Process Improvements Result in Schedule and Cost Savings for Waste Shipping Campaign - 8456

J. P. Curcio, C. Dayton,
West Valley Environmental Services LLC (WVES)
10282 Rock Springs Road
West Valley, N.Y. 14171

D. Garber, Environmental Chemical Corporation (ECC)
10282 Rock Springs Road
West Valley, N.Y. 14171

G. Gorsuch, U.S. Department of Energy (DOE)
10282 Rock Springs Road
West Valley, N.Y. 14171

ABSTRACT

In 2006, the U.S. Department of Energy-led nuclear cleanup project at the West Valley Demonstration Project (WVDP) in New York State initiated a waste processing and shipping campaign to accomplish the disposal of approximately 20,000 drums of low-level radioactive cement waste at the Nevada Test Site (NTS) in the state of Nevada. Although the WVDP had considerable experience in the processing and shipment of low-level waste (LLW), the WVDP had not previously embarked upon a waste shipping of this magnitude.

Efforts in 2006 focused on the development of processes and procedures to facilitate the start-up of this project. In 2007, the shipping campaign was redirected toward more efficient waste retrieval, processing and shipment. The last drum was accepted for disposal at NTS in November 2007, nearly one year ahead of the original estimated project completion date. The efficiency of this campaign is mainly attributed to process improvements.

INTRODUCTION

The initial estimates to package and ship approximately 20,000 drums of cemented waste from Western New York State to the Nevada Test Site in Nevada were 2.5 years and $25 M. Through a series of process improvements, West Valley Environmental Services LLC (WVES), contractor to the U.S. Department of Energy at the nuclear cleanup site safely completed the work in late 2007, approximately one year ahead of schedule and for considerably less than the original cost estimate.

The U.S. Department of Energy, which leads the cleanup of the nuclear site, identified off-site disposal of the approximately 20,000 waste drums as one of its cleanup priorities in early 2006. Preparing for this shipping campaign involved the design and implementation of equipment and procedures, the verification of waste characterization data, approval of the waste stream for disposal, and the development of the equipment and processes necessary for extracting the drums from storage, packaging, and then transporting the drums for disposal at NTS.

The success of this project was enhanced by a number of process improvements that led to significant cost and schedule savings and resulted in a considerable reduction in radiological dose. This paper discusses those improvements, many of which have application potential at other facilities preparing to ship large quantities of waste.

The WVDP Drum Cell Waste and Facility Features

Between 1988 and 1995, waste processing at the WVDP included the solidification of a secondary low-level radioactive liquid removed from the site's underground waste tanks. The waste was solidified by combining it with cement and pouring it into square, 269 L (71 gal) drums. Approximately 20,000 drums of waste were produced, each weighing about 454 kg (1,000 lb).

The 105 m (345 ft) long Drum Cell was designed specifically for the storage and disposal of the cement-filled drums. The concrete and steel structure was constructed on a base of stone with a gravel floor with concrete bumpers placed on the surface to match the configuration of the drums in a horizontal position.

The facility is equipped with an overhead crane capable of traveling the entire length and width of the cell. Drums were delivered to the Drum Cell on a shielded truck, then moved inside the facility on a conveyor. The overhead crane was used to lift the drums from the conveyor and move them to a storage location in the facility.

Fig. 1. File photo of the WVDP Drum Cell at near full capacity.

Waste Stream Profile Identification and Approval

Using information contained in production data records, ten radioisotopes known to be present in the waste were identified and quantified on a per-batch basis for each of the 188 waste batches that were solidified during the 7-year production period. The analysis of those records allowed the grouping of the waste into four waste stream categories that were consistent with the general categories of the liquid waste from which the drums were generated. Although all of the 20,000 drums had similar characteristics, the ratios of radiological and hazardous constituents in the drums differed based on the origin of the waste that was solidified: Supernatant, Flush, Sludge Wash, and THOREX wash.

The concentrations of the 50 radioisotopes of concern known to be present in the waste were calculated. By identifying and applying the highest value of each of the radioisotopes in a batch, a conservative waste profile was written for each drum that ensured that no actual drum would exceed the radiological profile. It should be noted that none of the 188 batches contained the highest concentration of each radioisotope.

This strategy allowed the consolidation of the waste streams under one of two disposal categories and was readily approved by the Nevada Test Site with no comments on methodology. The waste stream characterization led to the determination that all of the waste drums disposed at NTS were classified as Class C low-level radioactive waste.

