

**Retrieving Suspect Transuranic Waste from the Hanford Burial Grounds
–Progress, Plans and Challenges**

M. S. French
U.S. Department of Energy, Richland Operations Office
825 Jadwin Avenue, Richland, WA 99352

D. E. McKenney
Fluor Hanford
P.O. Box 1000, Richland, WA 99352

R. D. Greenwell
Fluor Hanford
P.O. Box 1000, Richland, WA 99354

ABSTRACT

This paper describes the scope and status of the program for retrieval of suspect transuranic (TRU) waste stored in the Hanford Site low-level burial grounds. Beginning in 1970 and continuing until the late 1980's, waste suspected of containing significant quantities of transuranic isotopes was placed in "retrievable" storage in designated modules in the Hanford burial grounds, with the intent that the waste would be retrieved when a national repository for disposal of such waste became operational. Approximately 15,000 cubic meters of waste, suspected of being TRU, was placed in storage modules in four burial grounds. With the availability of the national repository (the Waste Isolation Pilot Plant), retrieval of the suspect TRU waste is now underway. Retrieval efforts, to date, have been conducted in storage modules that contain waste, which is in general, contact-handled, relatively new (1980's and later), is stacked in neat, engineered configurations, and has a relatively good record of waste characteristics. Even with these optimum conditions, retrieval personnel have had to deal with a large number of structurally degraded containers, radioactive contamination issues, and industrial hazards (including organic vapors). Future retrieval efforts in older, less engineered modules are expected to present additional hazards and difficult challenges.

INTRODUCTION

At Hanford, beginning in 1970, waste suspected of containing significant quantities of TRU isotopes was segregated from other wastes and stored in low-level burial grounds on the Site. This suspect TRU waste was placed in the burial grounds with the intent that it would be retrieved and sent to a national repository when the repository was developed and became operational.

Suspect TRU waste continued, until the late 1980's, to be placed in the burial grounds for storage when the preferred storage location was changed to warehouses located in Hanford's Central

Waste Complex. A total of ~15,000 cubic meters of suspect TRU waste was accumulated prior to that time, in the burial grounds, direct buried in trenches, neatly stacked in engineered modules in trenches, or in underground vaults (caissons).

When the national repository for TRU waste opened, the Waste Isolation Pilot Plant (WIPP), Department of Energy sites could begin retrieving, certifying and shipping wastes for disposition. The TRU waste-retrieval project at Hanford was funded at relatively low levels for a number of years, due to competing higher priority projects at the Site. Though the retrieval project developed slowly during these early years, a series of pilot digs and studies were conducted that became the basis for the current program.

In 2002, priorities and funding at Hanford supported developing and implementing a production-oriented Waste Retrieval Project. After the basis for the Project was established (e.g., staffing, procedures, safety analysis, and regulatory approvals) suspect TRU waste began to be retrieved in earnest in late 2003. Waste retrieval operations quickly ramped up as worker proficiency developed, and as of August 2005, more than 3,300 cubic meters of waste has been removed from storage trenches.

RETRIEVAL PRIORITIES AND REGULATORY DRIVERS

A series of milestones for the Waste Retrieval Project have been developed as part of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement).[1] Key elements of the milestones include the following:

- Definition of the required order of retrieval of contact-handled, retrievably stored waste (CH-RSW) from the four burial grounds (218-W-4C, 218-E-12B, 218-W-3A, and 218-W-4B);
- Definition of the annual rate of CH-RSW retrieval, increasing from 1,200 cubic meters annually to a peak 2,800 cubic meters per year, leading to completion of all CH-RSW retrieval by December 31, 2010;
- Sampling and analysis requirements as CH-RSW retrieval progresses;
- Treatment requirements and schedules for regulated CH-RSW; and
- A similar set of requirements, as those described above, for remote-handled RSW (RH-RSW).

To date, the Project has been very successful in meeting all applicable milestones. The first two milestones for rate of CH-RSW retrieval, 1,200 cubic meters by December 31, 2004 and 2,700 cubic meters cumulative by December 31, 2005, were each completed five months ahead of schedule. The next major milestone is to complete a cumulative volume of 4,700 cubic meters of CH-RSW retrieval by December 31, 2006.

