Idaho Completion Project

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Idaho Completion Project's Accelerated Retrieval Project Overview Of The Pit 4 Non-Time Critical Removal Action

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ABSTRACT

This paper presents an overview of the Accelerated Retrieval Project performed by the Idaho Completion Project at the Idaho National Laboratory (INL). Topics include an overall description of the process and methods that will retrieve, characterize, and certify newly generated transuranic (TRU) waste for disposal at the Waste Isolation Pilot Plant (WIPP). The retrieval and characterization of buried TRU waste presents unique challenges. Innovative approaches developed and discussed are: excavation, RCRA waste sampling, visual examination, and deployment of the WIPP Central Characterization Project mobile systems to the INL.

INTRODUCTION

As part of a Comprehensive Environmental Response, Compensation, and Liability Act non-time critical removal action, the Department of Energy (DOE) Idaho Operations Office proposes to retrieve buried TRU waste from a defined area within the INL's Pit 4. This retrieval project will be executed by the Idaho Completion Project (ICP) Accelerated Retrieval (AR) Project. Pit 4 was open to receive waste from January 1963 through September 1967. Initially, containerized waste was stacked in the pit, until late 1963, when this practice was changed and containers were dumped into the pits to reduce labor costs and personnel exposures. Although the bulk of the waste is from the Rocky Flats Plant (RFP), INL waste generators and some offsite generators also disposed of waste in the pit. The retrieval and compliant characterization of buried TRU waste presents exceptional challenges. Typically WIPP characterization is performed on drummed waste in the "as shipped" containers. Wastes within Pit 4 have little or no container integrity and are extensively commingled with soil. Innovative approaches were developed to characterize this commingled waste for disposal at WIPP in a cost-effective Waste Analysis Plan (WAP) compliant manner.

The AR Project chose to deploy the Central Characterization Project (CCP) because of their current Carlsbad Field Office (CBFO) certification and their access to existing, certified characterization equipment and trained and qualified personnel. INL personnel who directly participate in CCP characterization activities will be fully qualified under the CCP program. Specifically, qualified INL personnel under CCP oversight will conduct solids sampling and visual examination activities. We expect that most of the remaining CCP waste characterization and certification activities will be conducted by non-INL personnel who are already trained and qualified under the CCP program. All characterization activities will be conducted in accordance with CCP procedures that are approved by CBFO and are fully compliant with the authorization basis for the INL's Radioactive Waste Management Complex.

WASTE DISPOSAL PRACTICES AND CURRENT CONDITIONS

To appreciate the challenges this waste form presents, the condition of the waste must be understood. The RWMC was used for subsurface disposal of both TRU and low-level waste in various pits and trenches from 1952 until 1970, when the practice was suspended in favor of aboveground retrievable storage. The majority of the waste disposed of in Pit 4 consisted of both debris and homogeneous solids. A summary of as-disposed volumes, weights, and waste categories for all shipments intersecting the defined area of

Pit 4 is given in Table I. The disposal process involved excavating an area in the SDA with a tractor-drawn scraper to the underlying basalt, followed by backfilling and leveling with a layer of native soil approximately 0.6 m thick on which the waste was placed. The waste zone was approximately 3.66 m deep when completed. Overburden soil was placed on the waste at a thickness of 1.2 to 2.7 m. Waste was disposed as received; hence, the waste is commingled within the pit.

Table I. Pit 4 area summary of as-disposed volumes, weights, and waste categories.

Waste Category	Number of Containers	Weight (Kg)	Volume (m^3)
[a]RFP Series 741 sludge (1st stage)	886	204,410.3	184.45
[a]RFP Series 742 sludge (2nd stage)	770	170,723.24	160.16
[a]RFP Series 743 sludge (organic setups)	634	154,406.64	132
[a]RFP Series 744 sludge (special setups)	81	17,322.07	16.9
RFP Beryllium	187	18,890.17	38.73
RFP Roaster oxide	109	33,525.12	22.68
RFP Graphite	490	52,299.62	101.91
RFP Filters	681	57,104.61	349.17
RFP comb debris	1,911	96,468.92	397.59
RFP metal debris	1,585	282,311.11	925.62
RFP mixed debris	1,341	87,501.25	362.34
Non-RFP sludge	3	19.051.2	36
Non-RFP comb debris	13	10,206	48.56
Non-RFP metal debris	32	89,322.45	422.48
Non-RFP mixed debris	39	63,798.84	223.43
Totals	8,762	1,356,981.5	3,422.13
a. Solids analysis data is available on this waste form from the INL 3100 m^3 Project.			

