Excavation and Repackaging of Retrievably-Stored, Remote-Handled Transuranic Waste at Oak Ridge National Laboratory - 8454

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Between 1972 and 1981, remote-handled transuranic (RH-TRU) wastes generated at Oak Ridge National Laboratory (ORNL) were retrievably stored through shallow land burial in a series of 22 earthen trenches in the northern portion of Solid Waste Storage Area 5 in ORNL's Melton Valley. A Dispute Resolution Agreement signed by the Tennessee Department of Environment and Conservation and DOE specified removal of the buried (stored) waste to allow for repackaging, processing, and offsite disposal at an appropriate facility. A total of 204 concrete casks were successfully retrieved and overpacked from the 22-trench area between November 2004 and June 2006. Wastes originally stored in boxes, drums or placed without packaging was also recovered and repackaged. The repackaged wastes were transported to a nearby temporary storage facility at ORNL pending processing at DOE's Transuranic Waste Processing Center.

INTRODUCTION

The U. S. Department of Energy's (DOE's) Oak Ridge Reservation (ORR) consists of 13,970-hectares within and adjacent to the city limits of Oak Ridge, Tennessee, in Roane and Anderson counties (Fig. 1). ORR hosts three major industrial research and production facilities originally constructed as part of the World War II (WWII)-era Manhattan Project: East Tennessee Technology Park (formerly the K-25 Site), Oak Ridge National Laboratory (ORNL), and the Oak Ridge Y-12 National Security Complex Plant. The Melton Valley (MV) watershed, an area of approximately 430 hectares, lies immediately south of the ORNL main campus and contains a number of waste management areas, including Solid Waste Storage Area (SWSA) 5 North.

The Melton Valley Transuranic (TRU) Waste Retrieval Project addressed retrieval of buried waste from the 22-trench area in SWSA 5 North. The waste was retrieved under DOE's Atomic Energy Act (AEA) authority per a *Dispute Resolution Agreement with the State of Tennessee under the Federal Facility Compliance Act Site Treatment Plan for the Oak Ridge Reservation*. The project was conducted as part of a DOE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program that addressed overall remediation of the Melton Valley Watershed. The selected remedy for remediation of Melton Valley was described in the *Record of Decision for Interim Actions for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (ROD).

