PACKAGING AND TRANSPORTATION OF DEPLETED URANIUM FOR DISPOSITION FROM THE SAVANNAH RIVER SITE

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ABSTRACT

The Savannah River Site (SRS) produced a large inventory of depleted uranium trioxide (DUO) in a powder form packaged in approximately 36,000 55-gallon drums that required final disposition. Each drum weighs an average of 680 kg (1,500 pounds) with some as much as 820 kg (1,800 pounds). The weight, and the fact that the material is in a powder form, requires detailed planning concerning the packaging and transportation (P&T) that must be used. Four disposition campaigns have been completed with the first in Fiscal Year 2003 (FY03), the second in FY04/05, and the most recent two campaigns being completed in early FY09. The remaining inventory of approximately 16,000 drums will likely follow similar paths in the future. This paper will describe the DUO inventory and the thought process behind determining the appropriate P&T for each campaign, very briefly covering the first two campaigns and emphasizing the most recent campaigns.

In FY03, SRS completed a pilot project that disposed of 3,270 55-gallon drums of DUO. The shipping method used 110-ton mill gondola railcars with a polypropylene coated fabric liner as the DOT "strong, tight" package. These railcars were shipped to the EnergySolutions low level waste (LLW) disposal facility in Clive, UT (previously Envirocare of Utah now referred to in this paper as the Clive Facility) for final disposition of the DUO as LLW. In FY04/05, an additional 7,296 drums that were overpacked in 85-gallon drums were shipped in boxcars (not part of the packaging) since the overpacks were qualified as IP-2 containers due to the excessive weight of the drums (over 680 kg each) to the Clive Facility.

The two most recent campaigns consisted of: 1) 5,408 55-gallon drums that were shipped to the Clive Facility in 52.5-foot gondola railcars with fiberglass lids; the railcar itself was the package as well as the conveyance, and 2) 4014 55-gallon drums that were shipped to the Nevada Test Site (NTS) in 20-foot modified cargo containers as the package and placed onto flatbed trucks.

INTRODUCTION

SRS began dispositioning large inventories of DUO in FY03. The DUO is in the form of a trioxide powder with widely varying particle sizes. The packaging for transportation varies for each campaign, from polypropylene coated fabric liners around the drums, to individual drum overpacks, to gondola railcars with hard lids, to cargo containers. Packaging decisions were

made depending on the original container, the destination, and experiences from previous campaigns as evaluated against DOT requirements. The transportation mode is on-highway truck or railcar depending on the package/conveyance availability and the destination. The disposal methods will only be briefly discussed in this paper since the focus is P&T; however, the disposal site for each stream strongly influences the P&T methods selection and, conversely, the desired P&T method strongly influences the decision on which disposal site to select.

The material streams involved have historically been managed as nuclear materials with the hope of finding reuse applications. However, cost-effective reuses for DUO have not been identified to date and, since these material streams are the responsibility of DOE Environmental Management (EM), these materials have been defined as excess and, therefore, must be dispositioned in accordance with EM-1 guidance. Actions to prepare for disposition actually began in FY02 for the DUO and the first material was disposed in FY03.

BACKGROUND

The DUO inventory at SRS was a by-product of decades of nuclear weapons production activities. This material was packaged into any available salvage (most previously used) 55-gallon drums and stored in any available space at SRS and is managed as accountable nuclear material. The DUO inventory consisted of approximately 36,000 55-gallon drums, a significant portion (~20%) of which was overpacked into 85-gallon drums. The inventory was stored in seven facilities at SRS; only two of these still store DUO.

In FY02, two of the storage facilities containing a total of 3,270 drums were determined to be in sufficiently poor condition that the decision was made to disposition these drums as LLW as rather than upgrading the facilities for continued storage. A waste sampling plan was developed with samples pulled in FY02. The final characterization was completed in early FY03. Extremely low detection limits were required to detect the plutonium contamination since the levels were in the parts per trillion range. The results of the sampling demonstrated that the material could be disposed of as LLW at either the NTS or at the Clive Facility. It also showed that the DUO met the Department of Transportation (DOT) definition of Low Specific Activity (LSA) 1, unirradiated material. As a result, the material could be shipped in an Industrial Package 1 (IP-1) package.

The drums were typically stacked three high in the SRS storage facilities. The two facilities involved in the FY03 disposal campaign had deteriorated to the point that rain water and mud had accumulated on the floors leaving the bottom layer of drums standing in water during portions of the three-decade storage period. The water and mud caused significant corrosion in some of the drums on the bottom tier placing the integrity of the drums into question. Drums in the upper two tiers also exhibited significant surface corrosion but drum integrity was not generally in question. The weight of the loaded drums averaging approximately 750 kg (1,650 pounds) each, coupled with the questionable integrity of the drums would not permit the drums to qualify as the "strong, tight" containers. For these reasons, the drums were not used as the shipping containers and actions were taken to determine the least expensive and DOT compliant packaging method.

