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Operating Experience and Lessons Learned in the Use of Soft-Sided Packaging for Transportation and Disposal of Low-Activity Radioactive Waste

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ABSTRACT

This paper describes the operating experience and lessons learned at U.S. Department of Energy (DOE) sites as a result of an evaluation of potential trailer contamination and soft-sided packaging integrity issues related to the disposal of low-level and mixed low-level (LLW/MLLW) radioactive waste shipments. Nearly 4.3 million cubic meters of LLW/MLLW will have been generated and disposed of during fiscal year (FY) 2010 to FY 2015—either at commercial disposal sites or disposal sites owned by DOE. The LLW/MLLW is packaged in several different types of regulatory compliant packaging and transported via highway or rail to disposal sites safely and efficiently in accordance with federal, state, and local regulations and DOE orders.

In 1999, DOE supported the development of LLW containers that are more volumetrically efficient, more cost effective, and easier to use as compared to metal or wooden containers that existed at that time. The DOE Idaho National Engineering and Environmental Laboratory (INEEL), working in conjunction with the plastic industry, tested several types of soft-sided waste packaging systems that meet U.S. Department of Transportation requirements for transport of low specific activity and surface contaminated objects. Since then, soft-sided packaging of various capacities have been used successfully by the decontamination and decommissioning (D&D) projects to package, transport, and dispose D&D wastes throughout the DOE complex.

The joint team of experts assembled by the Energy Facility Contractors Group from DOE waste generating sites, DOE and commercial waste disposal facilities, and soft-sided packaging suppliers conducted the review of soft-sided packaging operations and transportation of these packages to the disposal sites. As a result of this evaluation, the team developed several recommendations and best practices to prevent or minimize the recurrences of equipment contamination issues and proper use of soft-sided packaging for transport and disposal of waste.

INTRODUCTION

Over the last few years, a number of incidents involving receipt of contaminated transportation vehicles and waste packages at U.S. Department of Energy (DOE) sites resulted in the retention of commercial transport equipment for the purpose of decontamination to achieve the DOE free-release contamination levels for property, as specified in Title 10 Code of Federal Regulations

(CFR) Part 835, ***Occupational Radiation Protection***, Appendix D, ***Surface Contamination Values***. This has resulted in delays for generator shipment campaigns and formal requests for corrective action by the disposal site. In addition, commercial transport trailers have been effectively taken out of service in order to complete decontamination activities at both generator and disposal sites.

Incidents involving detection of radiological contamination on the exterior of soft-sided waste packages and trailers on which these packages were transported for disposal have raised potential concerns regarding the integrity of soft-sided packaging and its continued use for storing and/or transporting low-level and mixed wastes. Receipt of soft-sided packaging at the Nevada National Security Site (NNSS) is shown in Figure 1.

Figure 1 Receipt of Soft-Sided Packages at the NNSS

During the period from fiscal year (FY) 2009 through FY 2011, there were a total of 21 incidents involving radioactively contaminated shipment trailers and 9 contaminated waste packages received at the NNSS Area 5 Radioactive Waste Management Site. During this time period, the Energy***Solutions*** (ES) Clive, UT, disposal facility had a total of 18 similar incidents involving trailer and package contamination issues.

As a result of the increased occurrence of such incidents, the DOE Environmental Management Headquarters (EM/HQ) Office of Waste Management requested that the Energy Facility Contractors Group (EFCOG) Waste Management Working Group (WMWG) conduct a detailed review of these incidents and report back to EM regarding the results of this review, including providing any recommendations formulated as a result of the evaluation of current site practices involving handling and management of radioactive material and waste shipments. The WMWG identified and tasked an Evaluation Team, which included technical representatives from six

DOE sites, Waste Control Specialists, the Energy Solutions (ES) Clive site, four DOE sponsors, and five subject matter experts from the soft-sided packaging vendor community.

In recognition of the fact that trailer contamination incidents at the NNSS have caused some commercial equipment to be held (or required to be returned) for decontamination, resulting in significant project cost and schedule impacts, EM also requested that WMWG conduct a parallel review of the current disparity between equipment free-release limits (for radiological contamination) specified by the U.S. Department of Transportation (DOT) in 49 CFR 173–178 versus more restrictive limits specified for DOE sites in 10 CFR 835, Appendix D. There are no public or worker health and safety issues under either DOT or DOE contamination limits. DOT contamination limits are similar to those in the ***International Atomic Energy Agency Regulations for Safe Transport of Radioactive Materials*** (SSR-6, 2012 Edition).