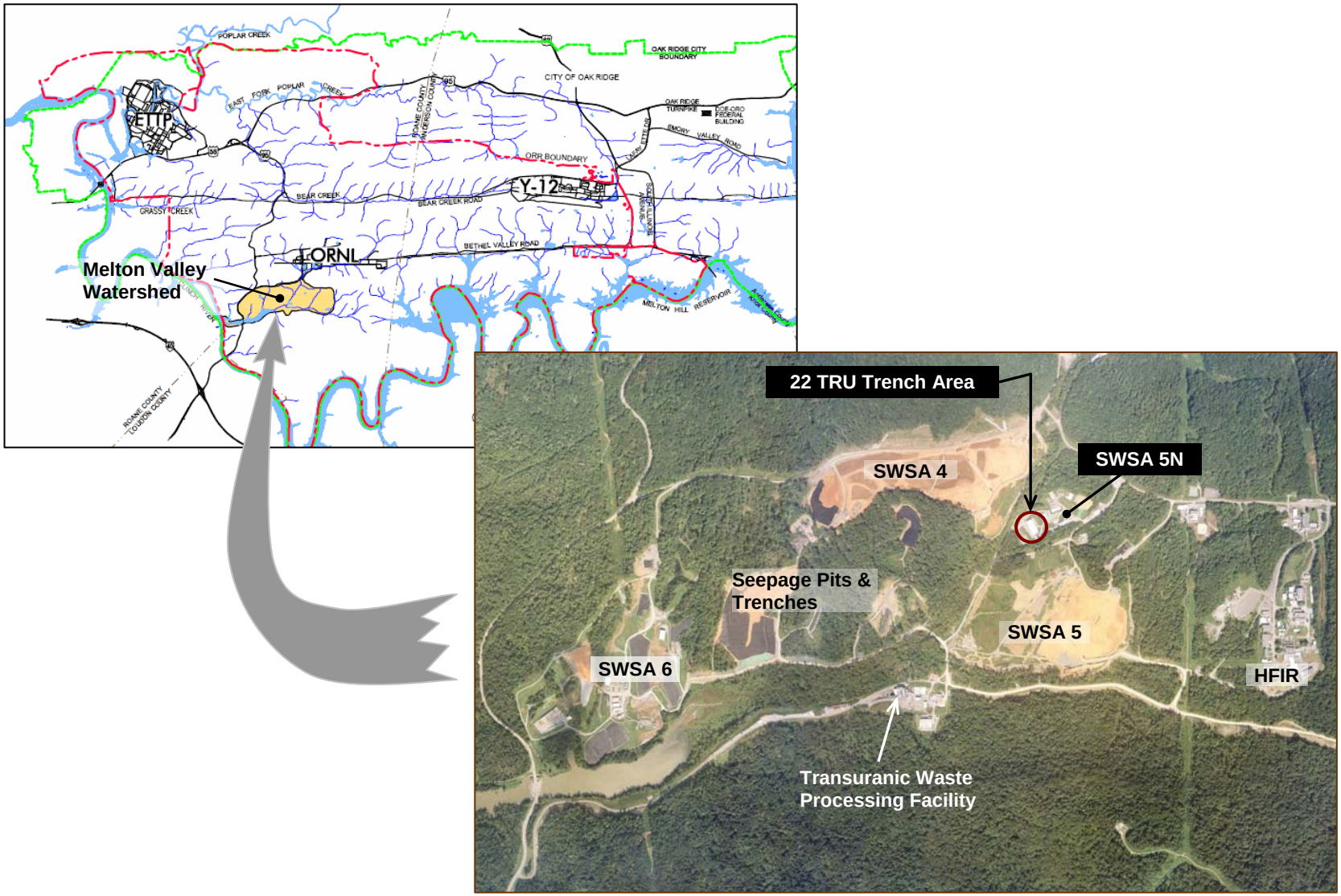

Fig.1. Location of Melton Valley Watershed and 22 TRU Trench Area in SWSA 5 North at ORNL

The primary function of ORNL over most of its existence has been to carry out research, development, and demonstration of civilian and defense uses of atomic energy and radioactive materials. ORNL also was a major center for production and distribution of radioisotopes. These research and development activities have generated radioactive wastes. Shallow land burial was used routinely for disposal of solid low-level radioactive waste (LLW) between 1943, when operations at ORNL began, and 1986, when improved disposal technology was implemented. The principal waste burial sites at ORNL were SWSAs 4, 5, and 6. Burial procedures typically involved the use of unlined trenches and auger holes covered by either soil from the trench excavation or by a combination of concrete caps and soil.

In 1970, AEC, a predecessor agency to DOE, established a TRU waste classification that required solid waste to be segregated and stored pending final determination of long-term disposal. TRU wastes are currently defined as those containing alpha-emitting transuranic radionuclides (i.e., radionuclides with atomic numbers greater than 92) with half-lives greater than 20 years and concentrations greater than 100 nCi/g. Remote-handled (RH) TRU waste is waste with dose rates at the surface of its container greater than 200 mrem/h. SWSA 5 North, located in the Melton Valley Watershed area at ORNL, was designated in 1970 as the ORNL RH-TRU storage area to abide by the AEC mandate.

The trenches in SWSA 5 North were excavated between March 1972 and April 1981. Beginning in 1972, RH-TRU wastes were retrievably stored, through placement and burial in a series of 22 earthen trenches located in the southeastern part of SWSA 5 North (i.e., 22-trench area). These wastes were later stored in engineered facilities (primarily Bldg. 7855, a concrete-walled bunker) constructed nearby. The 22-trench area includes trenches 1-7, 9, 10, 12, 13, 15, and 18-27, where wastes were emplaced during 1972–1981. RH-TRU wastes stored in the 22 trenches reportedly included 204 large concrete casks, 18 steel and/or wooden boxes, 12 steel drums, and approximately 15 m^3 of miscellaneous loose waste. Figure 1 shows site conditions prior to the start of the waste retrieval project. Most of the containers came from the ORNL Radiochemical Engineering Development Center (REDC), but solid radioactive wastes from seven other facilities were also stored in trenches in SWSA 5 North.