Campaign 1 – DUO Disposition Pilot

In FY03, the pilot project included the 3,270 55-gallon drums from F-Area that were in poor condition that required packaging into IP-1 compliant packaging. Three different attempts to use polyethylene soft-sided wrappers as the packages for this material were made before it was determined that several layers of protective materials were needed to meet the IP-1 packaging requirements. Package failures were significant in the first two attempts before the packaging vendor was able to meet the requirements. The poor performance of the soft-sided package for use under very heavy drums has been a prime decision factor in determining packaging for subsequent campaigns. Figure 1 shows a gondola railcar that is loaded and ready to close using the soft-sided wrapper packaging.

Figure 1. Loaded gondola railcar that is ready to close during Campaign 1.

Campaign 2 – DUO Drums in Overpacks

Of the approximately 33,000 remaining DUO drums, about 7,000 had been historically overpacked into 85-gallon drums for on-site handling purposes. These overpack drums are wider than the 55-gallon drums such that four overpack drums would not fit across the width of a standard railcar. Therefore, other options were needed. The overpack drums were relatively new and in excellent condition but the weight exceeded the DOT limits for a non-bulk, "strong, tight" package (i.e., IP-1 package). Since this was a significant quantity of drums, SRS decided to perform a drop test to qualify the overpack drums as Industrial Package 2 (IP-2) packages (IP-2 packaging was required due to the weight of the material, not due to the radioactive content). The overpack drums passed the testing and thus did not require additional packaging. SRS shipped these drums in wider-than-standard boxcars to the Clive Facility with the drum as the

shipping package and the boxcar as the conveyance in FY04/05. Figure 2 shows the interior of a boxcar loaded with drums.

Figure 2 – One end of loaded boxcar with 85-gallon overpacks during Campaign 2.

Campaign 3 – DUO from F-Area

At the completion of Campaign 2, two DUO storage facilities remained active in F-Area; one facility contained 5,408 drums that had been previously weighed, swiped, palletized (four drums per pallet), and labeled. This facility is a large metal-sided warehouse in good condition. The NNSA Mixed Oxide Fuel Fabrication Facility (MOX) construction is in the vicinity of this DUO storage building. MOX required additional construction storage space. The cost to dispose of the DUO was commensurate with the cost to build new warehouse space so MOX funded the transportation and disposal of the DUO from this facility.

One of the lessons-learned during the Pilot Project (Campaign 1) was that rail shipment in general is more cost-effective, uses less fuel, and is more safe than truck shipment (assuming all else is equal); therefore, rail is planned whenever possible for transportation of this material. Also, SRS owns a fleet of railcars (no lease expense was necessary) adding to the cost-effectiveness of rail shipment.

The Fernald Closure Project (FCP) used a fleet of gondola railcars. When the FCP was completed, the DOE-owned railcar fleet became excess. SRS acquired 52 of these 52.5-foot gondola railcars with hard lids for continued DOE use. These gondola railcars with lids are qualified as IP-1 packages and also performed well under a DOT waiver as IP-2 packages for the FCP. These SRS railcars were used as the packaging and conveyance for Campaign 3 for the DUO inventory from F-Area shipped in early FY09 (October 2008). The gondola railcars were used by SRS in a "Sole Use" application to avoid having to decontaminate each railcar following unloading. The railcars were used by the FCP to ship loose "soil-like" contaminated materials, without internal wrappers being required (wrappers were used for ease of gross decontamination though most of the FCP activities but none were used towards the end of the project). Therefore, the railcars were assumed to have internal contamination throughout the SRS project. Before SRS DUO drums were loaded into a railcar, the internal contamination of each railcar was

evaluated and managed using SRS procedures for site workers and within limits defined in 40 CFR 173.443 for on the rail use.

Two issues were considered when planning the use of these railcars. First, concerns were raised by the SRS M&O contractor related to the ability of the lids to contain the DUO powder during normal shipping operations (IP-1 capability of the railcars with lids). The scenario presented was that "wind" would blow (due to railcar movement) under the lip of the railcar lid, blow the lids off of the tops of the drums, and then blow the powder out of the drums up the inside of the railcars and out of the lip of the of the railcar lid. Considering that: 1) the railcar lids weigh approximately one ton, have a lip of approximately eight inches, and are clamped to the railcar, it is unlikely to allow any significant air flow to enter the railcars, 2) the drums lids are attached to the drums with bolted rings and the drums are then banded (steel bands) to the pallets over the top of the drums (previous accidental drops have shown the lids and bands will stay in tact), and 3) the DUO is very dense and is difficult to get airborne at all, much less raise it four feet from the top of the material in the drum to the lip of the railcar lid. This scenario was considered by DOE/SR to be incredible.

