WASTE ISOLATION PILOT PLANT RECOVERY: A STATUS REPORT

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ABSTRACT

The Department of Energy/Carlsbad Field Office (DOE/CBFO) manages the Waste Isolation Pilot Plant (WIPP), a deep geologic repository near Carlsbad, New Mexico. During almost fifteen years of operation WIPP achieved an enviable safety record permanently disposing of transuranic (TRU) and mixed-TRU waste. Regulated by both the state of New Mexico Environment Department Permit and US Environmental Protection Agency certification, WIPP established itself as a very efficient and safe final disposal solution. Two apparently unrelated incidents in February 2014 shut down the repository and temporarily suspended shipments for disposal. Significant physical plant and cultural changes are being made to restore and enhance the WIPP facility and its safety culture. Lessons learned will be shared internally and externally, including internationally. WIPP will recover and be a more robust facility. WIPP will continue to be a key part of the Cold War Era legacy defense waste cleanup effort by being the only defense-related transuranic waste repository serving to permanently remove risk from the biosphere.

I. INTRODUCTION

The Department of Energy/Carlsbad Field Office (DOE/CBFO) manages the disposal of transuranic (TRU) and TRU-mixed waste at the Waste Isolation Pilot Plant (WIPP), a deep geologic repository near Carlsbad, New Mexico. As shown in Figure 1, the WIPP mission is a nationwide mission, with 22 sites that formerly stored legacy defense-related TRU waste now unencumbered by the cost and risk associated with managing this material. Legacy waste from other major sites associated with the nuclear weapons complex, as well as newly generated waste from ongoing missions, will continue to require disposal at WIPP for decades to come.

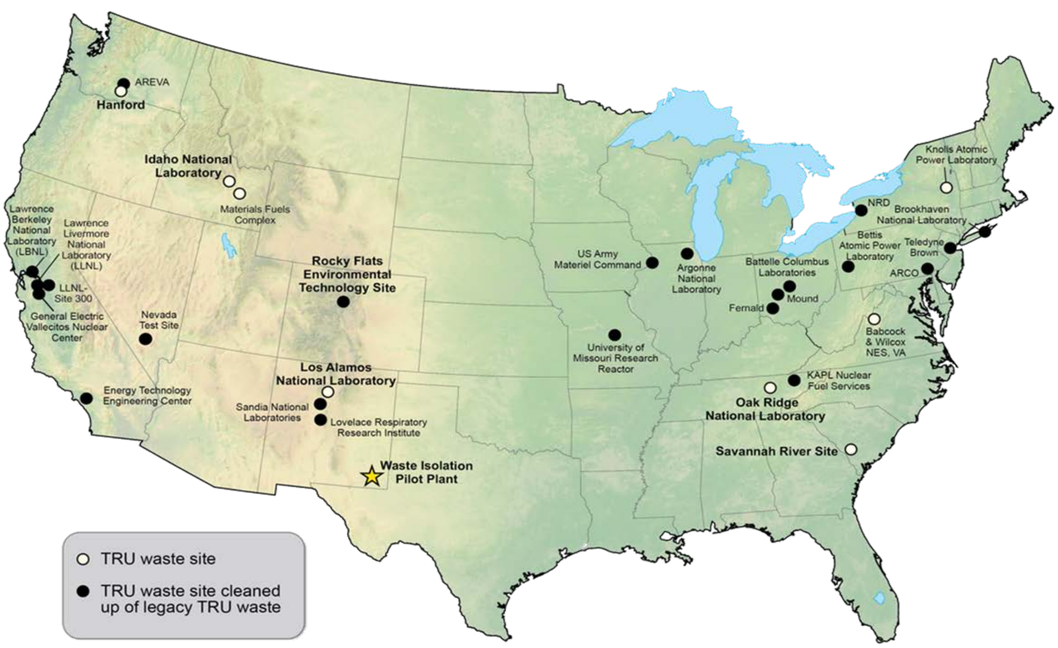

Figure 1: The WIPP transuranic (TRU) waste mission is a nationwide mission.

During almost fifteen years of operation WIPP achieved an enviable safety record and provided an efficient final disposal solution for the defense waste streams. Two events occurred in February of 2014 that temporarily halted disposal operations at WIPP. The first was a truck fire in the underground that forced evacuation of the mine and its closure until a thorough accident investigation by a formally appointed Accident Investigation Board had been completed. Before that investigation was completed, an unrelated second incident occurred that released airborne americium and plutonium into the underground, with a small amount escaping to the ambient air at the surface.

