shield valves and the port shield valves are then opened and the canister is grappled and drawn upward into the facility cask.

Next the shield valves are closed, the telescoping shield is retracted from the bottom of the facility cask, the shield bell is raised, and the facility cask is rotated into a horizontal position and moved onto the waste hoist shaft conveyance by a motorized transfer car. The facility cask and car are then lowered into the mine onboard the Waste Handling Hoist.

Upon reaching the underground the cask transfer vehicle moves the canister out into the station area. A forty-one ton forklift is then used to move the cask to the underground storage room. In the storage room horizontal emplacement holes are pre-bored into storage walls at a 5 foot height with eight-foot horizontal spacing. The RH emplacement machine is positioned and aligned at the proper hole. Then the facility cask is placed on the horizontal emplacement machine which then transfers the canister through the cask into the borehole (Fig. 1). A shield plug is inserted into the borehole by the emplacement machine prior to removal of the cask. The empty facility cask is then returned to the Waste Handling Hoist for transfer back to the surface.

OVERVIEW OF CH TRU WASTE HANDLING PROCESS

CH TRU Waste consists of transuranic waste with radiation levels on contact of less than 200 mRem per hour and thus requires no special shielding or remote handling. CH TRU waste shipments will arrive at WIPP in NRC licensed transuranic package containers (TRUPACTs) which meet DOT Type B shipping requirements for transporting CH TRU waste. Transported by truck from the DOE shipping sites to the WIPP site, trailers bearing TRUPACTs are backed into place in front of Waste Handling Building airlocks where an external contamination survey is conducted. Next the TRUPACTs are moved from the trailers and taken by 13-ton forklifts into the Waste Handling Building.

Once inside the Waste Handling Building each TRUPACT is set into one of two specially designed raised platform docks, each with three handling locations, that allow access to outer and inner TRUPACT lids. The TRUPACT lids are removed and contamination surveys are conducted as the waste packages are withdrawn using 5-ton overhead cranes. The waste packages consist of two 55-gallon drum arrays formed into seven-packs (Fig. 2) which are stretch wrapped or banded together, or two specially designed Standard Waste Boxes (SWB) for TRUPACT. Packages are removed and placed on facility pallets. When the facility pallet has been filled with 28 drums (four seven-packs or two TRUPACTs worth) it is transported to the waste hoist conveyance loading car using a 13-ton electric forklift. The conveyance loading car places the pallet of waste packages on the Waste Handling Hoist for the 2150 foot descent to the underground repository.

At the underground station an underground tractor trailer (transporter), which interfaces with the waste hoist, slides the facility pallet onto its bed. The transporter moves its load to the storage rooms which are located about -mile from the waste shaft. In the storage rooms the seven-packs are maneuvered off the underground transporter using six-ton forklifts equipped with push-pull devices. The seven-packs are then placed three high in the storage array.

Finally the location of each waste package is entered, via bar coding, into a record for that waste package in the WIPP Waste Information System computer database. Each data record then contains all pertinent package information, including contents and repository location. Empty facility pallets are returned to the waste shaft with the transporter.

CH TRU waste retrieval, should that be necessary, is achieved through a sequence that reverses the process of emplacement. It should be noted that should surface contamination be found any place at WIPP operations will immediately cease until the contamination is removed. Only after the removal of all contamination will operations continue. Using this "start clean, stay clean" philosophy WIPP will minimize employee exposure and continue its responsibilities to workers, community, and the environment.