RETRIEVAL PROCESS DESCRIPTION

The first step in retrieval of suspect TRU waste is a review of the existing information on record. The detail of information in the waste records varies, but in general the older the records, the less detailed the information. Review of the waste records can provide information on: container identification numbers and location in the storage module; physical waste form and container weight; radionuclide and chemical content; and details on the source of the waste (facility and process details). This information is reviewed and serves as a basis for work planning (long term and day-to-day), radiological and industrial health monitoring, criticality prevention program reviews and control sets, and provides information which is used as input to eventual designation of the waste (TRU versus non-TRU; regulated versus unregulated, etcetera).

The majority of the containers stored in the burial grounds have soil overburden which must be removed to access the containers, and many of the containers are actually below grade. Excavation of the modules is accomplished using heavy equipment, and great care is taken to avoid damage to the container arrays. The majority of the soil removal is accomplished with this heavy equipment, under careful supervision and accomplished with great skill by the heavy equipment operators. Hand digging is used to supplement the machine digging and for removal of the final remnants of soil from the container arrays. Figure 1 shows a partially excavated trench and “working face” in a TRU storage module.



Fig. 1. TRU storage module, burial ground 218-W-4C.

Once the containers are exposed, work plans are developed based on the record review information. The containers to be retrieved are inspected in place. The inspection targets a number of drum characteristics that will influence how the container is handled during retrieval, and also influences what will happen to the drum after it is retrieved. The inspection includes the following activities:

- Dose and radioactive contamination surveys.
- Industrial health monitoring (organic vapor surveys, etcetera)
- Structural integrity inspection. The structural integrity inspection looks for signs of structural failure (holes, cracks) and assesses the general state of corrosion of the container. (See Figure 2.)
- Container vent status (is the container vented?).
- Any other special conditions are noted (e.g., bulging, which could indicate pressurization).

After the container has been inspected, it can be physically retrieved. Some special conditions noted during the inspection can be addressed during the retrieval operations. If contamination or hazardous materials are an issue, accommodations can be made for dealing with the issue, including increased worker personal protective equipment and clothing, respiratory protection, work zoning and workspace monitoring. If container integrity is an issue, a number of alternatives to address the specifics of the issue are available, varying from taping and patching the degraded container to overpacking the degraded container into a larger new container. Some special conditions, such as an unvented container, can be addressed after the container is removed from the storage module.



Fig. 2. Severely corroded drum, requires overpacking

Retrieval operations are currently being conducted “open air” without the use of containment structures, based on a continuing assessment of container and worksite conditions. Favorable radiological and hazardous chemical conditions in the worksite have supported this approach to date, with the only major impact of open air retrieval being the impact of weather conditions on the ability to perform work (rain, wind, and etcetera). It is recognized that as older burial grounds are retrieved (with less adequately containerized waste) or radiological conditions at present retrieval sites degrade, containment enclosures similar to those employed at other Department of Energy sites will be used.

Once retrieved, containers are then moved to a process area located near the retrieval trench. This process area is shown in Figure 3. In this process area a variety of operations are performed to address container issues, to categorize the waste as TRU or non-TRU, and to prepare the waste for shipment to other Site treatment, storage or disposal facilities.

The process area is located adjacent to the storage modules in which retrieval operations are currently being conducted, and is actually located within the confines of the 218-W-4C burial ground. This decreases the degree of difficulty associated with container movement, as would be encountered if the waste had to be moved on Site roadways. The process area is sufficiently large to allow container segregation, storage, and movement consistent with documented safety analysis and operations requirements.



Fig. 3. Retrieval process area, indicating process operations and staging areas.

A mobile drum venting system is located in the process area for those drums which require venting. This system is configured to allow remote placement of specialized filters into drums. Venting involves a “cold drilling” process, in which WIPP-compatible NucFil® filters are installed in the drum lids. Vented drums can then be stored in the area to allow diffusion of contained gases through the filters.

A drum assay system, using gamma energy analysis, is also located in the process area. Much of the waste in the storage modules was placed there as “suspect TRU wastes”, a conservative categorization not based on a measured value, but instead based on generator process knowledge. Assaying the waste at the point of retrieval can allow the non-TRU fraction to be segregated for treatment/disposal and thus avoid sending it further through the expensive TRU waste certification process. Drums which are listed on the waste record information as having a plutonium inventory of ≥ 1 gram are assumed to be TRU and are not routed through assay (this has proven to be an effective method of screening). All drums that show inventories of < 1 gram are assayed. To date, ~50% of the retrieved waste has proven to be non-TRU.