Figure 2. Burnt salt hauling truck in the repository

Figure 2 shows the burnt truck in the repository. The Accident Investigation Board's examination of the truck fire pointed to faulty maintenance as a direct cause, and in evaluating the response to the fire pointed out significant physical and cultural changes that were needed in the facility and in its operations.[1]

The Accident Investigation Board's cause determination on the release event is ongoing and at this point in time indications are that there was a heat and gas producing oxidation reaction (combustion) in at least one waste container that deformed its lid and ejected some of its contents. A DOE Inspector General's report identified problematic waste treatment practices at the originator site as responsible for the release event while acknowledging that the exact nature of the invititing reaction is not yet known. [4] That release resulted in airborne radioactivity becoming entrained in the underground airflow. Ventilation air flowing underground is continuously monitored for airborne radioactive particulate, and the system worked as intended. The continuous air monitor detected the radioactive plume as it flowed out of the disposal panel where the event occurred, and the ventilation air handling system automatically switched to filtration mode, with all air then directed through High Efficiency Particulate Air (HEPA) filters at the surface. A small but measurable amount of contamination, well below any regulatory limits, was also released at the surface because of leakage in the ventilation system when it was put into filtration mode. The Accident Investigation Board's report on the Radiological Release Event at the Waste Isolation Pilot Plant on February 14, 2014, will be made available on the internet as soon as completed.[2] A report on the operational response to that release has already been made public.[3]

Figure 3 shows a view of the compromised drum in the underground. Note that the white granular material on the top of the drum is magnesium oxide, a chemical buffer material placed on top of the waste in large polyethylene bags. During the heating event, bags near the heat source melted and their granular content flowed out and over the edge of the underlying waste containers until reaching its natural angle of repose (see Figure 7). The material on the adjacent waste container (foreground) is suspected to be ejecta from the affected drum in the background.

Figure 3. View of the compromised waste drum in the repository.

Even though the exact initiating cause of the chemical reaction was still being investigated at the time, the Accident Investigation Board report on the reaction to the event suggested a number of additional physical and cultural/operational changes that need to be made. A thorough inspection by the Mine Safety and Health Administration identified still more physical and operational deficiencies. The facility's regulators, including the New Mexico Environment Department, the Environmental Protection Agency and the Defense Nuclear Facilities Safety Board have all weighed in with strong recommendations and orders to improve the safety of the facility in terms of its ability to prevent and cope with low probability internal mishaps.

It is important to note that the nature of the host rock and the repository itself were not the cause for either event. The events occurred in a deep geologic repository, but were caused by human error. They were not caused by the repository.

II. RECOVERY ACTIVITIES

The Accident Investigation Board did not just criticize the operation of WIPP, it also laid out a series of suggested corrective actions that are being addressed prior to the restart of operations[1,3] A careful and methodical resource-loaded schedule was created that leads from the present state of the repository to a physically enhanced facility with an enhanced safety culture. Partial operations are scheduled to be restored in early 2016, with full operations following, depending on the progress of the capital project expenditures planned for that time period, which include a new exhaust drift, shaft and fan system to provide more underground ventilation.

Highlights of the recovery plan effort are:

- **Decontamination of operational areas underground:** The release event has contaminated a sizable fraction of the underground facility. To the extent that contaminated areas are to be used to emplace waste or simply traversed by workers or waste conveyance, they will need to be remediated. That remediation may take the form of spraying fresh water on affected ceiling and wall areas. The water will dissolve the rock surface (Halite), thereby releasing the contamination, which will flow with the water into the fractured matrix. Most water (and contaminants) will wind up in the floor, trapped within the rock. The floor of decontaminated areas may then be covered with a Brattice cloth and run of mine salt. In some areas fixatives may be applied, but fresh water washing will likely be the most effective decontamination practice.
- **Permanently contain potential contamination source sources:** Current plans are to construct substantial barriers to isolate the room containing the compromised waste drum, as well as the panel with waste similar to the waste that sustained the reaction, from the underground working areas.
- **Restore conditions that will support operations:** This effort includes radiological characterization and posting; ground control activities (e.g., bolting) for mine safety; equipment and systems maintenance, cleaning, and upgrades, especially in terms of ventilation.
- **Incorporate cultural and training corrective actions:** Lessons learned from the fire and radiological event are being used to enhance safety-conscious work environment programs and procedures prior to resuming operations.

Barriers to be erected to preliminarily seal off the affected room and panel with potentially reactive waste are in the form of a chain-link and Brattice-cloth curtain and run of mine salt, with a steel bulkhead to effectively seal the area from ventilated underground working areas. Figure 4 provides a schematic of this barrier system. Figure 5 shows an example of the proposed steel bulkhead, which is already in common use in the repository. This preliminary closure system will be followed by a permanent closure system once regulatory approvals have been obtained. The preliminary closure system is sufficiently robust to stop aerosol particulate waste discharged into the underground air from a reactive drum.