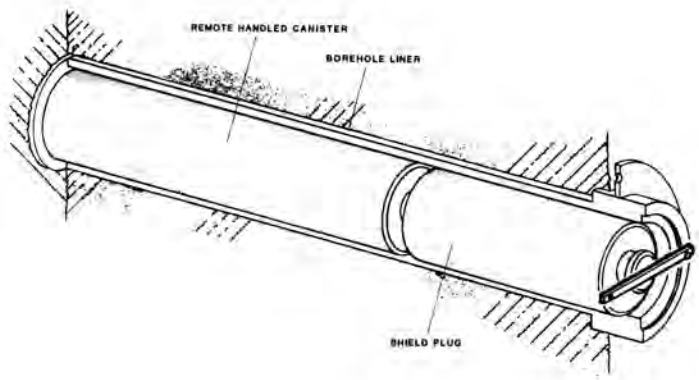
RH TRU WASTE MOCK RETRIEVAL DEMONSTRATION

On May 19 and 20, 1987 WIPP conducted a demonstration of the retrievability of RH TRU waste which provided objective evidence that canisters of RH TRU waste can be safely retrieved from the storage configuration used at WIPP. The demonstration validated WIPP procedures and Operational systems, and completed a milestone contained in the agreement for consultation and cooperation with the state of New Mexico. This RH TRU retrievability demonstration was conducted in the in-situ underground environment representative of the WIPP TRU storage area. It utilized the horizontal emplacement and retrieval equipment specifically designed and fabricated to accomplish this operation, and the operational procedures, techniques, and personnel which will be employed in routine WIPP operations.

Specific objectives of the in-situ RH TRU waste mock demonstration were as follows:

1. Demonstrate that the equipment was capable of

TYPICAL REMOTE HANDLED EMPLACEMENT CONFIGURATION



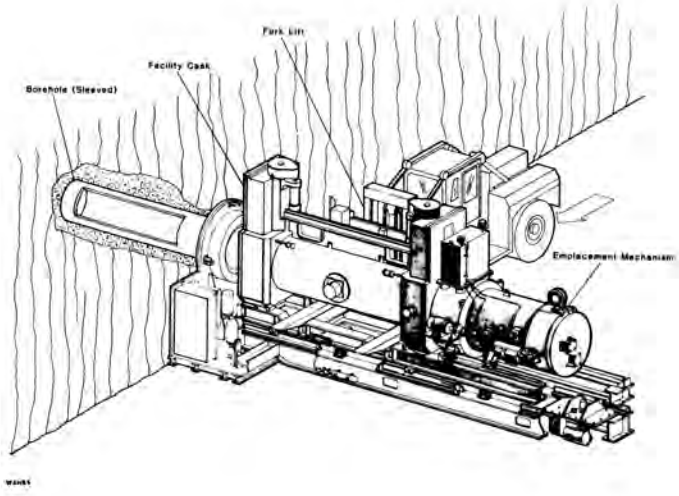


Fig. 1. Facility Cask Emplacement.

satisfactorily retrieving RH TRU waste canisters from sleeved boreholes.
2. Demonstrate that the time estimates for retrieval were acceptable.
3. Demonstrate that estimated operator exposures were acceptable.
4. Demonstrate that the operating procedures and training were appropriate to effectively perform the retrieval tasks.

The scope of the demonstration included retrieval of a simulated canister and retrieval of a simulated overpack canister. Prior to beginning demonstration, the boreholes were drilled, sleeves installed, equipment checked out, personnel trained, waste packages and shield plugs placed, and the empty facility cask delivered to the demonstration room. Operations outside the room were not included. The retrieval sequence consisted of the following basic steps:

1. Removing the shield plug restraint bar.
2. Setting up the emplacement/retrieval equipment at the borehole.
3. Installing the facility cask.
4. Realigning the cask to borehole.
5. Removing the seal plug.
6. Transferring the canister from the lined borehole to the facility cask.
7. Removing the facility cask, and placing it on the mine floor.
8. Movement of the horizontal emplacement retrieval equipment away from the borehole.

The retrieval sequence was repeated at the second borehole also.

Acceptance criteria were keyed to the objectives:

1. Retrieval of both canisters and both plugs, either by procedure or with safe, expeditious recovery from unanticipated or abnormal conditions.
2. Cumulative time less then or equal to 150% of the estimated time.
3. Total exposure less than or equal to 125% of the estimated total of exposure based upon estimated dose rates.
4. Performance of the demonstration according to plan through full scope of operations without evolution of unsafe operational conditions.