During the course of the trailer contamination evaluation, a total of three formal meetings were held: (1) in conjunction with the EFCOG WMWG session during Waste Management 2012 (Phoenix, AZ, March 1, 2012); (2) in conjunction with the NNSS Generator Workshop (Las Vegas, NV, April 24, 2012); and (3) in conjunction with the Contractor Transportation Management Association Workshop (Reno, NV, June 15, 2012). Additional team communication was conducted by e-mail and telephone.

DOE WASTE ACCEPTANCE AND FREE RELEASE REQUIREMENTS

The NNSS is a designated regional disposal facility for low-level waste (LLW) and mixed low-level (MLLW) radioactive waste for the DOE complex. The NNSS currently accepts waste from 25 generators with approved programs that certify waste to the NNSS Waste Acceptance Criteria (NNSS WAC). These generators include DOE sites (EM, NNSA, Office of Science, Office of Nuclear Energy, and Naval Reactors Programs) as well as the U.S. Army Aberdeen Proving Ground and selected commercial firms that support DOE D&D and site environmental cleanup projects. The National Nuclear Security Administration Nevada Field Office (NNSA/NFO) provides a comprehensive waste acceptance review and oversight function through the Radioactive Waste Acceptance Program, including providing waste generator technical assistance support for both new and current generators. The NNSS Management and Operating Contractor, National Security Technologies, LLC, operates the regional disposal facility at the NNSS and provides waste characterization and certification support to both onsite (NNSS) and offsite generators.

Waste generators that are approved to ship to the NNSS for disposal must meet a strict set of requirements for waste acceptance (NNSS WAC, DOE/NV-325-Rev. 10), applicable DOT requirements (49 CFR 172–173) during actual transportation, and DOE free-release criteria (10 CFR 835, Appendix D) prior to release of transporter vehicles and equipment following waste off-loading for burial. Waste shipments are refused by NNSS if determined to be noncompliant for any reason. In addition, the NNSS WAC contains other requirements related to shipment scheduling, advance notifications, safe route selection, packaging, marking, labeling, and special handling for higher activity packages.

Release of Property Containing Residual Radioactive Material

The release of property off the NNSS is controlled such that vehicles, equipment, structures, or other materials cannot be released unless the amount of residual radioactivity on such items is

less than the authorized limits. The default authorized release limits are specified in the ***Nevada National Security Site Radiological Control Manual***, DOE/NV/25946--801 Rev. 2, and are consistent with the limits set by U.S. Department of Energy Order DOE O 458.1 Chg 2, ***Radiation Protection of the Public and the Environment***. NNSA/NFO contractors use a graded approach for release of material and equipment for unrestricted public use. With regard to commercial transporters of waste shipments to the NNSS, no released items can have residual surface contamination in excess of the limits specified in Table 1.

Table 1 Allowable total residual surface contamination for property released off the NNSS

	Residual Surface Contamination (dpm/100 cm^2)[(a)]		
Radionuclide	**Removable**	**Average[(b)] (Fixed & Removable)**	**Maximum Allowable[(c)] (Fixed & Removable)**
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	20	100	300
Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	200	1,000	3,000
U-natural, ^{235}U, ^{238}U, and associated decay products, alpha emitters (α)	1,000 α	5,000 α	15,000 α
Beta (β)-gamma (γ) emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above	1,000 β+γ	5,000 β+γ	15,000 β+γ
^{3}H and tritiated compounds	10,000	N/A	N/A

(a) Disintegrations per minute per 100 square centimeters

Source: NNSS Radiological Control Manual

(b) Averaged over an area of not more than 100 cm^2

(c) Applicable to an area of not more than 100 cm^2

The NNSS WAC currently specifies that "External contamination levels for waste packages and transport vehicles ***shall*** meet the release limits specified in Title 10 CFR 835, Appendix D."

The DOE occupational radiation protection regulations that are disseminated in 10 CFR 835 and in DOE O 458.1 are more conservative than the DOT regulations in 49 CFR 173.443. This difference in the regulations significantly impacts offsite and onsite transportation of DOE wastes. For example, the 10 CFR 835, Appendix D release limits for alpha contamination are ~10 times more conservative, and they are ~2 times more conservative for beta gamma than those in 49 CFR 173.443 (taking into account the recommended 10% swipe efficiency). The DOT limits (see Table 2) are designed to be protective of the transport workers and the public and are based on the ***International Atomic Energy Agency Regulations for Safe Transport of Radioactive Materials***.