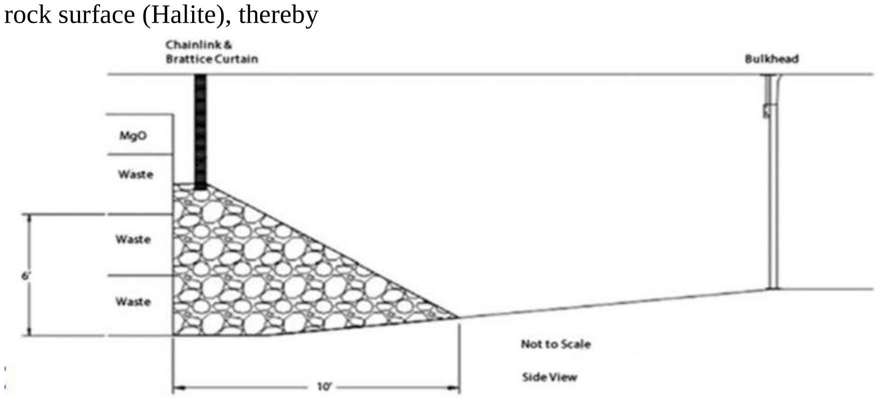

Figure 4. Schematic of chainlink, Brattice cloth, run of mine salt and steel bulkead preliminary room closure system.

Figure 5. Steel bulkhead doors in routine use in the Waste Isolation Pilot Plant underground facility.

The final step in the underground forensics activities being carried out uses a device to individually examine every drum in every waste stack in Panel 7's Room 7. This device, a very long boom of composite material with cameras attached, is shown being tested in Figure 6. This mapping is being done to exclude the possibility of any other cause for the radioactive release.

Panel 7 of Room 7 of Panel 7 is shown in Figure 7. Figure 7 indicates the extent to which heat melted the polyethylene bags holding magnesium oxide in this room. Polyethylene melts at 160C, suggesting a very high temperature heat source in the center-right side of the room (see Figure 8). Since the waste is stacked two or three layers of containers high with little space between waste stacks, maneuvering the boom with a camera moving up and down at its end to visually inspect every drum and container in the room, without touching the containers, is a delicate and difficult operation.

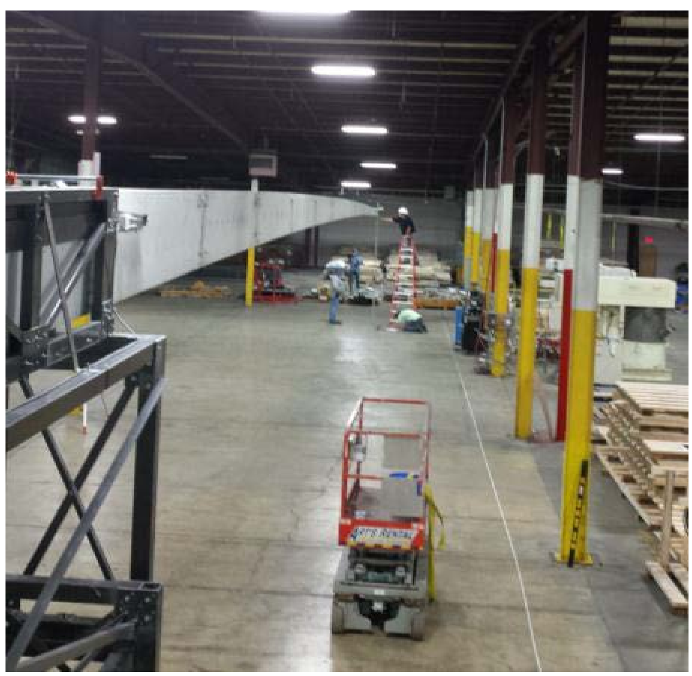

Figure 6. Testing of boom to be used in the underground to examine Room 7 of Panel 7.

Figure 7. Room 7 of Panel 7 showing extent of melting of polyethylene magnesium-oxide bags.