This waste has now been buried for over 30 years, and during that time the disposal area has been subjected to floods. The waste’s current condition within Pit 4 is pivotal in determining and designing a comprehensive approach to retrieval and WAP characterization. In spring 2004, the Glovebox Excavator Method Project retrieved approximately 60 m^3 (packaged into 454 drums) of buried waste from Pit 9 at the INL. The Pit 9 retrieval effort yielded valuable insight concerning what could be encountered in Pit 4. Pit 9 waste forms are analogous to those in Pit 4 in terms of form and time spent buried. Figure 1 provides a picture of the first signs of waste material in Pit 9; note the absence of a drum. Drum conditions ranged from completely deteriorated, i.e., could be ripped by leather-gloved hands in the glovebox, to relatively intact, i.e., would still hold waste. Of the corroded drums, only the drum lock rings had any integrity, but these could be folded by hand. There may be a correlation between drum condition and depth, with deeper drums being more corroded. This was not evaluated in detail.

Sludge in Pit 9 could be differentiated from soil as long as material mixing was avoided. A wide range of sludge colors (e.g., gray, olive-gray, dusty yellow, rust, and pale orange) and textures (e.g., pasty, peanut butter, shiny, silty, greasy, wet, play dough) was noted. Sludges were still largely contained inside the bags, but were liberated by excavation activities. Soil constituted a significant fraction of the material within the waste zone as illustrated in Figure 1. Visibly contaminated soil was observed in the waste zone. The process of retrieval further contaminates the surrounding soil. It was also noted that soil was often retrieved with sludge.

In general, Pit 9 debris waste inside plastic bags was in excellent condition. Debris was easily distinguishable once released from the bag; however, it is not generally possible to distinguish a bag containing debris from a bag containing sludge by visual observation in the pit. Some of the bags may have been breached during original disposal operations, and debris near the outside edges of the breached bags showed some signs of rust staining and color fading (e.g., yellow tape was somewhat lightened). Plastic drum liners were in good condition; some plastic was still elastic and could carry a load, while other plastic seemed to be dry, brittle, and could not carry a load.

Fig. 1. The first signs of waste material in Pit 9.

Volatile organics within the Pit 9 zone have migrated from their original disposal location. Shallow soil gas measurements (76 cm below ground surface) have detected carbon tetrachloride at concentrations up to 6,400 ppmv. Organics have also migrated downward: carbon tetrachloride has been detected in the vadose zone.

PROCESS OVERVIEW

AR Project waste retrieval will occur in a large, metal-framed fabric enclosure constructed over the retrieval area to minimize contamination spread and provide protection from the weather. The retrieval enclosure is a rectangular building 88.39 m long by 51.81 m wide with attached bays for maintenance and drum loading. The enclosure's domed roof is approximately 17.67 m tall in the center and slopes down to intersect with its 6.4-m high sidewalls. The ceiling and walls of the enclosure incorporates steel beams covered with a polyethylene inner and outer membrane. Housed within the enclosure are an excavator to retrieve waste and a telehandler (used as a forklift) to move trays of recovered waste to the examination station.

To mitigate airborne emissions, the enclosure is equipped with a 566 m^3/min high-efficiency particulate air (HEPA) ventilation system. Additionally, fugitive dust emissions are controlled with an excavator-mounted dust suppression spray system. The dust suppression system entails a Soiltac (vinyl acrylic copolymer emulsion that binds the soil particles together) holding tank, pump, and spray nozzles. Excavator operators apply the Soiltac on an "as-needed" basis to mitigate fugitive dust.

- At the digface, an excavator will retrieve targeted wastes and place these wastes within lined trays. Targeted wastes (TW) are considered to be RFP waste streams that are highly contaminated with TRU radionuclides, volatile organic compounds, and various isotopes of uranium. Targeted retrieval primarily focuses on removal of the Series 743 sludge (high VOC concentrations), Series 741 sludge (high TRU activity), graphite (high TRU activity), filters (high TRU activity), and roaster oxide (high uranium content) waste.