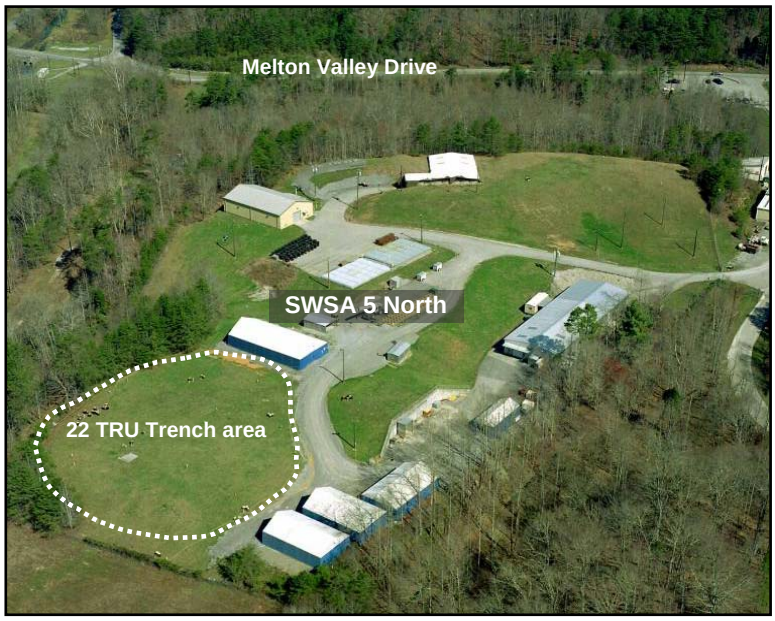

Fig.1 Site Conditions at 22-Trench Area Prior to Retrieval of TRU Waste

When originally constructed, the trenches in the 22-trench area were typically 3 -5 m deep, 2-3.5 m wide, of variable length, and intended primarily for the interim storage of concrete casks. The casks were typically tightly packed within the trenches (i.e., there was little spacing between adjacent casks) and excavated soil from construction of the trench was used as backfill. The tops of the waste containers were typically between 1 and 4.5 m below ground level. The approximate locations of the waste containers in each trench were recorded during waste management operations.

MOBILIZATION AND EQUIPMENT

Mobilization entailed the erection of a movable, temporary structure that was used as a weather enclosure for trench excavation activities and to prevent the spread of contamination. The weather enclosure was supplied with a ventilation system, which provided sufficient air flow and an adequate number of air changes to maintain the levels of carbon monoxide and carbon dioxide produced by equipment operation below Occupational Safety and Health Administration limits.

A drainage/leachate removal system was installed under the weather enclosure. This system was designed to drain any water encountered during excavation to a collection tank where water could be sampled and either pumped to the outfall, allowed to evaporate, or pumped to a tanker for transport to an appropriate treatment facility.

A Caterpillar 963 track loader, a Grove 530 all-terrain crane, and a John Deere 160C trackhoe were used inside the weather enclosure to excavate soil, move casks, and excavate loose waste. The track loader was used for transporting containers and moving soils. The track loader was outfitted with either a bucket or extended forks, depending on the task being performed. The loader accommodated a bucket of up to 2.4 m^3 and/or a side-dumping bucket to allow placing loose debris into smaller containers. The trackhoe was outfitted with a bucket arm and a front bucket that were used for removing soil around the waste containers and excavation and loading of loose waste or degraded waste containers into overpacks. A Grove RT9100 mobile crane was located outside the enclosure and used to handle the casks during overpacking. Equipment selection was based on the need to maintain rigorous control of the operations required to remove the soil, expose the casks, and then handle the casks during retrieval and overpacking.