Drum Quantification and Identification

With support from the Information Technology group, a database that was compiled shortly after the first drums of cemented waste were produced was reactivated and updated to match to current computer hardware and software technology. Features were added to the database to enable automatic retrieval of the drum's record when the barcode or manual numbering system code for a specific drum was entered into the system.

The ability to access the database using multiple triggers allowed operators to retrieve drum information using a hand-held scanner capable of reading the drum's barcode from a distance (the preferred method) or to visually read and record the number painted on the drum's exterior in the event a barcode could not be scanned.

A typical record included the drum's batch of origin, weight, time and date of generation, and characteristics specific to the waste batch from which it originated. Use of the database provided the necessary waste generation data to substantiate waste stream compliance for packaging and disposal purposes.

Preparing for Drum Retrieval

As with any project, there were aspects of the Drum Cell project that required evaluation before actual drum removal could begin. Although the operational status of the Drum Cell crane was periodically verified by routine system checks as part of the WVDP's regular maintenance schedule, the age and length of time the crane had been in disuse was a consideration in assessing its long-term suitability for retrieving all of the drums.

The configuration of the Drum Cell and the lack of an adequate packaging area at the conveyor area prevented drum retrieval by simply reversing the operations performed when the drums were placed in storage. Therefore, alternative means of processing and alternate retrieval methods were investigated.

Two possible options were considered: a newly constructed packaging area surrounding the load-in conveyor area and a renovated existing crane maintenance bay at the east end of the facility between the drum storage area and the control room. While neither area provided immediate packaging capability, constructing a new packaging area surrounding the conveyor area was determined to be cost prohibitive and would have significantly impacted project schedule.

The crane maintenance bay between the drum storage cell and the facility's control room was selected as the packaging area because of the existence of overhead steel beams and the ability to install a concrete floor. New features were added to the area to accommodate packaging, including a second overhead crane capable of limited north-south and east-west travel, two drum "upenders" to orient the drums into an upright position, and two drum packaging systems.

Getting Started

The drum retrieval process began in mid-2006 using the existing crane to remove drums from storage in their horizontal positions. Each drum was lifted and carried the length of the Drum Cell and hoisted over the concrete shield wall that separates the storage area from the crane maintenance bay. Once clear of the shield wall, the drum was lowered onto the horizontally-positioned drum "upender." The upender was then activated to stand the drum upright. The overhead crane was removed from the packaging area to allow unobstructed travel of the grapple crane, which was used to lift the drum by either its side seams or fill port. The drum was then moved to the packaging area where it was processed.