Once drums have completed all preparation and designation steps in the process area, they are moved to the Central Waste Complex for indoor storage, the WRAP Facility for processing or certification, T Plant for processing or repackaging, and, if they are non-TRU, to commercial treatment and onsite disposal cells. Movement from the process area to other onsite treatment, storage or disposal facilities is accomplished in accordance with the requirements of the Hanford Sitewide Transportation Safety Document.[2] Drums and boxes can be transported directly if the container integrity is sufficient and safety analysis supports direct transport, or special packaging such as “industrial packaging systems” can be used should the safety analysis require them.

Boxes are also being retrieved from the storage modules. These boxes are varied in shape, size and weight, and are constructed of different materials (metal or fiberglass reinforced polyester plywood). These boxes are stored in the process area. Assay of the boxes is accomplished using a Pacific Northwest National Laboratory assay service, using a “slab counter” located in a nearby empty trench to reduce background count. Once assayed and designated, the boxes can be moved to the Central Waste Complex for indoor storage.

FOCUS ON RETRIEVAL HAZARDS

Waste container fires that have occurred recently across the U.S. Department of Energy complex underscore some of the distinctive hazards associated with transuranic waste retrieval projects. These projects regularly involve the recovery and processing of drums that may contain pyrophoric materials or flammable headspace gases. Retrieved drums are frequently heavily corroded, breached, or otherwise damaged as a result of long-term underground storage. Likewise, industrial safety concerns as well as the potential for chemical or radioactive material exposures are hazards that must be addressed by each project’s integrated safety management approach.

An extensive evaluation of hazards was completed for Hanford’s suspect-transuranic waste retrieval project prior to project start and documented in the Solid Waste Operations Complex

Master Documented Safety Analysis (MDSA).[3] The foundation of the MDSA is a detailed assessment of the waste streams to be retrieved. Hanford’s retrievably-stored waste predominately consists of miscellaneous debris, e.g., plastics, metals, fabrics, wood, soil, etcetera, containing <1 gram of plutonium. These waste streams known as “room waste” or “glovebox wastes” contain no pyrophoric materials and only low concentrations of volatile organic compounds (VOCs). A small fraction of the approximately 32,000 containers to be retrieved contain higher concentrations of transuranic wastes, flammable chemicals, or other wastes that require additional hazard controls. Nearly all drummed waste is contained in inner single or double-layered plastic bags, and drums with higher concentrations of transuranic wastes typically contain robust pipe over pack inner-container systems. The selection of engineered, administrative and Safety Management Program controls documented in the project’s Technical Safety Requirements (TSRs) [4] is tailored to the specific waste stream hazards. Examples of project hazards and controls are summarized in Table I.

Table I. Summary of Hazards and Controls Applied to Hanford’s Transuranic Waste Retrieval Project

Hazards	Controls
Hydrogen/Flammable gas Deflagration/Explosion/Fire of Container	<ul style="list-style-type: none"> • Venting Waste Containers TSR/Administrative Control (AC) • Over-packing of drums if higher source strength, bulged, heavily corroded, or breached • Remote venting operations-minimize handling • Hydrogen sampling and diffusion to safe levels before further drum movement • Safety significant venting equipment • Hoisting & Rigging TSR-AC • Container Management TSR-AC • Transportation Safety Document TSR-AC • Source Strength Control TSR-AC • Safety Management Programs ^a • Retrieval of waste preceded by review of records for hazards • IH monitoring during retrieval operations; same controls as hydrogen applied if other elevated flammable gases suspected • Verification of flammable gas levels through WIPP certification head space gas sampling
Fire//Explosion from Other Sources: <ul style="list-style-type: none"> • Vehicle Impacts and Fuel Spills • Incompatible Waste • Propane Tank BLEVE • Range Fire • Aircraft Crash 	<ul style="list-style-type: none"> • Truck & Equipment Refueling TSR-AC • Fire Protection Program TSR-AC • Vehicle Access TSR-AC • Hoisting & Rigging TSR-AC • Container Management TSR-AC • Transportation Safety Document TSR-AC • Source Strength Control TSR-AC • Safety Management Programs ^a