Since the M&O contractor was not able to appropriately qualify the railcars with lids as IP-1 packages, DOE/SR decided to obtain a logistics vendor to provide services related to this campaign. DOE is required to use "8(a)" small business vendors and this activity lent itself to this requirement. DOE contracted with Cavanagh Services Group, Inc. (Cavanagh) to provide a number of services for this campaign including:

1) Performing railcar inspections required to verify that the condition of the railcars meet the Association of American Railroads (AAR) requirements,
2) Developing the Blocking and Bracing (B&B) Plan and obtaining approval for use from the railroads,
3) Providing validation that the M&O contractor loaded each railcar per the B&B Plan,
4) Providing validation that the M&O contractor properly installed the lid clamps on each railcar,
5) Assuring that the railcars meet IP-1 requirements for this waste form,
6) DOT and AAR marking/labeling requirements on the railcars,
7) Providing logistics with the railroad to ship the railcars as a unit train,
8) Providing logistics with the Clive Facility,
9) Preparation and approval of the waste profile,
10) Performing minor modifications to the railcars, some performed at SRS, others performed at the Clive Facility,
11) Integrating the loading and on-site rail activity with the M&O contractor.

The second potential problem that was identified was concerns with the performance of the railcar lid clamps used to hold the lid onto the railcar. Problems had been identified commercially with the performance of these clamps in a very limited number of railcars. After SR evaluation of these problems, and review of the one issue noted by the FCP in the eight years of operating, SR determined that the problem mainly revolved around improper installation of the clamps vs. the ability of the clamps to perform. SR also noted that the issue of damaged clamps results from the techniques used by the rail yards to recouple railcars. The rail yards tend to use excessive force during this operation that can cause damage to the clamps and/or lids.

This information was used in the preparation of the Cavanagh work scope to provide an additional level of validation that the clamps were properly installed and to require that the railcars be shipped as a unit train to avoid potential handling damage in rail yards while enroute. During the loading process, Cavanagh and the M&O collaborated in determining which clamps needed to be replaced due to previous damage. Of the 208 clamps on the 52 railcars, 20 were replaced by the M&O during this campaign.

The process used to load and ship the railcars included:

1) Placing the railcars, two at a time, on a rail spur close to the storage facility,
2) Removing the lid of the first railcar to be loaded,
3) Inspecting the condition of the exterior and interior of the lid,
4) Inspecting the lid clamps while the lid is on the ground and replacing damaged clamps,
5) Swiping the interior of the railcar to determine the protective clothing needed for the workers,
6) Transporting by forklift the palletized drums from the storage facility to the rail spur where the railcar is staged,
7) Rigging the pallet and lifting it into the railcar via crane,
8) Placing the pallets into the railcar in two rows of 13 pallets each (extremely tight fit – less than ½ inch per pallet excess space),
9) Installing the B&B materials between the two rows of drums,
10) Reinstalling the lid, validating that the lid and clamps are properly installed,
11) Moving the full railcars to another on-site rail line where the train was staged until all railcars were loaded.

As issues were identified with the railcars, they were dealt with, such as:

1) Several small holes in the railcar lids were repaired,
2) Twenty railcar lid clamps were replaced,
3) Small areas on the exterior of two of the railcars were found to be contaminated with fixed contamination. One of these areas was above Occurrence Reporting and Processing System (ORPS) reporting levels. Both areas were decontaminated.
4) Missing AEI tags were replaced,
5) One lid was found to be damaged beyond repair but was determined to acceptable for one trip (this lid must be repaired or replaced before this railcar is used again).

Figure 3 shows a railcar fully loaded, including required B&B materials, and ready for lid replacement.

Figure 3 – Fully loaded railcar during Campaign 3.

Once the railcars were loaded and staged on site as a unit train, the next stages of this campaign included:

1) Installing labels on the railcars,
2) Moving the train to the access point for CSXT Railroad to pick up,
3) Tracking the train during transportation to the Clive Facility,
4) Unloading the railcars at the Clive Facility,
5) Performing modifications to the railcars,
6) Shipping the railcars as a unit train back to SRS.

The first pallet of drums was loaded into the first railcar on August 18, 2008 and the last pallet of drums was loaded on October 7, 2008. The unit train was picked up by CSXT Railroad from SRS on October 15, 2008 and arrived at the Clive Facility on October 20. The railcars were unloaded at the Clive facility by November 3, 2008. Final modifications were complete on November 7, 2008. The unit train of empty railcars left the Clive Facility on November 13, 2008 and arrived at SRS on December 1, 2008. The railcars, railcar lids, clamps, and B&B all performed well. No issues were noted. The conclusion is that this is the best approach of the P&T methods used so far in dispositioning the DUO material.