- The trays of targeted waste are transported from the digface to a drum packaging station where packaging and visual examination (VE) activities are performed.

- Wastes from the drum packaging station are then stored pending final CCP characterization (Nondestructive Assay, Head Space Gas Sampling, and Gas Generation Testing) and shipment to WIPP.

WASTE EXCAVATION

The AR Project area of excavation comprises three stratified layers. The top 2-ft-thick layer consists of dirt and rock placed on top of the waste and compacted. This top 0.6-m-thick layer is called potentially contaminated soil (PCS) and is considered to be less contaminated than either the waste or the underburden. The middle 3- to 4.26-m-thick layer consists of a mixture of TW, nontargeted waste (NTW), soil, and rock. The bottom layer consists of underburden soil that was deposited within the pit to level out basalt outcroppings before waste disposal.

To selectively retrieve TW while leaving NTW behind, the project plans a staged excavation campaign. This staged campaign will segment the excavation site into an initial trench and a moving trench. The initial trench excavates and relocates approximately one-eighth of the total pit volume and is required to open a region within the pit for the second moving trench operation.

As shown in Figure 2, formation of the initial trench includes removing a swath of the 0.6-m-thick PCS and positioning the excavator within close proximity to the PCS/waste edge. From this vantage point, the excavator removes waste from the pit while maintaining an approximate 1:1 angle of repose. An individual assisting the excavator operator by way of closed-circuit television cameras will make a TW/NTW determination. TW is placed within TW trays and transported to a drum packaging station by telehandler. NTW is containerized and transported to an alternate location within the retrieval enclosure by telehandler. Following waste removal, a narrow band of PCS is removed from an area directly adjacent to the pit on the excavator side. This narrow exposed waste band provides a starting point for the moving trench campaign.

Once the initial trench has been created, the moving trench waste retrieval will be accomplished by excavating TW and NTW on the east face of the trench while maintaining a 1:1 angle of repose and placing/compacting NTW on the west face. Retrieved TW are again placed within TW trays for further processing within the drum packaging station and TW determinations are again made by a separate individual through the use of cameras. During the retrieval process, NTW (staged from the initial trench campaign) are retrieved from a staging area and placed on the lower newly formed NTW shelf. Following waste removal, a narrow band of PCS is removed from an area directly adjacent to the pit on the excavator side. This PCS is used as a cap on top of the newly returned NTW.