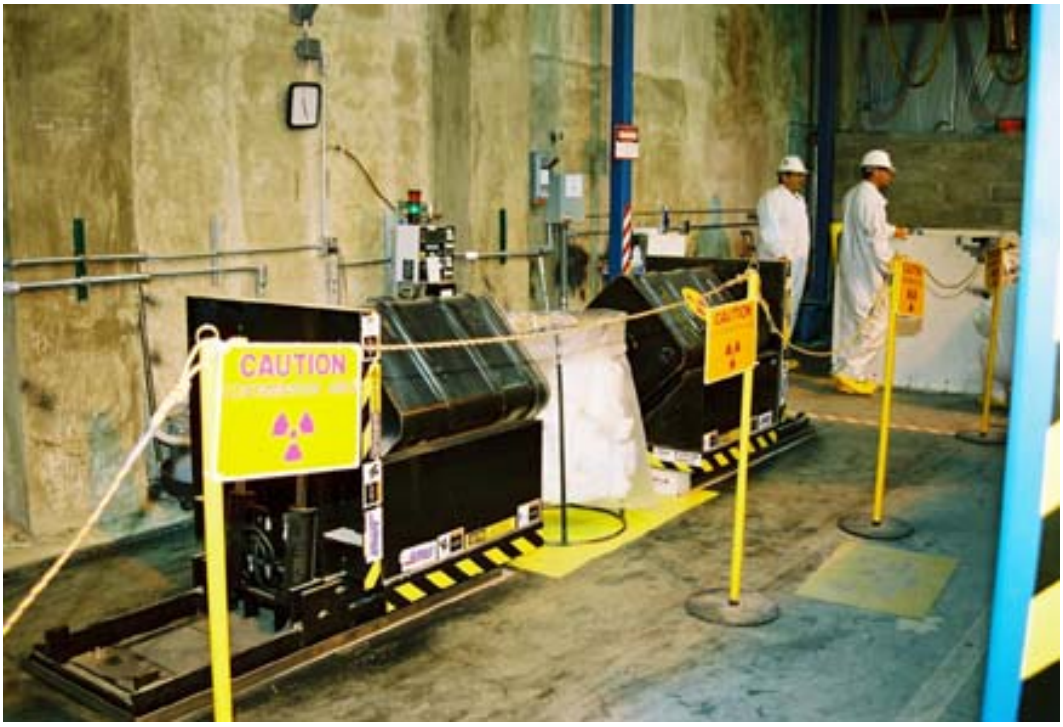

Fig. 2. Drums are loaded in “upenders” in the processing area of the Drum Cell.

The packaging method for the first drums shipped from West Valley to NTS involved placement of six drums in a “six pack” configuration on a steel pallet. Each drum was considered an individual waste package for transportation, therefore, each drum required waste certification paperwork and external decontamination to ensure the drum met U.S. Department of Transportation regulations for radioactive and hazardous materials. In some cases, drums retrieved from storage required multiple evolutions of decontamination to remove dust particles to meet those standards. In addition, some drums’ fill ports required the application of caulk, curing time, and subsequent re-inspection to ensure the drum had an air-tight seal capable of preventing the migration of dust particles from under the fill port cover. Since each drum was considered an individual waste package at the disposal facility, waste acceptance and disposal paperwork were compiled for each drum.

Prepared drums were placed onto a steel pallet, where the array of drums was banded together and also banded to the pallet. The entire package was then wrapped in plastic, tagged, and moved with a forklift to outdoor storage. Packaged drums were loaded onto flatbed trucks for the 3,785 km (2,350 mi) cross country transport to Nevada.

Fig. 3. Operators secure a plywood top to a pallet load of six drums in preparation for shipment.

WVDP employees packaged and shipped 1,524 drums of waste using the pallet packaging method and truck transport in 2006, however, the Drum Cell team saw opportunities for process improvements in several areas, including:

- External decontamination requirements;
- The need to prepare documentation for transport and disposal of each drum;
- Labor-intensive, time consuming packaging;
- Rates of worker exposure resulting from working in close proximity to the drums;
- Weight limitations on semi-trucks that restricted each truck load to just 36 drums; and,
- The cost of transportation by truck.

Process Improvements – Drum Packaging

In 2007, DOE identified shipping the remaining 18,500 drums off-site as a priority. Cost-efficient, labor-saving initiatives were sought to improve the packaging and transportation process.

Overpacking the drums was considered a possible means of eliminating the need for drum decontamination and reduced the number of individual waste packages that would be generated. Waste boxes were considered, but due to the cost of the boxes and their production time, alternative methods were sought. The use of IP-2 soft-sided containers, a packaging system typically used to transport non-rigid materials such as soils, was considered viable, but thus far, had not been approved for packaging waste of this type.

Based on the specific needs of this project, a triple-layer bag design was developed and certified by manufacturer MHF to meet DOT specifications for drum overpacking. Package features included a series of attached lifting straps to provide lifting capabilities.

This packaging method eliminated the steps of external decontamination, survey, inspection, and fill port caulking of the drums, as the IP-2 container served as the transportation and disposal package.

Fig. 4. Operators lower a drum into an IP-2 bag.

This method reduced by six-fold the amount of documentation required for this transportation and disposal project. This was accomplished by combining drums into packages of six and considering each six pack a disposal package. The paperwork was further standardized by weighing the first few packages of bags to establish an average weight per package and using that average weight with a plus/minus factor of ten percent for the disposal documentation paperwork.

A number of process improvements were also developed to speed the rate of drum retrieval and packaging, including the simultaneous use of dual packaging systems. Two identical drum upender units installed in the packaging area created two packaging areas which allowed non-stop processing. Due to space limitations for finalizing the packages, temporary weather shelters were added to the Drum Cell at each of the crane maintenance bay overhead doors, extending each section of the bay by approximately 3.66 m by 6.1 m (12 ft by 20 ft). The weather shelters provided space to stage empty bags, working space to survey and tag bags prior to outdoor staging, and increased safety by providing more working space for safe fork truck operation.

Construction of the weather shelters was ongoing while packaging operations were underway. Since the area was active as both a packaging and construction zone, only one shelter was built at a time, with the corresponding packaging system taken out of service during construction. Upon completion of the first shelter, packaging operations were moved to that packaging system to accommodate establishment of a construction exclusion area at the second packaging system. Both weather shelters were completed and available for use in 2007, allowing simultaneous use of the two packaging areas and weather shelters.