ANALYSIS OF THE RH UNDERGROUND RETRIEVAL DEMONSTRATION

Two simulated canisters and two plugs were retrieved by procedure. No unanticipated or abnormal conditions developed during the demonstration which proceeded according to plan through the full scope of Operations. The

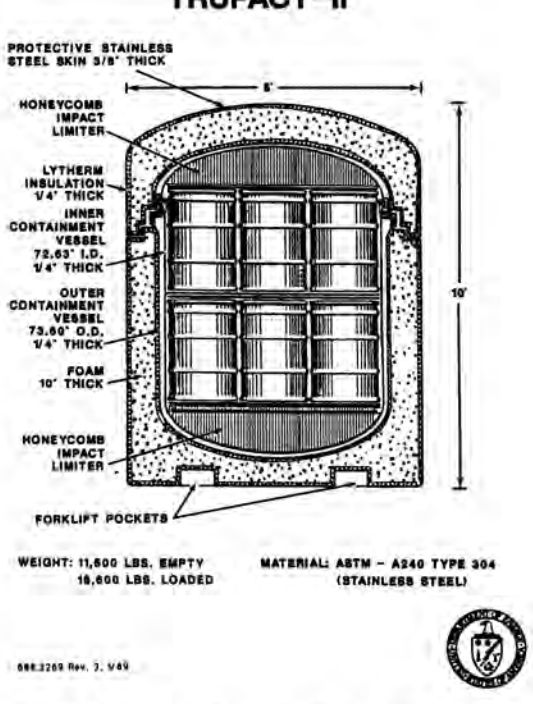


Fig. 2. Exploded View: TRUPACT - II.

satisfactorily retrieving RH TRU waste canisters from sleeved boreholes.
2. Demonstrate that the time estimates for retrieval were acceptable.
3. Demonstrate that estimated operator exposures were acceptable.
4. Demonstrate that the operating procedures and training were appropriate to effectively perform the retrieval tasks.

The scope of the demonstration included retrieval of a simulated canister and retrieval of a simulated overpack canister. Prior to beginning demonstration, the boreholes were drilled, sleeves installed, equipment checked out, personnel trained, waste packages and shield plugs placed, and the empty facility cask delivered to the demonstration room. Operations outside the room were not included. The retrieval sequence consisted of the following basic steps:

1. Removing the shield plug restraint bar.
2. Setting up the emplacement/retrieval equipment at the borehole.
3. Installing the facility cask.
4. Realigning the cask to borehole.
5. Removing the seal plug.
6. Transferring the canister from the lined borehole to the facility cask.
7. Removing the facility cask, and placing it on the mine floor.
8. Movement of the horizontal emplacement retrieval equipment away from the borehole.

The retrieval sequence was repeated at the second borehole also.

Acceptance criteria were keyed to the objectives:

1. Retrieval of both canisters and both plugs, either by procedure or with safe, expeditious recovery from unanticipated or abnormal conditions.
2. Cumulative time less then or equal to 150% of the estimated time.
3. Total exposure less than or equal to 125% of the estimated total of exposure based upon estimated dose rates.
4. Performance of the demonstration according to plan through full scope of operations without evolution of unsafe operational conditions.

ANALYSIS OF THE RH UNDERGROUND RETRIEVAL DEMONSTRATION

Two simulated canisters and two plugs were retrieved by procedure. No unanticipated or abnormal conditions developed during the demonstration which proceeded according to plan through the full scope of Operations. The cumulative time of 374 minutes for the two retrievals was 72% of the estimated 520 minute retrieval time. Total simulated exposure to the five participants was 1.20 mRem per retrieval, which was 24% of the estimated 5.06 mRem. The mock onsite RH TRU retrieval demonstration was highly successful with all acceptance objectives being met or exceeded. The demonstration not only fulfilled the RH TRU retrieval milestone of the Consultation and Cooperation agreement but also effectively demonstrated the retrievability of RH waste at the Waste Isolation Pilot Plant.