Outside the weather enclosure, a Volvo L150C wheel loader with articulated steering was used to move soils and handle overpack containers. This loader also served as a backup for the track loader. Other mobile equipment included a forklift, manlift, roll-off truck for transporting containers, a flat bed truck for moving overpacks and waste containers, a dump truck for moving excavated soil, and tanker trucks for transporting fuel and contaminated water if necessary.

WASTE RETRIEVAL OPERATIONS

All excavation of waste containers was performed within the confines of the weather enclosure. The excavation began by removing the undisturbed soil between the trenches (or immediately in front of Trench 1). Historical records indicated there was approximately 1.5 m of undisturbed soil between trenches. This soil was removed using the track loader or backhoe and loaded into either a roll-off container positioned at an exit point from the enclosure or a dump truck. As the roll-off container or truck was filled, the soil was moved to another location on the site and either stored in a roll-off container or dumped onto an open soil pile.

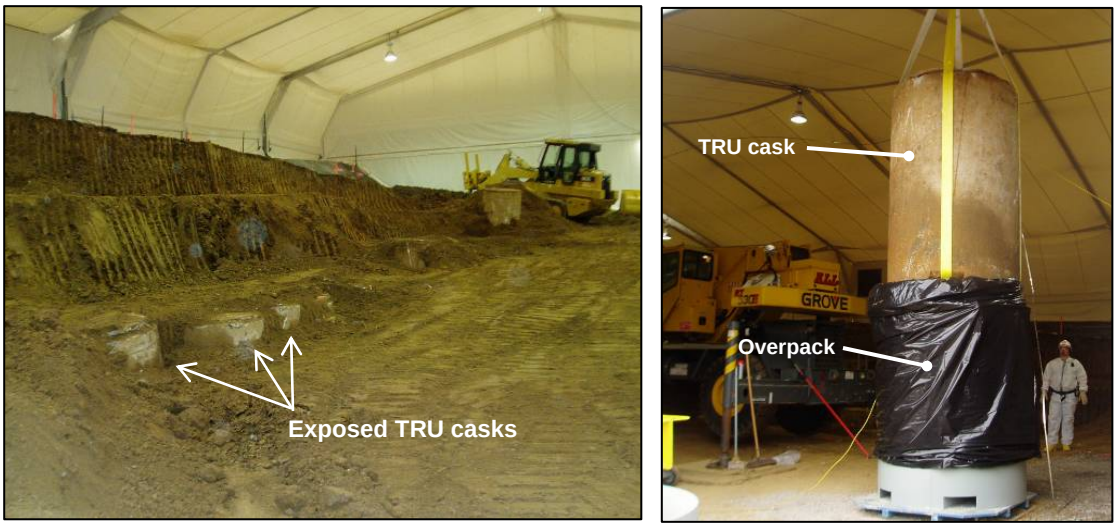

Fig. 3. Excavation showing exposed TRU casks (*left*) and the transfer of casks to overpack (*right*

When the excess soil had been removed, a backhoe was used to remove the soil immediately around the waste cask. While the tops of the casks in a trench were initially exposed to verify the number and locations of casks present against the historical records, no more than two to three casks were typically fully unearthed at a time. Once a cask had been exposed and was ready to be removed from the trench, the Grove 530 all-terrain crane was typically used to lift the cask from the trench. The track loader was available and could be used to remove the container from the trench area as needed, depending on the cask location within the enclosure.

After each waste cask was removed from the trench, any adhered soil that would interfere with loading the cask into the overpacks was removed. Unique numbers or other markings found on the outside of the cask were recorded, and digital pictures were taken of each cask.

The cask was then transported to the loading area in the weather enclosure. At the loading area, the cask was positioned into a lifting sling. The cask was then lifted and placed into the overpack lined with a plastic bag. The lifting sling was considered sacrificial and left in place around the cask which was wrapped in the bag. The gasket and lid were then bolted onto the overpack. Once the lid was secured, the overpack was verified to be free of external contamination. The overpack was then transported from the weather enclosure to the storage area using the wheel loader.