Table 2 Summary of DOT Return to Service Limits

Return to Service	Removable surface contamination levels must be less than 4 Bq/100 cm^2 for α (220 dpm α/100 cm^2) and 40 Bq/100 cm^2 for β-γ (2,200 dpm β-γ/100 cm^2). The radiation dose rate at each accessible surface must be less than 0.005 mSv/hr (0.5 mrem/hr). The contamination levels apply to all internal and external surfaces of the transport vehicle.	49 CFR 173.443(c)

SUMMARY OF RELEVANT INCIDENTS

Prior to FY 2009, there were isolated and intermittent incidents at NNSS involving radiological contamination on either waste packages or transport vehicles and, in most cases, the contamination was due to leaking/damaged packaging (including metal, wood, and soft-sided containers). In these instances, NNSS issued specific Corrective Action Requests, and the waste generators took incident-specific action to correct the problems. There were only sporadic situations where NNSS was unable to release transport equipment due to external contamination, and NNSS personnel provided decontamination services.

During the period of study reviewed by the EFCOG Team (FY 2009 through FY 2011), the rate of such contamination incidents increased substantially, and the failure of waste packaging integrity was a contributing factor for the source of the contamination. In addition to the increased number of contaminated transport vehicles, the nature of the contamination also changed, and it became more difficult to decontaminate the affected items.

From FY 2009 though FY 2011, there were a total of 21 incidents involving radiologically contaminated shipment trailers and 9 contaminated waste packages received at the NNSS disposal facility. During this time period, the ES/Clive disposal facility had a total of 18 similar incidents involving trailer and/or package contamination issues. Ten of the 21 trailers received at the NNSS were contaminated to levels above “Return to Service” removable contamination limits (see Table 2) and radiation dose rate specified in 49 CFR 173.443(c), after applying the recommended 10% swipe efficiency specified in 49 CFR 173.443(a)(1).

Some of the commercial trailers that failed release criteria at NNSS required extensive effort in order to perform decontamination services down to the DOE release levels. This resulted in considerable “out of service” time for which one motor carrier pursued negotiation with the DOE waste generator and its subcontractors to recover lost “opportunity” costs associated with lack of access to this privately owned equipment over an extended period of time.

<u>Analysis of Trailer Contamination Incidents</u>

October 2008: Three shipments of MLLW debris grouted into nine boxes; no contamination detected on the tractors or trailers; several waste packages contaminated with weapons-grade plutonium at levels exceeding the DOE 10 CFR 835, Appendix D release limits; waste boxes returned to generator site for evaluation.

Generator subsequently determined that the presence of external contamination was due to limited access to the underside of the boxes during the final radiological surveys prior to release for shipment. Generator took several corrective actions including revision to site package

handling procedures in order to permit greater access to the underside of boxes during final survey.

December 2010: Total of 47 shipments containing uranium metal waste shipped as part of a larger shipment campaign; two trailers failed NNSS free-release survey; generator personnel verified that contamination was isolated to small areas near the centerline of the trailer flooring; trailers were returned to generator site as "rad empty" for further evaluation and corrective action.

Generator determined that the root cause involved legacy contamination on the exterior of the waste boxes (which had been packaged and stored for extended time) that had been transferred to the trailer flooring. Corrective actions taken by generator included the following:

- Implementation of an engineered racking system to permit enhanced visual and radiological surveys of the container bottom surfaces
- Enhanced oversight of both pre-loading and pre-shipment vehicle surveys
- Comprehensive re-survey of both loaded and empty (staged) trailers that involved enhanced large area swipe surveys on all accessible areas of the boxes

March 2011: Group of 35 shipments received; two trailers failed to meet the NNSS free-release criteria and were returned to generator for evaluation; generator determined contamination was limited to a 2-foot square area on each trailer floor (within the loading footprint of the waste box); re-survey of other trailers staged for shipment identified one additional case of similar external contamination.

During corrective action evaluation, the generator evaluated multiple potential root causes: vibration loss during transit, legacy contamination on boxes or trailers, and legacy particle contamination not previously detectable during release surveys. No single factor was ruled out. In addition, the generator also conducted a self-assessment of site radiation control processes and procedures.

