

**FINAL CAMPAIGN FOR THE 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 fifth underway at the time of the development of this paper. The first in Fiscal Year 2003 (FY03), the second in FY04/05, two campaigns being completed in early FY09 and the most recent started at the end of 2009 and continues as of the writing of this paper. 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 four campaigns and emphasizing the most recent campaign.

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, 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 campaigns in 2009 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) 4,014 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.

The most recent and last campaign consists of three unit trains totaling approximately 14,800 drums of DUO most of which are 55-gallon drums with a small percentage being 85 gallon overpacks that are being shipped to Clive, Utah in 52.5-foot gondola railcars with fiberglass lids; the railcar itself being used as the package as well as conveyance.

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 and the associated cost as well as 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.

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 available space at SRS and managed as accountable nuclear material. The DUO inventory consisted of approximately 36,000 55-gallon drums, a significant portion of which was overpacked into 85-gallon drums. The inventory was stored in seven facilities at SRS. In 2009, only two of these facilities were still utilized to store DUO in drums.

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 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 Class A, 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, DOT compliant packaging method.

Campaign 1 – DUO Disposition Pilot (FY03)

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 (FY04/05)

Of the approximately 33,000 remaining DUO drums, about 7,000 had been historically overpacked into 85-gallon drums for on-site handling purposes. Overpack drums are wider and taller than the 55-gallon drums. 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 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 (FY08/09)

At the completion of Campaign 2, two DUO storage facilities remained active in F-Area; one facility contained 5,408 ready-to-transport, drums that had been previously weighed, swiped, palletized (four drums per pallet), and labeled. Lessons learned from Campaign 1 indicated that rail shipment in general is more cost-effective, uses less fuel, and is safer than truck shipment; therefore, rail is planned whenever possible for transportation of this material. SRS owns a fleet of railcars (no lease expense was necessary) adding to the cost-effectiveness of rail shipment. The SRS railcars are covered gondolas that had been qualified and proven IP-1 packages on over 12,000 shipments at the Fernald Closure Project.

DOE-SR contracted Cavanagh Services Group, Inc. (Cavanagh) during Campaign 3 to over see the loading of the railcars. Cavanagh developed an innovative and cost effective, railroad approved Blocking and Bracing Plan. Using this Blocking and Bracing Plan, SRS loaded the 5,408 palletized drums into the fleet of 52 IP-1, covered gondola railcars. The cars were then assembled into a 52-car unit train and shipped to Clive, Utah for disposal. Figure 3 shows the loaded gondola railcar ready for the installation of the lid.



Figure 3. Loaded gondola railcar that is ready to close during Campaign 3

Campaign 4 – DUO from R-Area (FY08/09)

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. The facility contained 4,014 DUO drums that needed to be removed to allow the characterization to be completed. Since there was no other facility on site that could 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. Further, the Savannah River Site rail system to R Area had been out of service for a number of years which would have entailed multiple handling from R-Area to a rail served area at the site before loading into railcars. 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.

It was determined that 20-foot cargo containers would be used as IP-1 package loaded onto flatbed trucks. 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 for final disposal. The fully loaded containers were placed in the disposal unit at NTS (20-foot containers with drums inside were placed in disposal). Campaign 4 began on August 7, 2008, with the first drums loaded into the first cargo container. 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 transport) left SRS on August 14, 2008. The last of the 174 trucks left SRS on November 20, 2008. No packaging issues were noted on the road or at NTS. However, two of the truck drivers were directed by their dispatch to travel through the Las Vegas Valley, a direct violation of the NTS routing requirements. Hazardous shipments to NTS are not permitted to travel through Las Vegas.

See figure 4 showing installation of bulkhead into 20-foot container during Campaign 4.



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

Campaign 5 – DUO from F-Area and N-Area (FY09/10)

During FY09/10, American Recovery and Reinvestment Act (ARRA) funding became available that provided the funding of the final campaign to disposition the remaining DUO at the Savannah River Site, including the packaging and transportation necessary to accomplish this project.

At the completion of Campaign 4 a total of approximately 15,600 DUO drums remained located in two DUO storage facilities, one in F-Area and one in N-Area. F-Area contained approximately 9,100 DUO drums and N-Area approximately 6,500 drums. All of the drums in both facilities remained in the original storage positions stacked three drums high and therefore would require swiping, weighing and palletizing and labeling prior to loading into packages for transportation.