In contrast to the concrete casks, the metal drums and wooden boxes buried at SWSA 5 North typically were in poor condition, having been corroded or decomposed because of high soil moisture content (resulting from infiltration of precipitation through the soil covering the wastes). As the drums or boxes were uncovered, a visual inspection was performed on each container to assess its integrity. Drums, boxes, and loose waste were retrieved and placed into either a B-25 or B-88 metal box. As with the cask overpacks, the waste overpack containers were surveyed to document radiation dose rates and verify that the exterior of the overpack was free of contamination. Once confirmed to be free of contamination, the overpack container was transported from the weather enclosure to the storage location.

Excavation and retrieval operations began at Trench 1 and continued trench-by-trench until all 22 trenches, with the exception of Trench 13, had been excavated and the waste casks retrieved and overpacked. Completion reports providing a summary of the field operations for each trench and

an inventory of the waste retrieved from each trench were prepared and included with the project documentation. As these reports and inventories indicate, the waste found and retrieved matched quite well with the waste reported to have been buried in the 22-trench area based on historical records. A total of 204 casks were indicated by historical records to have been buried in the 22-trench area, and 204 casks were found and overpacked during the retrieval operations. Some minor discrepancies between the historical records and the waste containers actually discovered are noted in the completion reports. For example, casks were occasionally found in an adjacent trench that was apparently open to receive waste at the same time the cask was buried rather than in the trench indicated on the historical records.

The historical records also indicated that some 18 steel or wood boxes, 12 steel drums, and approximately 15 m^3 of loose waste were buried in the trenches. These packages had mostly deteriorated due to their prolonged period of burial, but the contents of approximately 12 boxes, 3 drums, and approximately the expected 15 m^3 quantity of loose waste was retrieved and overpacked. Most of the discrepancy is accounted for by the nine drums that were left in place in Trench 13 and several containers that were not found in Trench 27. In addition, one box that some records indicated was buried in Trench 1, and one drum that records indicated was buried in Trench 3, were not found.

Historical records for the disposal of drums, boxes and similar types of containers are not as definitive as the records for concrete casks. It is thought that some of the records represent duplicates for the same container, and so some containers were not actually buried in SWSA 5N as indicated. Extensive excavation until undisturbed native soil was encountered in the area around each trench demonstrated convincingly that all waste buried in the 22-trench area has been retrieved (except the material left in Trench 13 discussed below).

STAGING OF RETRIEVED WASTE

As noted previously, the primary purpose of the TRU Waste Retrieval Project was to retrieve the waste inventory stored in the 22-trench area in accordance with the Dispute Resolution Agreement between DOE and the state of Tennessee. The retrieved casks, drums/boxes, and loose waste were packaged in steel overpacks in accordance with a specially-developed technical specification. The overpacked waste was staged on-site at ORNL, pending future processing through DOE's TRU Waste Processing Facility. The radiological inventory for individual waste containers stored in the 22 trenches is maintained in the Waste Information and Tracking System (WITS) using a unique identification number, known as an Accountability Transfer Number (ATN), that had been assigned to each cask, drum, box, or shipment of loose waste.

The inventory of waste containers, identified by ATN, was reviewed prior to the start of trench excavation. As each trench was excavated, as much information as was available about the waste containers being retrieved was documented on a "Cask Traveler Documentation" form (informally known as a traveler) in accordance with project procedures. The containers were overpacked, with each overpack assigned a unique container ID number in accordance with BJC waste management procedures. The overpack container ID number was included on the traveler. BJC reviewed the information on the completed traveler form against historical records and attached the correct ATN from the container inventory in SWSA 5 North to each retrieved/overpacked waste container.

RADIOLOGICAL INVENTORY MANAGEMENT

Since the waste being retrieved from the trenches was already included in the WITS inventory, preparation of a UCN-2109 form to enter the waste into the BJC tracking system was not required. The original waste containers were typically documented on UCN-2822 forms (i.e., the predecessor to current form UCN-2109) when placed into storage. The UCN-2822 forms were compiled where available and used to support attachment of the correct ATN to each retrieved and overpacked container. Once the ATNs were attached, BJC completed a data package for each overpack.