Container Breach/Loss of Contents	<ul style="list-style-type: none"> • Fire Protection Program TSR-AC • Vehicle Access TSR-AC • Hoisting & Rigging TSR-AC • Container Management TSR-AC • Transportation Safety Document TSR-AC • Source Strength Control TSR-AC • Safety Management Programs ^a
Nuclear/Criticality	<ul style="list-style-type: none"> • Container Management TSR-AC • Transportation Safety Document TSR-AC • Source Strength Limits • Safety Management Programs ^a
Natural Phenomena: <ul style="list-style-type: none"> • Earthquake -- bounds: <ul style="list-style-type: none"> • High Winds/Tornado • Volcanic Ash Fall/Heavy Snow Fall • Flooding 	<ul style="list-style-type: none"> • Source strength limits • Container management program • Safety Management Programs ^a
Industrial	<ul style="list-style-type: none"> • Safety Management Programs ^a • Worker PPE including hard hats, high visibility vests, etcetera
Chemical/Radioactive Material Exposures	<ul style="list-style-type: none"> • Source strength limits TSR-AC • Container management program TSR-AC • Safety Management Programs ^a • Dig-face and retrieval face full-time chemical and radiological monitoring • Worker PPE including contamination protection clothing and respirators used on a graded-approach
Radioactive/Toxic Air Emissions	<ul style="list-style-type: none"> • Venting Waste Containers TSR-AC • Safety significant venting equipment • Safety Management Programs ^a • Drum venting controls/limits • Radiological limits • Retrieval quantity limits
Transportation	<ul style="list-style-type: none"> • Transportation Safety Document TSR-AC • Safety Management Programs ^a

^a Safety Management Programs include: 1) Prevention of Inadvertent Criticality, 2) Radiation Protection, 3) Hazardous Material Protection, 4) Radioactive and Hazardous Waste Management, 4) Initial testing, In-Service Surveillance, and Maintenance, 5) Operational Safety, 6) Procedures and Training, 7) Human Factors, 8) Quality Assurance, 9) Emergency Preparedness Program, 10) Provisions for Decontamination and Decommissioning, 11) Management, Organization, and Institutional Safety Provisions.

The project experience to date has demonstrated that the Safety Basis provides adequate analysis and control of the hazards. The presence of hydrogen in un-vented retrieved drums was evaluated in the accident analysis as an anticipated event, consequences were considered, and

controls implemented. Low levels (less than the LFL) of other flammable gases were also anticipated and deflagration pressures from the worst case gas mixtures were shown to be no greater than the hydrogen gas deflagration analyzed in the MDSA. Of the 4,250 vented to date, only 3% required staging to allow hydrogen diffusion to lower levels prior to handling. These drums are retained in a protected zone and allowed to diffuse through the installed drum filter to safe levels before further drum movement is allowed. Head space gas sampling of retrieved transuranic waste drums is later performed as part of the WIPP certification process. This sampling has verified that only low levels of flammable gases are present in retrieved drums. The highest identified concentration is 3,100 $\mu\text{L/L}$ acetone compared to the 26,000 $\mu\text{L/L}$ lower flammability limit. Most VOCs measured are of lower concentration, e.g., 1000 – 2000 $\mu\text{L/L}$, and similarly well below the lower flammability limit of the chemicals measured. It should be noted that these concentrations are for a drum that has been vented for some period of time. If the time between retrieval and sampling is in excess of a week or two, the concentration within the container could be higher, however, this impact has been reviewed and it is anticipated that the resultant concentration will still be at or below the LFL for flammable gases from VOCs typically seen at these high concentrations (e.g., acetone, xylene).

Waste streams have been identified during the retrieval preparation processes that require special consideration of the hazards. An example is a group of about 1100 debris waste drums originating from Kerr-McGee's plutonium fuels production plant in Crescent, Oklahoma. The waste was apparently compacted tightly into the drums, causing increased risk of contamination during venting operations. A Justification for Continued Operations was developed to allow transportation of the drums and venting using equipment specifically designed for this waste stream. The resulting sub-project was completed on schedule without incident.

There are considerable differences in the waste streams and storage configurations of the several retrieval project sites across the DOE complex, which creates unique safety management challenges at each site. Hanford's retrieval project is continuing to evaluate available information of waste streams that will be retrieved in future years. Project personnel are also communicating with the other retrieval projects across the DOE complex to gain lessons learned from safety incidents and to identify best practices applicable to Hanford's project. Additional controls may be applied in the future to strengthen our defense-in-depth approach to the recognition and mitigation of hazards.