Lessons learned carried over from the first four prior DUO Campaigns were employed in developing the approach for Campaign 5. One of the lessons-learned during Campaigns 1 and 3 was transportation by rail is more cost-effective, consumes less fuel, provides increased safety and enhanced transportation security than that offered by on highway truck shipments. Therefore, it was determined that transportation of the DUO drums during this final Campaign would be performed by rail for all but approximately 800 DUO drums scheduled to be moved to the Oak Ridge National Laboratory (ORNL) (as product vs. waste to be used as a blending agent in an ORNL project), leaving approximately 14,800 drums for Campaign 5 by rail to Clive, Utah.

The Fernald Closure Project (FCP) used a fleet of gondola railcars. When the FCP was completed, SRS acquired 52 of these 52.5-foot gondola railcars with hard lids. These gondola railcars with lids are qualified as IP-1 packages having completed over 12,000 shipments from 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 excellent performance

of these railcars as IP-1 packages during Campaign 3 was the deciding factor in using the SRS gondola fleet for the transportation of drums to the Clive Facility.

During Campaign 3, DOE-SR contracted with Cavanagh Services Group, Inc, a small 8(a) business for services including oversight of the loading of railcars, development of Blocking and Bracing Plans, all rail transportation and manifesting. Because of the success of Campaign 3, DOE-SR decided to contract for like services from Cavanagh during Campaign 5.

In Campaign 3, all DUO drums identified for transportation had previously been palletized on oak pallets, four drums to each pallet some years prior to the start of the Campaign. All 14,800 DUO drums involved in Campaign 5 were stored as individual drums that therefore required palletization prior to loading of the gondola railcars. In the development of the Blocking and Bracing Plans, Cavanagh determined that CXS railroad had a new banding requirement. Cavanagh developed a compliant palletized banding approach to affix 4 DUO drums to each oak pallet utilizing 1.25" metal banding and featuring an intersecting cross seal design. Prior to loading of the drums, SRNS performed the palletizing operation utilizing this new design.

The gondola railcars were used by SRS in a "Sole Use" application to avoid having to decontaminate each railcar following unloading and release at the disposal facility. Before SRS DUO drums were loaded into each railcar, the internal contamination of each railcar was evaluated and managed by the SRS contractor, Savannah River Nuclear Solutions (SRNS), using SRS procedures for site workers and within limits defined in 40 CFR 173.443 for on the rail use.

Concerns raised by the SRS Maintenance and Operations (M&O) contractor during Campaign 3 were taken into consideration in Campaign 5. These issues were considered when planning the use of the SRS railcars. During Campaign 3 the SRS M&O contractor questioned the ability of the railcar gondola lids to contain the DUO powder during normal shipping operations. The scenario presented was that airflow due to the movement of the railcars would enter under the railcar lids, blow the lids off the DUO drums and then blow the DUO powder out of the drums and back out of the lids. Since the M&O contractor was not able to qualify the railcars with lids as IP-1 packages, DOE-SR obtained Cavanagh to provide Packaging and Transportation support during Campaign 3.

Cavanagh provides a number of packaging and transportation services including:

- 1) Provide daily communication and coordination with the on-site SRS Project Management personnel (both DOE and SRNS), with Contractor on-site project personnel, and with the Contractor home office;
- 2) Perform the daily function of tracking and reporting issues to the DOE-SR Project Manager;
- 3) Coordinate with SRNS pre loading inspection to ensure railcars will be available per schedule;
- 4) Performing railcar inspections required to verify that the condition of the railcars meet the Association of American Railroads (AAR) requirements,
- 5) Developing the Blocking and Bracing (B&B) Plans and obtaining approval for use from the railroads,

- 6) Providing validation that SRNS loaded each railcar per the B&B Plan(s)
- 7) Providing validation that SRNS properly installed the lid clamps on each railcar,
- 8) Assuring that the railcars meet IP-1 requirements for this waste form,
- 9) DOT and AAR marking/labeling requirements on the railcars,
- 10) Providing logistics with the railroad to ship the railcars as a unit train,
- 11) Providing logistics with the Clive Facility,
- 12) Integrating the loading and on-site rail activity with SRNS.