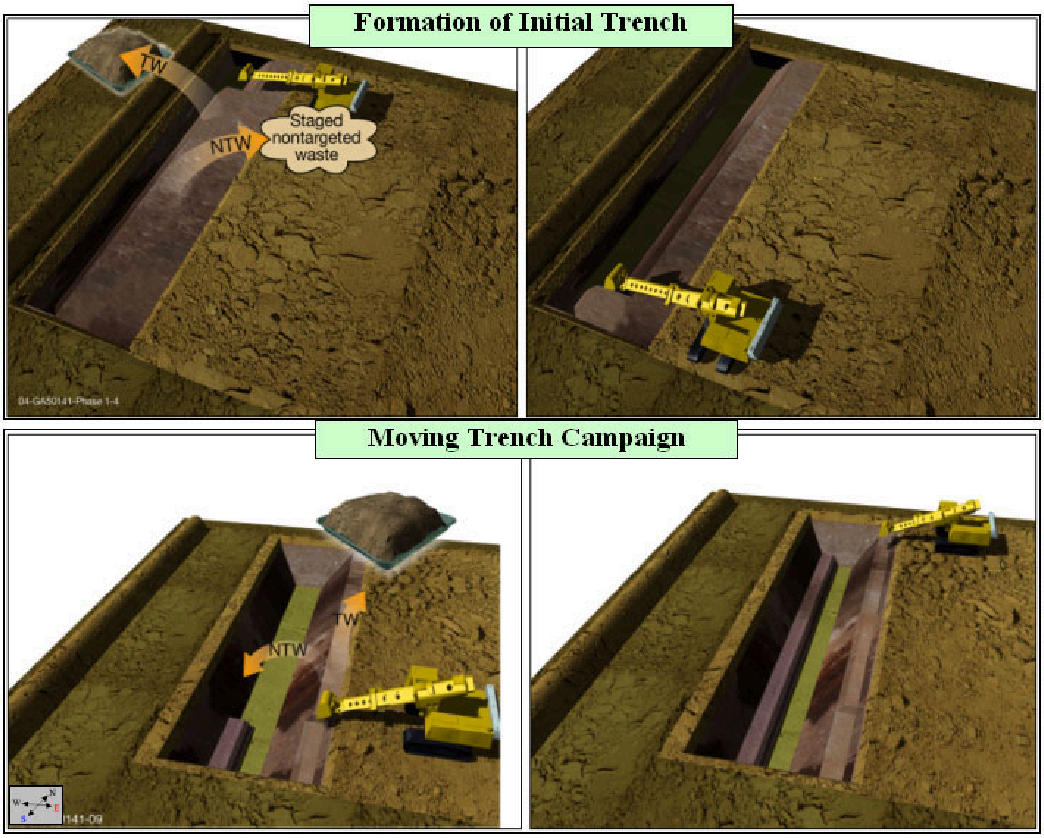

Fig. 2. Initial trench and moving trench waste excavation campaigns.

WASTE ANALYSIS PLAN IMPLEMENTATION

Of particular interest to the AR Project are the WIPP WAP requirements associated with newly generated waste. Since the waste is considered newly generated, it may be sampled and visually examined before it is packaged. This is advantageous, since it eliminates the need for post-packaging characterization processes that include intrusive core sampling, real-time radiography, and intrusive VE as a quality control check for real-time radiography. Headspace gas sampling and analysis processes for newly generated waste are the same as for retrievably stored waste, and will be conducted using standardized techniques that are common throughout the complex.

ACCEPTABLE KNOWLEDGE

The Acceptable Knowledge (AK) process begins with gathering historical documentation used in support of materials and processes. The AK for Pit 4 forms the foundation of the characterization process by defining waste streams, presence of prohibited items, and Environmental Protection Agency (EPA) hazardous waste numbers that will be assigned to the newly generated waste. Over 3,000 source documents were collected, reviewed, and distilled for the AR Project. Information about the physical waste forms, the base materials composing the waste (especially hazardous and radioactive materials), and the process that generated the waste were collected from Rocky Flats, INL Naval Reactor Facility, and other INL generators. This information was reviewed, compiled, and an AK summary report written to initially characterize the waste. This AK summary report discusses:

- The defense relationship

- Basis and rationale for delineating waste streams
- Assignment of EPA hazardous waste numbers (HWNs)
- Establishing Summary Category Groups (i.e., Homogeneous Solids – S3000, Soils/Gravel – S4000, Debris Waste – S5000), and Waste Matrix Code Groups
- Estimated isotopic ratios
- Presence of prohibited items (i.e., pyrophorics, explosives, PCBs > 50 ppm, reactives)
- Estimate for the weight fraction of cellulosics, plastic, and rubber .

Examination of the waste during packaging at the drum packaging station will provide confirmation of AK and confirm compliance with WIPP transportation and disposal requirements for physical attributes of the waste.

WASTE SAMPLING

The sampling and analysis of homogeneous solids and soil/gravel for a defined area within the (ICP’s) Pit 4 is unique. The sampling methodology is area-based and relies on constrained random selection. The sampling and analysis plan addresses both the spatial and temporal variability of the waste, consistent with EPA sampling methodologies found in Statement-of-Work-846, Chapter 9. ICP personnel discussed this concept with the CBFO relative to WAP requirements. All parties agreed that the proposed methodology meet WAP requirements. WAP samples will be collected real time to retrieval. To demonstrate compliance with WIPP WAP data quality objectives, the sampling design will confirm that the sample size is sufficient.