The data package typically included the completed traveler forms described above, overpack fabrication certifications, unique overpack container ID number, historical ATN, copy of the UCN-2822 form, and any associated waste container documentation. The data package also included current radiological inventory information for each container based on the TRU Waste Retrieval Project nuclear safety basis inventory and a change log if this radiological inventory differed from that carried in WITS or DOE's Facility Acceptance Testing-Container Analysis Tool.

As data packages were completed, they were periodically submitted to the BJC Waste Operations organization to allow WITS to be updated with the overpack storage location, to revise container radiological inventory where required, and to associate the existing ATN with the corresponding overpack container ID number for reference and future tracking. The data packages will be maintained in the BJC document management center in accordance with existing procedures until each overpack is transferred to the TRU Waste Processing Facility for repackaging and final disposal (outside the scope of this report).

SOIL MANAGEMENT AND DEMOBILIZATION

The majority of the soil removed during excavation of the waste containers remains in the SWSA 5 North area. Clean soil, as verified by radiological screening, removed from the site was staged on open ground to the west of the 22-trench area. Sediment controls were installed for all soil storage locations. Approximately 3,825 m^3 of soil were staged in these areas during the excavation. This soil was contoured and reseeded at the completion of the project.

The objective of soil management during TRU waste excavation was to minimize potential exposures to site workers and releases to the environment from the handling and staging of soil containing radioactive material. This was accomplished through the establishment of two field control limits defined and approved by BJC's Radiological Control organization. The control limits were based on soil contamination levels that, if dispersed (e.g., through dust emissions), could result in an airborne exposure risk to the site worker. These control limits were based solely on anticipated airborne exposure level to site workers and do not correlate to ROD cleanup goals. Verification that soil contamination levels in the 22-trench area met ROD cleanup goals was performed by under a separate project as part of the Melton Valley remedial action.

The Lower Control Limit was defined as soil contamination levels that warranted some type of mitigation measure such as covering or misting to prevent the generation of dust when workers were actively working with or adjacent to the soil. Soils exceeding the Upper Control Limit had to be containerized to prevent exposure to site workers. Soils exceeding the Upper Control Limit could not be used to backfill the excavation or be placed onto the adjacent spoils area. These soils were transported to the Oak Ridge Environmental Management Waste Management Facility for disposal.

The project was implemented in a manner that maintained worker radiation exposures as low as reasonably achievable (ALARA). After removal of the waste from a trench, a layer of clean soil and gravel was placed over the excavated area. Some site grading and erosion control actions were conducted during excavation of the trenches. The site was restored by backfilling with excavated soil and gravel and recontouring to obtain a suitable slope for drainage and erosion control. The enclosure used during retrieval operations was left in place for future use by others.

TRENCH 13

Trench 13 was constructed (excavated) on June 22, 1976, and received waste containers on June 23, 1976. The original 2822 forms report the contents of this waste as follows:

- One carbon steel drum, containing 14,255 g of natural uranium and 7,368 g of depleted (0.66%) uranium. The 2822 form reported the contents as converted and passivated resin scrap; the materials were loaded into quart Mason jars, which were packed in vermiculite in the drum. It is believed that the uranium, resulting from coated nuclear fuel development activities in ORNL Building 4508, is in the form of uranium carbide particles, which is pyrophoric.

- One 114-liter (30-gal) and seven 208-liter (55-gal) stainless steel drums, containing 12 g of plutonium, 23.2 g of U-233, and 65.2 g of 93% enriched U-235. The contents were reported as Pu, U-235, and U-233 waste and highly contaminated equipment. A note on the 2822 form says, “This material, in some cases pyrophoric, cannot be separated.” These materials also came from ORNL Building 4508.