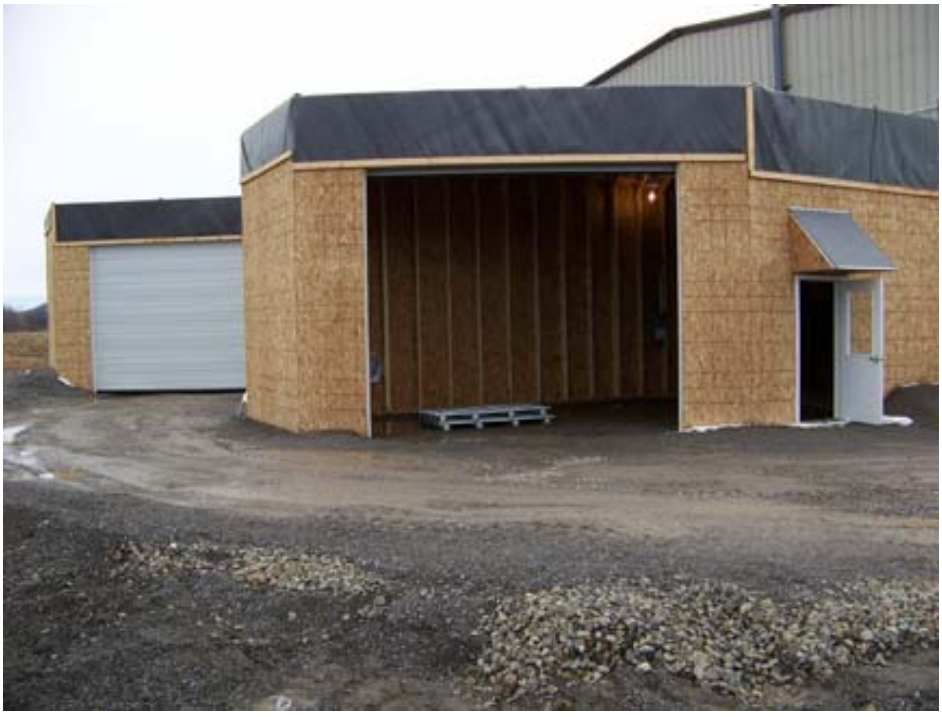

Fig. 5. The construction of two temporary weather shelters provided additional working space for package finalization and tagging.

Packaging rates were significantly changed as a result of the process improvements. Using the pallet method, a maximum of 14 drums per work shift were prepared for shipment. Using the bag method, workers routinely packaged 50 to 65 drums per shift. As worker proficiency increased, a peak number of 98 drums was achieved in a single work shift.

As each waste package was finalized, a forklift was driven inside the weather shelter to collect the package. Bagged drums were moved to a staging area. Due to the proficiency of packaging, a backlog of hundreds of drum packages were staged at the height of packaging operations while waiting for transport operations to begin. The drums were protected from the weather by slip covers that were removed prior to package loading.

Process Improvements – The Use of Rail

Due to the estimated $8 M cost of shipping the 20,000 drums of waste by truck, alternative methods of shipment were investigated. Rail, while the preferred method, presented logistical problems including the lack of service to the destination point (Nevada Test Site) and required repairs to reestablish rail access to the WVDP. Transportation costs could be dramatically decreased by using rail to the fullest extent possible, therefore, a waste shipment method that included a combination of rail and truck transport was pursued. Using the services of transportation subcontractor MHF, the WVDP established a rail-to-truck transportation plan that involved loading the IP-2 waste bags into gondola rail cars at the WVDP site, cross-country transport by rail, and off-loading the bags to trucks for the final segment of the shipment.

The process of loading the bags into rail cars was evaluated to ensure worker safety, reduce rates of exposure, and to preserve the integrity of the bags during shipment. Various types of rail cars were evaluated, with gondola cars offering the best cumulative options to reduce worker time and exposure during the loading process. Cargo cars were also considered, however, based on evaluations that determined the loading process for cargo cars would increase the ALARA budget for the project, gondola cars were selected as the preferred transport method.

Packages selected for shipment were moved from the staging area to a loading area adjacent to the WVDP rail spur via forklift. A 36 Mg (40 T) crane positioned at the rail loading area was used to lower a lifting frame over the bag. Each of ten lifting straps installed on the bags during the fabrication process were hooked to corresponding hooks on the lifting frame. The secured bag was then lifted with the crane, moved into position over the gondola car, and lowered.