RH TRU WASTE HANDLING PREOPERATIONAL CHECKOUT

The Remote Handled TRU Waste preoperational checkout was completed at WIPP on March 22, 23, and 24, 1988. The scope of this checkout included handling a total of five RH TRU mock (non-radioactive) waste canisters beginning with shipping cask preparatory activities in the RH side of the Waste Handling Building, progressing through hot cell operations, and ending with emplacement operations in the underground storage areas. Of these five canisters the preoperational checkout required one canister be overpacked. With the exception of using a dummy single-contained shipping container mounted on its transport skid and non-radioactive mock-ups of RH TRU waste canisters, this preoperational checkout was conducted using Waste Handling equipment, operational techniques, specific procedures, and personnel which will be used to handle actual RH TRU waste at the WIPP site.

Specific objectives of the RH TRU preoperational checkout were to:

1. Demonstrate that Waste Handling equipment, operating techniques, procedures, and personnel could safely handle RH TRU waste canisters.
2. Establish the duration for Waste Handling Operations so that the WIPP RH TRU throughput could be determined.
3. Provide the basis for projecting personnel exposures.

ANALYSIS OF THE RH PREOPERATIONAL CHECKOUT

Successful completion of this checkout was a prerequisite to the receipt of actual RH TRU waste at WIPP. Further, this checkout satisfied a key milestone contained in the agreement for Consultation and Cooperation with the state of New Mexico. Table I provides the summary of durations for the major operational sequences utilized. It should be noted that there was no significant variability in the time status of the five runs of the preoperational checkout.

To provide a conservative basis for projecting WIPP throughput based on time lines resulting from the preoperational checkout, the same data has been reformatted to address duration applicable to major facility items and is presented in Table II. On a steady state basis WIPP throughput is constrained by the sequence of operations beginning in the high bay of the Waste Handling Building, progressing through hot cell operations, and ending with the completion of emplacement operations underground. These operational sequences total 341 minutes. On a steady state basis other operations would be conducted in parallel, i.e., fixture assemblies would be completed while hot cell operations were in progress. Therefore, based on 6.5 hours of productive time per day and 250 work days per year, the WIPP throughput capability for normal waste handling operations is 286 canisters per year. This capability exceeds

the specified WIPP design capacity of 250 canisters per year.

The RH TRU waste preoperational checkout, witnessed by members of the Environmental Evaluation Group of the state of New Mexico and the Department of Energy, was completed successfully. The acceptability of WIPP operating procedures, personnel, equipment, and techniques was confirmed as was the design throughput capability of 250 canisters per year.

Finally, radiation doses projected from the time lined data confirmed that WIPP will satisfy the radiological requirements of DOE 5480.1B with a projected total dose of 2.3 Rem for all worker groups per year, and under 100 mRem per person per year.

CH TRANSURANIC WASTE MOCK RETRIEVAL DEMONSTRATION

On September 28, 1987 the CH TRU waste mock retrieval demonstration was conducted at WIPP. A prerequisite to the receipt of actual CH TRU waste, the demonstration was witnessed by members of the Environmental Evaluation group of the state of New Mexico, Westinghouse, and Department of Energy officials. The demonstration was performed in Room 1, Panel 1 of the WIPP underground storage area. This area was configured to simulate in-situ storage conditions projected to be encountered late in the retrieval period. The retrieval period extends for ten years beyond the operations demonstration period which is up to five years in duration. Even though salt creep in the storage area is not projected to contact the waste stack, as a worse case scenario the demonstration included retrieval techniques which would be employed should stack contamination be encountered. A contamination control barrier was installed upstream of the demonstration waste stack. This barrier incorporated a passthrough system which was used to overpack simulated contaminated waste packages.

Specific objectives of the CH TRU waste mock retrieval demonstration were to:

1. Demonstrate that equipment, operational techniques, and personnel were capable of safely retrieving CH TRU waste containers.
2. Establish the aggregate time estimate for in room retrieval operations.
3. Provide the basis for projecting the dose to be received by waste handling personnel should retrieval be required.