A second potential problem identified during Campaign 3 concerned 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. During Campaign 3, and following an evaluation of the FCP experiences SR had determined that the problem mainly revolved around improper installation of the clamps rather than the functionality of the clamps. SR in Campaign 3 had identified the potential for damage to the clamps during rail yard re-coupling exercise. 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.

Cavanagh had developed an innovative, light weight and cost effective blocking and bracing approach during Campaign 3 which included the use of an expanding honeycomb blocking system placed between the rows of palletized drums running down the center of the length of the railcars.

During the unloading of the railcars at the Clive Facility in Campaign 3, it was noted that the blocking material used in the blocking and bracing plan had deformed slightly due to water condensation that had formed inside of the railcars during the period of time while loading and traveling to the Clive Facility. While this slight deformation to the bracing had no impact on the blocking and bracing of any of the 52 cars in Campaign 3, Cavanagh determined that an improvement in material design would be employed in Campaign 5. The blocking material was redesigned to utilize a double layer of honeycomb material on the top section of the blocking material to provide increased strength.

During this campaign Cavanagh collaborated with SRNS and determined that a number of the SRS railcars were in need of minor repairs and AAR required air brake functionality testing. In order to eliminate any chance for the unit train to be stopped or broken up due to a required AAR repair, Cavanagh recommended and performed inspections and repairs of the SRS gondola railcars at the SRS site prior to loading. These repairs included hand brakes that were seized, worn brake pads, out of date brake hoses, ladder rungs below minimum requirements and performance of mandatory 60 month AAR air brake tests.

During the loading process, Cavanagh and SRNS collaborated in determining which clamps needed to be replaced due to previous damage. Of the 208 clamps on the 52 railcars, 7 were replaced by SRNS during this campaign.

Based on the Blocking and Bracing plan, it was determined that a total of 26 pallets of 4 drums could be loaded into each of the SRS gondola railcars for a total of 5,408 DUO drums per 52 car unit train. The total of 14,800 DUO drums would therefore require a total of 3 train shipments from SRS to Clive, Utah with the first and second train consisting of 52 cars and the third train consisting of 39 cars.

As noted previously, the 14,800 DUO drums were in storage in two separate buildings located in separate areas of the SRS site, F-Area and N-Area. This separation of storage areas required the palletizing and loading activities be developed at the two separate locations. The facility in F-area was planned to be handed over to the MOX Project for continued use after the facility was deinventoried. Further, the F-Area facility contained a larger number of DUO drums. DOE-SR determined that the first of the three trains would be loaded from F-Area.

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 noted and Cavanagh developed a repair procedure that was adopted by SRS and placed into operation;
- 2) Seven railcar lid clamps were replaced;
- 3) During Campaign 3, one lid was found to be damaged beyond repair but was determined to be acceptable for one trip and during Campaign 5, it was replaced with a new lid obtained by DOE-SR prior to the start of the project.

Figure 5 shows a railcar fully loaded, including required B&B materials, ready for lid replacement.



Figure 5 – Fully loaded railcar during Campaign 5.

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) Inspection of the arriving unit train at Clive,
- 5) Unloading the railcars at the Clive Facility,
- 6) Inspection of the unloaded railcars at Clive,
- 7) Shipping the empty railcars as a unit train back to SRS.

The first pallet of drums was loaded into the first railcar on October 15, 2009 and the last pallet of drums was loaded on December 4, 2009. The unit train was picked up by CSXT Railroad from SRS on December 15, 2009 and arrived at the Clive Facility on December 20, 2009. The railcars were unloaded at the Clive facility by December 31, 2008. The unit train of empty railcars left the Clive Facility on January 5, 2010. The railcars, railcar lids, clamps, and B&B all performed well. No issues were noted.

SUMMARY

SRS began disposition actions on the legacy inventories of DUO in FY03 with 5 campaigns completed and the final campaign of 3 trains, 1/3 completed so far. These efforts have resulted in over 70% of the original inventory being dispositioned in the last seven years using various packaging and transportation methods. Campaigns 3 and 5 have proven the safety and effectiveness of transportation by rail utilizing the DOE-SR owned fleet of covered gondola

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railcars. With ARRA funding in place, Campaign 5 will continue until that last DUO drum is transported from the Savannah River Site.