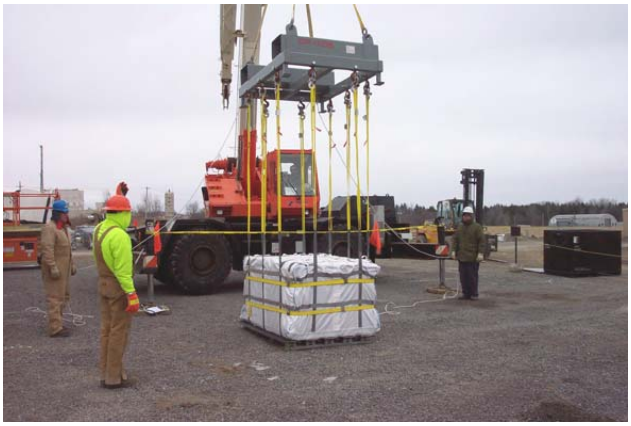

Fig. 6. A loaded bag is lifted by a crane.

Fig. 7. A bag of drums is lowered into a rail car.

As each bag was guided into position in the rail car and the tension was released, quick-release hooks were disengaged from the lifting frame by operators standing alongside the gondola car on a scissors lift platform using a long-handled tool designed specifically for this purpose. A fully loaded gondola car contained two layers of bags, with a total capacity of 180 drums.

Drum packages were secured in place with straps and wooden cribbing was placed inside the gondola cars to fill voids to prevent movement and subsequent damage to the packages during transport. Groups of the bags were also secured together to prevent shifting of the loads.

Loading operations were conducted exclusively outdoors, with no protection from the elements. As a result, drum loading operations were conducted when weather permitted and were suspended during inclement weather.

Because the Nevada Test Site is not serviced by a rail line, transportation arrangements included the establishment of a transload facility near the NTS to transfer the drum packages from rail cars to trucks. Arrangements made with transportation subcontractor MHF resulted in the establishment of transload facility in Utah for offloading of the rail cars onto semi trucks. This temporary arrangement was made to initialize shipping, and the transload facility was later relocated to Parker, AZ.

Transloading operations consisted of removing the drum packages from the rail cars and placing them onto waiting trucks, six packages per truck. Due to the requirement of two sets of shipping papers (paperwork to facilitate gondola transport to the transload facility and paperwork to facilitate truck transport to the disposal facility), all waste documentation was prepared as the rail cars were being loaded. The documentation package for the transloading facility was express-mailed to the transload facility and included an off-loading plan for placing specific bags on each truck. This pre-preparation eliminated the need for the WVDP to post its own waste shipping personnel and waste compliance officer in Arizona for the duration of the shipping campaign while it maintained the WVDP's ability to implement the NTS disposal program.