Acceptance criteria applicable to the above objectives were:

1. Retrieval of a total of 57 waste drums and four waste boxes, including those with simulated external radioactive contamination, and transfer out of the contamination control area while maintaining control of contamination.
2. Performance of the demonstration through the full scope of Operations without evolution of unsafe conditions.
3. Confirmation that in-room retrieval of waste emplaced during the operations demonstration period could be accomplished within the ten-year retrieval period.
4. Confirmation that the radiation protection standards of DOE Order 5480.1B were satisfied (personnel exposure less than 1 Rem).

This demonstration used nonradioactive mock-ups of representative CH TRU drums and boxes. The waste packages were installed in the WIPP TRU storage area with an in-situ underground environment representative of that to be encountered late in the retrieval period. The room in which the demonstration was conducted reflected projected salt creep affects, including floor heave.

To address a worse case scenario for a demonstration of retrievability, the demonstration included: handling of simulated contaminated waste packages, handling a crushed drum, and as low as reasonably achievable (ALARA) techniques to be used in WIPP Operations should retrieval be required. Drum waste packages were assembled using stretch wrapping and banding. The demonstration waste stack included 15 six-packs, six seven-packs, and four boxes. The stack was placed directly against the east rib of the storage room. The inclusion of simulated contaminated packages represented the worse case retrieval scenario. The general arrangement used for the demonstration is shown in Fig. 4.

ANALYSIS OF THE CH TRU UNDERGROUND RETRIEVAL DEMONSTRATION

Extrapolation of the data generated during this mock retrieval demonstration confirmed that in-room retrieval can be accomplished within the planned time period of ten years, and that the dose limits of DOE Order 5480.1B will be satisfied. Data for two bounding cases are presented in Table III. The first case addresses retrieval of 930,000 cubic feet of waste and clean drums while the second case addresses the retrieval of the same amount of waste assuming that 5% of the waste drums are contaminated by undefined causes. In-room retrieval operations can be completed in four years or under for both cases, well within the ten-year period allowed. Personnel doses over the ten-year period are also less than 500 mRem per year per person, under half of the design objective. Every objective for the CH TRU waste mock retrieval demonstration was very successfully met.

CH TRU WASTE HANDLING PREOPERATIONAL CHECKOUT

The contact handled transuranic waste handling preoperational checkout was completed at the Waste Isolation Pilot Plant June 8, 9, and 10, 1988. A prerequisite to the receipt and emplacement of actual CH TRU waste at WIPP, this demonstration confirmed the acceptability of WIPP Waste Handling Operations to safely receive and emplace CH TRU waste at WIPP. The scope of this checkout included handling a total of ten CH TRU Type B shipping containers (TRUPACTS) beginning with preparatory activities outside of the Waste Handling Building, progressing through TRUPACT unloading bay operations in the Waste Handling Building, and ending with emplacement opera-

TABLE I

Time Line Data

	Operation	Time-Minutes*
1.	Receive Shipment	9.5
2.	Transfer Shipment to Receiving Yard	27.0
3.	Clean Road Cask and Trailer	38.0
4.	Transfer Cask and Trailer to WHB	15.5
5.	Offload Road Cask	73.1
6.	Cask Preparation	63.8
7.	Cask Unloading31.0	
8.	Canister Inspection and Transfer27.5	
9.	Facility Cask Preparation	11.0
10.	Facility Cask Loading	23.4
11.	Transfer Facility Cask into Conveyance	11.7
12.	Transfer Facility Cask to Storage Area	30.8
13.	Assemble Emplacement Equipment	56.0
14.	Emplace Canister	35.3
15.	Emplace Shield Plug	18.7
16.	Disassemble Equipment	64.0
17.	Replace Shipping Cask Lid	58.5
18.	Load Cask onto Trailer	68.4
19.	Transfer Trailer to Hold Area	44.0
20.	Dispatch Truck	25.0
21.	Transfer Facility Cask to Surface	50.2

* Total does not include operations performed in parallel within a given sequence.

is 687 and the average source dose rate is 10.9 mRem per hour.