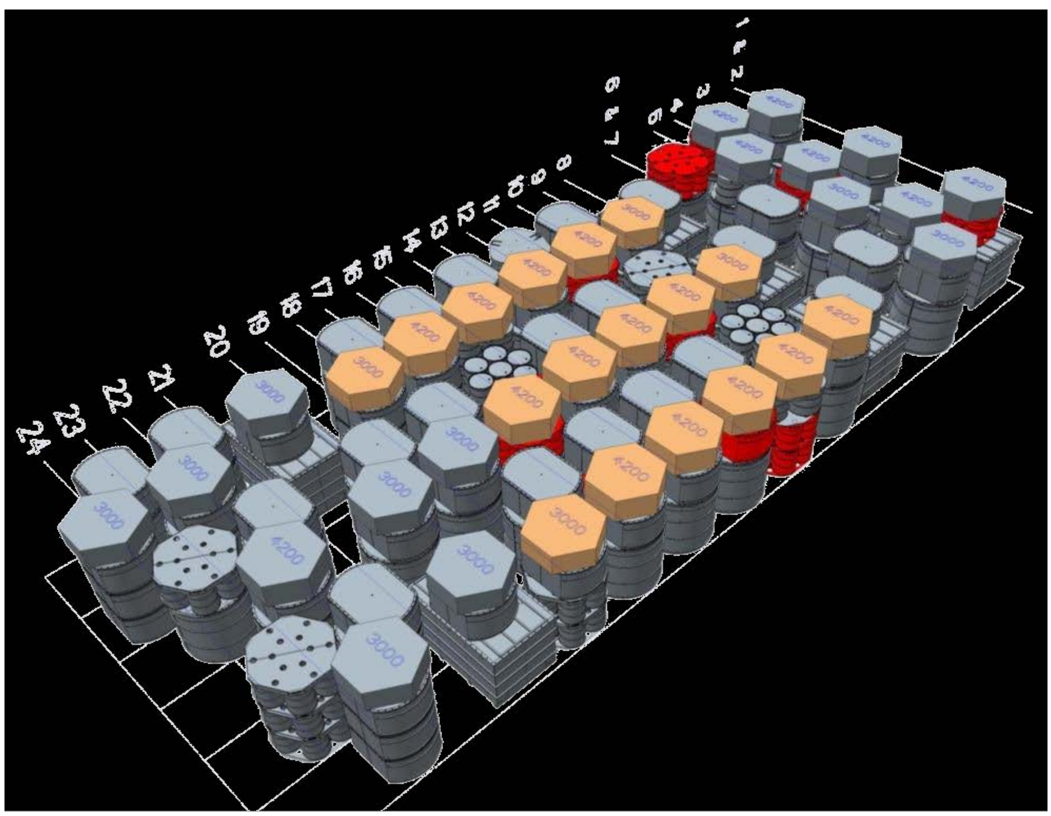

Figure 8. Room 7 of panel 7 schematic indicating the location of melted magnesium oxide bags and showing the complexity of using a camera on a boom extended over the waste

Providing ventilation underground is a key aspect of the recovery process. When the repository is in filtration mode it is limited to 60,000 cfm (28 m^3/s), which does not allow operation of more than one piece of diesel powered equipment and restricts other activities.

Previous to the release event the (unfiltered) operational airflow was 425,000 cfm (200 m^3/s), sufficient to allow populating the underground with a full workforce, to emplace waste, and to run numerous pieces of diesel powered equipment simultaneously. The WIPP Permit requires 260,000 cfm (122 m^3/s) of airflow, so the current filtration mode situation does not meet that requirement.

Recovery of underground airflow is a process to be carried out in several stages. The first stage is to add high-efficiency particulate air (HEPA) filtration capacity using a skid-mounted filtration unit and additional fans. This will allow an increase in the underground airflow to 114,000 cfm (54 m^3/s), not enough to allow waste handling operations but sufficient to allow underground preventive maintenance activities to be conducted more efficiently than is currently possible.

The next stage involves reconfiguring mine ventilation circuits and adding additional fans. This will allow the underground ventilation to be enhanced to 180,000 cfm (85 m^3/s) of airflow. This is sufficient to allow limited waste operations and to continue preventive and routine maintenance activities underground.

To fully recover, a new (permanent) ventilation system is being designed and planned, involving new ventilation drifts and a new exhaust shaft. Completion of this new permanent ventilation system will bring the underground airflow up to 420,000 cfm (198 m^3/s), at which time full permit compliance will be achieved and hence full operations and maintenance activities will be resumed. At this point, air flowing past waste emplacement panels will be in filtration mode and airflow past areas where there is mining and experimental work can continue safely and efficiently unfiltered.

III. CONCLUSION

Almost fifteen years of performing routine operations day after day without any challenging events eroded the WIPP nuclear safety culture. Nuclear safety assurance requires continual questioning attitudes on the part of all workers, whether at WIPP or in the pipeline that ships waste to WIPP for permanent disposal. The challenge is to actively and consistently promote continual improvement in operational safety and efficiency.

WIPP will recover and be a more robust and safer facility than it has been in the past. WIPP will continue to be a key part of the Cold War Era legacy defense waste cleanup effort by continuing to remove risk from the biosphere.

REFERENCES

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