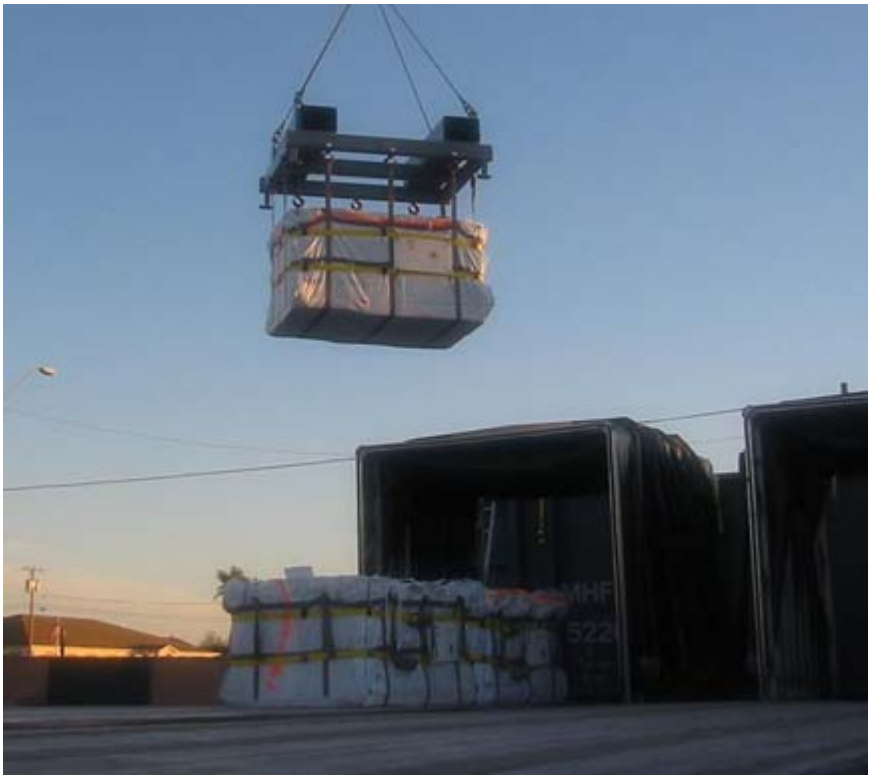

Fig. 8. Drum packages are off loaded at the Parker, AZ transload facility.

As a gondola car was being prepared for unloading at the transload facility, MHF operators used the already prepared documents to determine which packages were loaded on each truck and then recorded truck-specific information, such as the license plate number and the driver's name. An MHF designee was assigned to check and verify each shipment, and the documentation was then sent in an electronic form back to West Valley for final certification. When all approvals and certifications were made, the truck was released for NTS.

Although loading the gondola cars was labor-intensive, the process improved as operators developed proficiency. The first rail car required one week for loading, however, at peak loading operations, operators achieved two rail cars in one day.

To ensure rail transportation safety, rail line owner Buffalo & Pittsburgh inspected the spur leading to the West Valley site prior to each shipment. More than 14,000 drums of waste were shipped using the rail to transload method. Off-site damage to the rail line, however, caused the line to be taken out of service in September 2007. Because of the length of time required to study and repair the rail line, a return to truck shipments was made to expedite completion of the project.

Process Improvements – Worker Exposure Rates

Radiological worker exposure rates were an area of concern because of the amount of hands-on work and the number of tasks performed in close proximity to the drums. As part of the planning phase for process improvements, the WVDP's As Low As Reasonably Achievable (ALARA) Committee conducted an extensive review of the work processes to ensure activities were conducted in a safe and expeditious manner. Planned activities were also evaluated to identify tasks that could be conducted using long-handled tooling.

A step-by-step evaluation was conducted to determine the amount of time required to perform each task proposed in the drum packaging and loading process and the immediate and collective dose workers would receive by performing those tasks. Each step was examined to identify opportunities to improve the process or perform the task in a different manner that would decrease worker dose. Based on the ALARA evaluation, packaging in bags and rail to truck transport offered the best method of packaging and transport available in terms of reducing the rate of worker dose.

Lessons Learned – The Crane and Rodents

Because the Drum Cell overhead crane provided the only means of retrieving the drums from storage, it represented a single point of failure throughout the drum extraction process. On several occasions, operational difficulties with the crane resulted in a temporary suspension of packaging operations while the crane was repaired. In an attempt to preserve the crane's operational life and reduce the frequency of outages, crane operators were instructed on preventative operational techniques. A preventative maintenance outage lasting about two weeks was taken at the approximate mid-point of the project to perform crane repairs and realignment.

Recognizing that crane failure had the potential for unexpected and immediate packaging operations shutdown, a flexible scheduling plan was developed to facilitate the temporary

reassignment of drum processing personnel to other work assignments in the event an outage of significant duration occurred.

With vigilant operation and maintenance, the crane remained operational throughout the drum extraction process.

The Drum Cell shipping campaign was conducted simultaneously with infrastructure reduction activities in a number of areas of the WVDP site. As structures and facilities were being removed from the site, rodents that lived in and under those facilities were displaced.

During packaging and loading operations, operators observed irregular holes in some of the IP-2 bags. The source of the damage was traced to rodents, which were found to be using the woven fabric of the bags for nesting material. Upon discovery, the bag manufacturer was consulted and was able to provide patching material to repair the damage. Since the damage was limited to the outer layer of the bag which was considered a weather deterrent and was not necessary for the bags' certification as a waste container, the integrity of the packaging system was not compromised by the rodent damage.

Project Summary

The last drums were shipped from the WVDP Drum Cell in October 2007 with all drums received and accepted for disposal at the NTS in November 2007. The total Project cost of this workscope, including packaging, transport, and final demobilization was approximately $20.7M. Process and engineering improvements were key to the success of this project, and resulted in project completion more than one year ahead of schedule and at a sizeable cost savings over preliminary cost estimates.