A computer simulation model of the waste handling process was utilized in evaluating the time line data. Table IV provides a summary of calculated radiation fields for the source configurations of the normal waste handling process, reflecting a 60/40 drum/standard waste box split.

The dose assessment results on a per shipment basis are summarized in Table V. As expected, the dock operations and the underground operations are the primary contributors to total occupational exposure since they require operating personnel in close proximity to the source. It should be noted that the total number of operating personnel within any given occupational group will be larger than that utilized in this preoperational checkout to account for time devoted for training, non-waste handling activities, vacation, etc. As an example, the CH TRU waste handling operating group is expected to number 15 versus the 11 utilized in this checkout, thus the average waste handler annual dose in the preoperational checkout, .95 Rem per year per person, will be reduced to about .7 Rem per year per person.

Based on the computer simulation of the normal waste handling process the WIPP single-shift throughput capability for normal waste handling is 273,000 cubic feet per year. This compares very favorably with an anticipated steady state receive rate of 230,000 cubic feet per year. On the basis of operating two waste handling shifts WIPP can process in excess of the WIPP design throughput rate of 500,000 cubic feet per year. At the anticipated CH TRU receive rate of about 230,000 cubic feet per year for the normal waste handling process the combined CH TRU annual operator exposure and the average individual exposure is conservatively projected to be 13.7 Rem and 0.7 Rem respectively. This average individual exposure is based on a minimal crew size and satisfies the radiological requirements of DOE Order 5480.1B.

Completion of the full scope of this checkout, without incident, has demonstrated that the WIPP waste handling process, including waste handling equipment, procedures, and personnel, is ready for the receipt of the first CH waste. Witnessed by members of the New Mexico Environmental Evaluation Group and Department of Energy Officials, the CH preoperational checkout completed a key WIPP milestone of the agreement for Consultation and Cooperation between the U.S. Department of Energy and the state of New Mexico.

CONCLUSION

The Waste Isolation Pilot Plant has employed the latest technologies in its waste handling operations and processes

TABLE II

Time Line/Dose Assessment Summary

Operations	Description	Time Minutes	Total Dose(1) mrem
1.1 to 3.7	Yard - Incoming	75	.92
4.1 to 6.10	High Bay - Incoming	142	6.52
6.11 to 10.7 (2)	Hot Cell - Incoming	103	.39
11, 12, 14, & 15	FC XFR and Emplacement	96	1.39
17.1 to 17.7	Hot Cell - Outgoing	26	0
17.8 to 19.6	High Bay - Outgoing	120	0
19.7 to 20.6	Yard - Outgoing	50	0
21	FC XFR - Outgoing	50	0
13	HERE Assembly	56	0
16	HERE Disassembly	64	0
			9.22

(1) Per Canister (2.3 rem for 250 canisters)
(2) Excluding Overpacking (8.3 A to E - duration 24.5 minutes)

while emphasizing safety, quality, and responsibility to the workers, public, and environment. A total quality waste handling environment was demonstrated at WIPP during the RH and CH TRU mock retrieval demonstration and preoperational checkouts. Waste handling personnel will receive less exposure than originally projected while operating at an increased throughput over design. These demonstrations and preoperational checkouts confirm the acceptability of WIPP waste handling operations to safely receive, emplace, and retrieve (should it be necessary) CH and RH TRU waste.

These startup activities also demonstrated a firm commitment by both Westinghouse and the Department of Energy to prove that the long-term disposal of nuclear waste can be performed in a safe, efficient, and environmentally acceptable manner.

REFERENCES

1. DOE/WIPP 86-011, Demonstration Plan for the RH TRU Waste Mock Retrieval Demonstration (January 1987).
2. DOE/WIPP 87-009, WIPP RH TRU Waste Mock Retrieval Demonstration Final Report
3. DOE/WIPP 88-013, Final Report for the WIPP RH TRU Waste Preoperational Checkout (June 1988).
4. DOE/WIPP 88-006, Final Report for the CH TRU Waste Mock Retrieval Demonstration (January 28, 1988).
5. DOE/WIPP 88-003, WIPP CH TRU Preoperational Checkout Plan (February 1988).
6. DOE/WIPP 88-012, Final Report for the Waste Isolation Pilot Plant Contact-Handled Transuranic Waste Preoperational Checkout (July 1988).