WIPP sample locations were predetermined by partitioning the 0.5-acre retrieval area into nearly 400 cubical volumes and then randomly selecting 60 volumes for sampling. The cubical volumes were grouped into three pit layers. The first level starts at the top of the waste zone and stops at approximately 1.2-m waste depth. Layer two starts at the 1.2-m waste depth and stops 2.4 m below grade level. The third layer starts at the 2.4-m waste depth and continued to the underburden surface. The required accuracy for retrieving a WIPP sample is ± 0.9 m in the horizontal and ± 0.6 m in the vertical direction. To achieve this accuracy, samples are retrieved using the excavator bucket, suspended markers, and an excavator mounted depth monitor.

Sixty locations within the area of excavation must be sampled for WIPP. Twenty of these samples start at a North American Vertical Datum (NAVD) elevation of 1,527 m (approximately 0.9 m below the pit surface); 20 of the samples start at a NAVD elevation of 1,526 m (approximately 2.1 m below the pit surface); and 20 samples start at a NAVD elevation of 1,525 m (approximately 3.3 m below the pit surface). As shown in Figure 3, each marker has one of three colors and symbols to indicate the depth of that sample. Green with a circle is used for the highest sample, yellow with a square indicates the middle sample, and red with a triangle is used for the lowest sample. Elevations in the following figure denote the NAVD elevation (in feet) at the top of each cubical volume of sample.

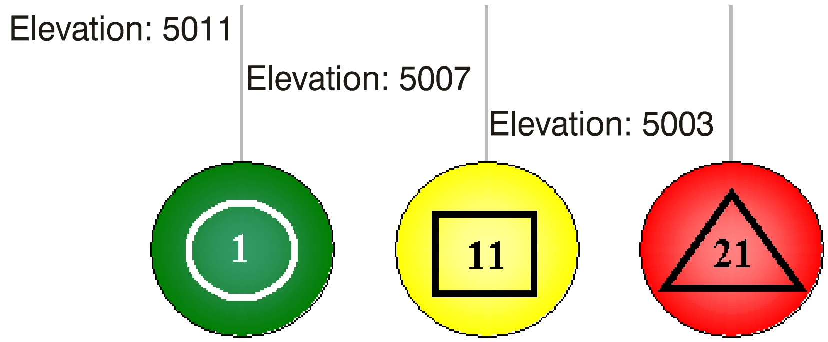

Fig. 3. Sample markers (using English units–feet).

As shown in Figure 4, WIPP samples are retrieved by:

- Touching the north side of the excavator bucket to the south side of the suspended marker.
- Communicating the marker color, the horizontal distance from the excavator cab (shown within the excavator cab on a depth monitor), and the vertical distance from the bottom of the excavator tracks (also shown within the excavator cab on a depth monitor) to a data recorder.
- The data recorder then takes this information and subtracts the vertical distance between the base of the marker to the top of the WIPP sample by the vertical distance to the marker (referenced from the bottom of the excavator tracks). This provides the depth beneath the excavator tracks to the top of the WIPP sample. The depth information is then relayed back to the excavator operator.
- While maintaining the same horizontal distance from the cab, the excavator retrieves the sample at the depth indicated by the data recorder.

Fig. 4. Waste Isolation Pilot Plant sampling.

To maintain the ± 0.9 m tolerance in the horizontal direction, the sample markers are surveyed to a point 35.5 cm to the north of the WIPP sample center point. This offset allows the center point of a standard 71-cm-wide bucket to be directly over the center point of a WIPP sample when the bucket is touching the marker as shown in Figure 4. To maintain the ± 0.6 m tolerance in the vertical direction, the bottom of the sample markers are surveyed in at a NAVD elevation of 919 m.

WIPP samples are placed within TW trays equipped with colored liners. These trays are transferred to a drum packaging station, where a sample is extracted into a sample bottle. The sample bottle is then bagged out of the drum packaging station and labeled. Sample information (e.g., coordinates) is recorded on a sample tracking form. The sample bottle is then transferred to a sample support trailer and placed within a fissile material monitor and assayed for transportation. The sample is then transferred to the Idaho Nuclear Technology and Engineering Center for analysis.

WASTE VISUAL EXAMINATION AND PACKAGING

VE is conducted using the "VE technique," which is a WAP-approved process that is exclusive to the examination of newly generated waste. During the VE technique, material parameter weights are determined, the absence of prohibited items is verified, and the waste stream and waste matrix code group is confirmed. Because of the commingled nature of the waste, AR Project waste streams and waste matrix code groups are limited to three categories: heterogeneous debris, homogeneous solids, and soil/gravel.