Excavation for Trench 13 waste retrieval was initiated on July 26, 2005. Information on the resin material expected to be encountered in the trench was reviewed, and adequate precautions and awareness were in place for handling the potentially pyrophoric material. On August 3, 2005, workers retrieved and overpacked two damaged drums in a lined B-25 box. Additional waste was exposed, including four glass jars containing “greenish black jelly like substance believed to be carbonized resin.” One additional broken jar was observed in the trench with spilled contents. On August 4, two 208-liter (55-gal) drums were retrieved and overpacked into drum overpacks. Five of the glass jars discovered the previous day were retrieved, placed in individual plastic bags, and overpacked into the B-25 box along with some soil.

A reaction occurred in the trench and excavator bucket on August 8 while retrieving additional loose waste, consisting of glass jars along with spilled material. A flame, approximately 1.5 to 3 m high, formed and lasted approximately 5 seconds. Workers immediately evacuated to the boundary control station. Before evacuating, the equipment operator emptied the bucket into the trench and swung the bucket away from the trench so as not to involve the hydraulic hoses. The site superintendent notified the ORNL Laboratory Shift Superintendent, and ORNL emergency personnel responded. It was determined that no emergency situation existed, and no personnel contamination or release or spread of contamination was detected at that time or during subsequent surveys. Field work was suspended until information could be collected, the event could be critiqued, and work procedures and safety basis documents could be reviewed and revised as necessary to ensure that future field activities continued to be conducted safely.

The Melton Valley Core Team (DOE, EPA and TDEC) concurred with a DOE proposal in October 2005 to stabilize the Trench 13 material in place with an approximate 1-m thick cover of dry sand and petroleum coke while alternatives were evaluated and retrieval of the waste in the

remaining trenches proceeded. The four overpacked drums and the box of loose material recovered from the trench were placed back in the Trench 13 area and stabilized as well. Trench 13 interim stabilization was completed by October 21, 2005.

The Dispute Resolution Agreement completion date was revised to allow this material to remain stabilized in place as interim storage until a disposition path is established for this pyrophoric material. The final disposition of the Trench 13 pyrophoric material will be addressed prior to the established BJC contract termination date, which is currently September 30, 2009

Fig. 4. Photo showing stabilized Trench 13 and the weather enclosure

SUMMARY AND CONCLUSIONS

The objective of the MVTRU Waste Retrieval Project was to satisfy conditions of the Dispute Resolution Agreement. This remedial action consisted of removal of all buried waste containers and loose items from the 22-trench area. The TRU waste casks were placed in steel overpacks, while other waste boxes, drums, and loose items were placed in steel drums or boxes. The overpacked waste was placed in an approved staging area until it can be accepted for treatment at the ORNL TRU Waste Processing Facility and ultimately disposed.

A total of 204 casks were indicated by historical records to have been buried in the 22-Trench area, and 204 casks were found and overpacked during the retrieval operations. The historical records also indicated that some 18 steel or wood boxes, 12 steel drums, and approximately 15 m^3 of loose waste were buried in the trenches. The contents of approximately 12 boxes, 3 drums, and approximately the expected 15 m^3 quantity of loose waste were retrieved and overpacked.

One significant deviation from the actions described in the Dispute Resolution Agreement occurred during the excavation of Trench 13. Pyrophoric material was encountered and a reaction occurred, causing a brief flame in the excavator bucket. No personnel contamination or radioactive material release occurred. The waste buried in Trench 13, consisting of approximately eight 208-liter (55-gal) drums and one 114-liter (30-gal) drum, was stabilized in-place due to risks associated with the retrieval and handling of this pyrophoric material. The Dispute

Resolution Agreement completion date was revised to allow this material to remain stabilized in-place as interim storage until a disposition path is established.

The baseline schedule called for site mobilization and preparation to begin in November 2003, soil excavation and waste retrieval to be completed by March 2006, and site restoration and demobilization to be complete by April 2006, with the draft letter of completion submitted in May 2006. Soil excavation and waste retrieval were completed in March 2006 as planned, and no significant deviations to the baseline schedule were encountered.