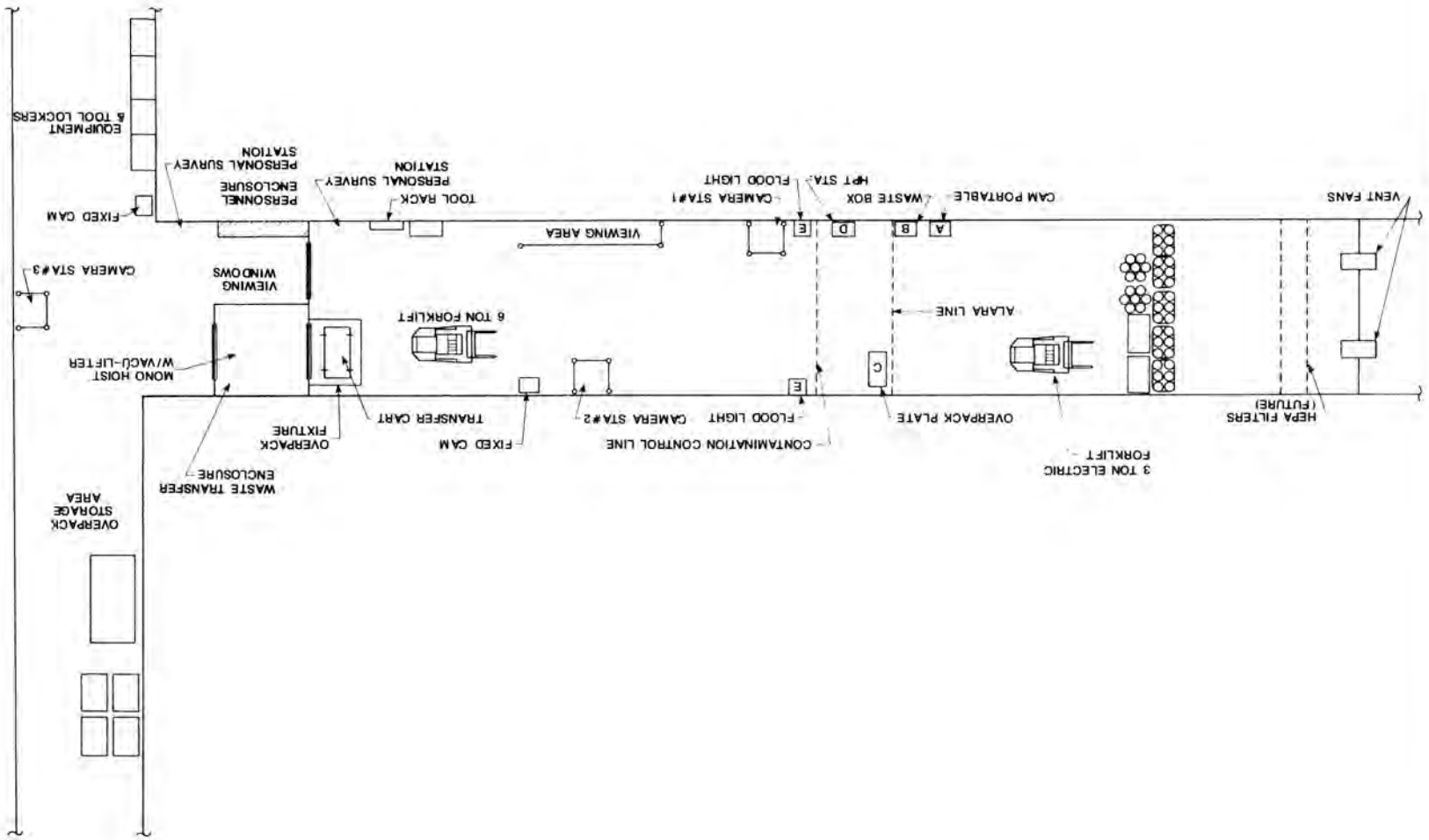


Fig. 4. Plan View of Demonstration Area.