- Waste material parameter estimates are challenging because of the random nature of the commingled waste materials. Where historically derived weight data are not available, debris materials are segregated into each material parameter type and weighed using scales located inside each drum packaging station. For homogeneous materials such as sludges or soil, the weight is estimated using volume and density estimates. Final estimates are adjusted when the final container weight is determined following the packaging process; these adjustments are typically limited to homogeneous waste material that cannot be easily segregated and weighed during the VE technique. All data is recorded electronically in an Excel spreadsheet (VE data form) where the material parameter volume and weight calculations and waste stream and waste matrix category determinations are executed real time.

- While the waste is segregated and waste material parameter weights are identified, the waste is examined for prohibited items such as residual liquids, pressurized containers, etc. If prohibited items are found, they are either remediated or segregated from the waste for future disposition.

- Radiological levels are monitored in two locations when a TW tray reaches the drum packaging station. First, a reading is taken through a window before allowing the tray into the packaging station. Second, once inside the drum packaging station a near contact reading of the waste is taken. Following radiological screening the waste tray is identified as either a sample or TW.

- If the TW tray contains a sample, then sampling and decontamination supplies are bagged into the drum packaging station and a sample of the waste is placed within a transfer bottle. The transfer bottle is then bagged out of the drum packaging station and sent to a support trailer for further processing.

- Following any potential sampling, contents of the waste tray are examined for the presence of TW. Trays comprised solely of NTW are removed from the drum packaging station and transferred back to the pit. A VE technician then examines the tray of TW. After the VE technician determines waste stream identity, the waste stream information is recorded on a VE data form and an estimate of the overall weight is determined based on the contents.

- Following an inspection for free liquids and outliers, the tray liner and contents are lowered into a prepared drum through a drum port. The VE technician then records the weight of the drum, compares the weight to the estimate, completes the VE data form, and signs the VE data form.

- With radiological support, the filled drum is detached from the drum packaging station, labeled and sealed. The waste drum is then transferred to an assay station to determine fissile content. If the drum assay results indicate fissile concentrations greater than 380 fissile-gram equivalent (FGE), then special storage conditions are required. If drum concentrations are less than 380 FGE, then the drum is transferred to a storage facility pending additional waste characterization for required shipment and disposal at WIPP.

Startup activities for the retrieval area and drum packaging station were completed in December 2004 and authorization to begin retrieval of buried TRU waste was received in early January 2005. Recovery of targeted waste forms in currently underway and VE and sampling of the waste is being performed.

CCP DEPLOYMENT OF CHARACTERIZATION SYSTEMS

CCP will conduct a suite of TRU waste characterization activities required by WIPP, which includes VE and solid sampling of newly generated waste, radioassay, headspace gas sampling and analysis, and gas generation testing for test category waste. An existing storage module, Building 628, was modified to support CCP characterization activities. Heating, ductwork, and electrical systems were upgraded to accommodate the CCP. CCP will deploy several systems to characterize newly generated waste at INL Building 628. These include two radioassay systems, the High Efficiency Passive Neutron Counter and Tomographic Gamma Scanner, and one online headspace gas sampling and analysis unit. All of these systems are trailer-based, self-contained mobile units. Additional equipment will include an initial ten gas generation testing units that will be later increased by a number of additional units based on the projected inventory of test category waste. To augment CCP operations, two existing INL assay systems were reactivated under the CCP program. Summa canister sampling and laboratory analysis will augment the online headsapce gas system. The solid samples will be conducted by the INL under a separate program that is currently certified by the CBFO.

Installation and setup of the CCP mobile characterization systems is complete. Startup activities are underway and all characterization systems are expected to be operational by March 31, 2005. Continued characterization (headspace, gas sampling, and radioassay) and certification of retrieved buried TRU waste will be initiated in April 2005.

SUMMARY

The retrieval and characterization of buried TRU waste are complex. Multiple organizations have been leveraged together to perform start-up of this project. Full operational status will be achieved in April 2005 followed by a certification audit.

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