PROJECT SAFETY RECORD

The TRU Retrieval Project has an aggressive monitoring approach for industrial, chemical and radiological hazards potentially present in the workplace. The Project scales hazard controls up or down based on the work activities being conducted and worker input. The Project has extremely good safety statistics measured since full scale retrieval operations commenced in December 2003 (over 450,000 work hours):

- Zero injuries classified as OSHA recordable;
- Zero injuries resulting in days away from work;
- Zero injuries resulting in restricted work days;

- 27 first aid injuries; and
- Zero reportable chemical or radiological exposures/uptakes.

This safety performance is even more amazing given the character of the work being performed, as it involves heavy equipment operation, excavation, forklift and crane operations, degraded containers, radiological and chemical hazards, and “hands on” drum movement and handling. Drum movement and handling traditionally has a high potential for pinches, strains and sprains. The fact that these operations are performed outdoors adds additional risks, such as adverse environmental conditions (e.g., summer heat, winter cold, and dust storms), insects’ stings and bites, and variable light conditions.

WORKER INVOLVEMENT - WORK PLANNING AND INNOVATION

Worker involvement is key to the success of the Project and is a continual source of operational strategies and innovations. The Hanford Integrated Environment, Safety and Health Management System (ISMS) utilizes worker involvement practices during work planning, hazard analysis and control selection, and during field work. Feedback is actively encouraged to continuously improve operations and to identify potential problems or changed conditions in the field.

Workers continue to develop specialized tools, procedures, and equipment to stabilize heavily corroded drums with questionable structural integrity. These “repair” methods significantly improve the safety of the retrieval operations during the critical phase when drums are removed from the storage array and placed in overpack drums. Similarly, workers are actively involved in tactical project planning including selection of retrieval locations, excavation sequencing, and assignment of work to balance production. This flexibility is needed to respond to variations in weather and as-found drum conditions. Ultimately, worker involvement builds ownership of project objectives and a true sense of accomplishment for Project successes.

CHALLENGES

Although the challenges of the retrieval Project have already been significant, challenges for the Project in the out-years will be even more substantial. Operations are currently being conducted in one of the “newer” storage areas, but will soon progress to older burial grounds where the storage containers are expected to be even more deteriorated and may contain unique wastes. Exploratory investigations into these older burials grounds have been conducted and will be oriented to assess conditions and develop data to support future work. Figure 4 shows the manner of “storage” and the condition of a drum examined as part of the exploratory investigation of a storage module in the 218-W-12B burial ground (circa 1970-1973). Unique containers and waste forms will be encountered. Examples include remote-handled wastes, large boxes, tanks or other pieces of large equipment, and in some cases, stored fuels. These challenges and other project performance risks are regularly updated in the Project Execution Plan [5], which details risk response actions.

Hanford personnel are also working with other DOE sites to share lessons learned that can help in developing plans for unique containers and other out-year retrieval efforts. Site experiences are shared via periodic teleconferences, and Hanford personnel (including representatives of the operations workforce) have visited several other sites to view their operations and share experiences.



Fig. 4. Direct buried suspect TRU drum in burial ground 218-E-12B.

CONCLUSIONS

Full scale waste retrieval operations at Hanford were initiated in December 2003. Since operations were initiated, over 3,000 cubic meters of suspect TRU waste have been retrieved from a total of 15,000 cubic meters. This retrieval operation has been a great success: applicable enforceable regulatory milestones for rate of retrieval were completed early, project performance in the area of worker protection has been excellent (as reflected in the project safety statistics), hazardous and radioactive waste in degrading containers has been removed from the environment, and DOE commitments for shipment of stored TRU wastes to a national repository have been supported by shipment of retrieved wastes to WIPP.

Although the Project has been very successful in meeting commitments to date, significant challenges face the Project over the next few years. Regulatory commitments for the annual rate of retrieval increase over the next few years, and at the same time retrieval will become much more difficult and risky as older modules of stored waste must be retrieved. Sharing experience developed at other DOE sites, worker involvement, and a continuing process of innovation (technical and regulatory) are essential to Project success.

REFERENCES

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