Campaign 4 – DUO from R-Area

The SRS R-Reactor facility was shut down in 1964 and has provided excellent storage capabilities for DUO drums since the early 1970's. The final decommissioning of this building has been in planning for several years. In order to meet a SRS regulatory milestone, the final characterization of the facility needed to be complete by October 2008. However, there were 4,014 drums of DUO stored in a portion of this facility that needed to be removed to allow the

characterization to be completed. Since there was no other facility on site that could to store this quantity of drums, and since the cost to dispose of the drums off site was not significantly higher than moving them on site and continued storage (with ultimate disposition still required), it was decided to dispose of this portion of the inventory. The requirement to transport and dispose of these 4,014 drums arose at the same time that Campaign 3 was underway; therefore, the SRS railcars would not be available for Campaign 4. Also, there is not a functional rail spur to the R-Reactor facility so the drums would have to be transloaded on site from a truck to the railcars which would have added cost and complexity to the project. If railcars were to be used, the site would have had to rent railcars which again would have added cost to the project. With all of these factors involved, a new P&T approach was required for Campaign 4. It was determined that it was most cost-effective to package these drums into IP-1 packages and ship to them by truck to NTS. The fact that NTS was "self funded" (no funding from the SRS budget would be needed) also helped decide that using NTS was cost-effective (relative to the SRS budget) in this case.

With the decision to use IP-1 containers on trucks made, the next decision was determining which IP-1 package to use. The weight of the drums would limit the number of drums per truck to around 25 depending on the weight of the IP-1 package used. Some of the options considered were:

1) Individual 85-gallon overpacks loaded into standard trucks, either closed vans or flatbeds – the overpacks would be the IP-2 package similar to Campaign 2 described above,
2) Soft-sided 4-drum or 6-drum overpacks as the IP-1 package loaded onto flatbed trucks,
3) 20-foot cargo containers as the IP-1 package loaded onto flatbed trucks.

Option 1 was determined to require excessive amounts on time to transfer each drum into individual overpacks. Option 2 was complicated by the inability of the soft-sided overpack to perform to specification with the heavy drums, taking into account the issues with Campaign 1 and other issues at NTS related to similar soft-sided packages. Also, capacity issues at NTS (considering that these 4,000+ drums were not in the SRS FY08 waste forecast for NTS) required that the most efficient handling method at NTS be considered. The cargo containers with 23 – 25 drums each, was determined to be the most efficient approach for NTS. Therefore, option 3 was selected.

After the determination of the P&T approach was made for Campaign 4, the M&O decided that the doors of a standard cargo container would not contain the powder if a drum breached. Modifications to the containers were made to ensure the powder could not escape the bottom of the door. There were debates as to the extreme levels that were being required by the M&O and the associated cost (lower cost alternatives were possible but were not fully considered by the M&O), but the modified containers functioned well above requirements. Once these decisions were made, the loading became simple. The drums were removed from the facility, swiped, labeled, and loaded into the container. The drums were blocked and the container was sealed. The containers were loaded onto the flatbed trucks and the trucks sent to NTS. The fully loaded containers were placed in the disposal unit at NTS (they were not unloaded at NTS).

Campaign 4 began on August 7, 2008 with the first drums loaded into the first cargo container. The modifications added to the cargo containers increased the time required for delivery of cargo

containers to the site by the container vendor. This extended the loading schedule with the last drum loaded on November 17, 2008. The first set of trucks (six to ten trucks at a time were loaded and released for tranport) left SRS on August 14, 2008. The last of the 174 trucks left SRS on November 20, 2008. No issues were noted on the road or at NTS.

As the DUO drums were being removed from the facility, several drums were found to be damaged. The damaged drums were individually overpacked into 85-gallon drums to reduce the possibility of contamination spread during loading operations and were then loaded into the cargo containers for disposal. Figure 4 shows a bulkhead being installed on a cargo container. This is the bulkhead that was added to the cargo containers to ensure powder would be contained if a drum were to breach in transit.

Figure 4 – Installation of bulkhead to seal door during Campaign 4.

SUMMARY

SRS began disposition actions on the legacy inventories of DUO in FY03 with a total of 4 campaigns so far resulting in over 55% of the original inventory being dispositioned over the last five years using various P&T methods. The remaining inventory is safely stored awaiting DOE funding to implement final disposition. Since several P&T methods have been used and both disposal facilities have accepted portions of the inventory, the final actions for the remaining inventory will be easily implemented as soon as funding is identified.