TABLE III

Summary Time Line and Dose Assessment Data

Waste Container Type and Condition	Quantity Retrieved	Retrieval Time - (Minutes)	Average Retrieval Time Per Container (Minutes)	Number and Type of Workers Required	Total Crew Radiation Dose (mrem)	Total Crew Dose Per Container (mrem)
Clean Drums						
Top Level	7	28	4	2HPT/4WH	7.4	1.1
Middle Level	7	12	1.7	2HPT/2WH	3.3	0.5
Bottom Level	7	13	1.8	2HPT/2WH	3.2	0.5
Average	--	--	2.5	--	--	0.7
Contaminated Drums						
Top Level	6	47	7.8	2HPT/4WH	15.5	2.6
Middle Level	6	35	5.8	2HPT/4WH	8.9	1.5
Bottom Level	6	28	4.7	2HPT/4WH	8.6	1.4
Top Level	6	39	6.5	2HPT/4WH	11.4	1.9
Middle Level	6	27	4.5	2HPT/4WH	8.3	1.4
Bottom Level	6	25	4.2	2HPT/4WH	7.1	1.2
Average	--	--	5.6	--	--	1.7
Clean Boxes						
Top Level	1	5	5	2HPT/2WH	1.4	1.4
Bottom Level	1	5	5	2HPT/2WH	1.4	1.4
Average	--	--	5	--	--	1.4
Contaminated Boxes						
Top Level	1	49	49	2HPT/4WH	18.6	18.6
Bottom Level	1	29	29	2HPT/4WH	11.0	11.0
Average	--	--	39	--	--	14.8

TABLE III

(Continued)

EXTRAPOLATED RETRIEVAL TIMES AND PERSONNEL DOSE

	Minimum Retrieval Time(1) Years	Retrieval Time(2) 1 Person rem/yr	Retrieval Dose (3) Person mrem/yr
Clean drums, (930,000 ft3)	3.5	3.7	370
95% clean, 5% contaminated	3.7	4.0	400

(1) In-room retrieval operations

(2) Based on 16 waste handlers and 8 HPTs

(3) Based on 16 waste handlers and 8 HPTs; 10-year retrieval period

TABLE IV

Source Configuration Radiation Fields

SOURCE CONFIGURATION	RADIATION FIELD - mrem/hr(1) ZONE 1 (0-2 ft)	ZONE 2 (2-6 ft)	ZONE 3 (6-10 ft)	ZONE 4 (10-20 ft)
A	2.49	1.17	0.47	0.16
B	1.48	0.86	0.47	0.16
C	0.16	0.16	0.16	0.16
D	1.71	0.62	0.39	0.16
E	17.13	5.61	1.56	0.47
H	27.25	15.57	7.16	3.4
I	1.25	0.55	0.23	0.07
O	0.01	0.01	0.01	0.01

(1) Based on 60/40 drum/SWB split; average SDR of 10.9 mrem/hr.

TABLE V

Normal Waste Handling Process Dose-Assessment Summary

OPERATION DESCRIPTION	TOTAL EXPOSURE (1) mrem/shipment	PERCENTAGE
1.0 Receive Truck	0.20	1.0
2.0 Transfer to Receiving Area	NIL	NIL
3.0 Clean TRUPACTs/Trailers	0.16	0.8
4.0 Transfer to WHB	0.28	1.4
5.0 Dock Operations	8.42	42.3
6.0 Hoist Loading	1.63	8.2
7.0 U/G Operations	8.85	44.5
8.0 Reassemble/Transfer	0.31	1.6
9.0 Transfer to Receiving Yard	NIL	NIL
10.0 Dispatch Trailer	NIL	NIL
TOTAL	19.9	

(1) Per shipment, based on average SDR of 10.9 mrem/hr, 60/40 drum/SWB split.