Corrective actions taken by the generator included the following:

- Revision of onsite survey procedures to include a 10% independent verification
- Implementation of a tacky roller approach to enhance large area swipes on trailer floors and outer surfaces
- Re-wrapping of remaining waste boxes with clear stretch wrap
- Specification that transporters provide "new" trailers (no prior use on a DOE site) for transport of the remaining shipments

Lessons learned as a result of the corrective action process included increased emphasis on transport trailer history and trending, introduction of independent oversight for radiological survey activities, and enhanced trailer bed surveys using large area floor monitors.

August 2011: One cargo container and 10 boxes were received; after unloading, contamination was detected above DOE free-release limits in the middle area of the wooden trailer bed; no external contamination found on waste packages; NNSS decontamination services resulted in

extensive activities, including removal of wood flooring and physical scouring of accessible metal surfaces.

During the corrective action evaluation, the generator identified the following potential causal factors:

- Trailer release surveys were performed as spot surveys on less than 100% of the accessible load-bearing areas
- No incoming survey was performed on the trailer upon arrival at the site, and only a limited survey was conducted prior to waste loading
- Review of site procedures indicated that radiological survey guidance was in general not adequate to ensure consistency

After completion of corrective action planning, the generator issued enhanced survey requirements (100% coverage of accessible areas) and revised applicable site procedures for radiation control and waste generator services functions.

September 2011: Debris in Supersacks shipped to NNSS under large American Recovery and Reinvestment Act campaign; over 200 shipments containing more than 700 bags received without incident when trailers started to fail the NNSS free-release survey; no external contamination observed on bags off-loaded. A total of 13 flatbed trailers were subsequently held at NNSS for decontamination; generator personnel visited the NNSS to evaluate the issue; shipments were self-suspended in order to determine appropriate corrective action. See Figure 2 for a representative photo illustrating the trailer contamination locations.

Figure 2 Representative Areas of Trailer Contamination

The generator subsequently made several shipments of Supersacks to ES/Clive, and surface contamination was observed on three of the bags prior to disposal. The following details were provided with regard to those shipments:

- The bags were extensively surveyed before being loaded and found to not have external contamination.
- One bag was placed on clean plastic on the trailer, another on clean plywood, and the third directly on the trailer floor, which had been extensively surveyed and found not to be contaminated.
- All three bags had surface contamination when they arrived at Clive. All three surfaces that were clean at the time of shipment were contaminated when they arrived at ES/Clive. See Figure 3 for a representative photo showing the area of external contamination.

Figure 3 Representative Area of External Contamination

Causal analysis and corrective action evaluation was conducted by the generator, which identified the following causal factors:

- Packages were not stored in accordance with requirements in the NNSS WAC—although packages were stored in a secure location, they were stored outside without any additional protection from rain and snow.
- Generator personnel closed the package in accordance with vendor instructions but did not consistently secure the weather protection flaps; improper closure was also noted by NNSS during unloading activities.
- During periods of heavy rainfall, the plastic on which filled bags were staged inhibited water runoff and caused water to pool around the bottom of packages.
- Localized areas of standing water potentially penetrated the packages to create conditions that allowed radioactive contamination to migrate through the external bag surfaces during extended transport.
- Although contamination was detected on the outside of several packages received at ES/Clive, including discoloration along several package seams, no visual indications of package breaches were identified during inspection.
- Trailer surveys were limited by lack of physical access for generator personnel to the center portion of the trailer bed, resulting in un-surveyed areas along the centerline that could not be ruled out as having detectable contamination.
- Procedural inconsistencies were noted with regard to radiological surveys of loaded shipments; no incoming surveys were performed on empty trailers upon receipt at the loading area.

In response to these factors, the generator implemented the following corrective actions:

- All remaining and newly filled waste packages (including unused bags) were relocated to secure areas with protection from adverse weather, including storage on pallets, inside covered facilities, or under tarpaulins.
- Waste Certification Official surveillance requirements were expanded to include evaluation of package storage adequacy.
- Detailed radiological surveys were implemented on packages and trailers prior to loading waste to verify that any exterior contamination is within limits allowed by NNSS.
- Enhanced 100% survey procedures were implemented for all accessible load surfaces (including trailer centerlines) prior to vehicle entry to a controlled area, package loading, and shipment release for transport.
- Generator conducted and documented training of project operations personnel to the enhanced package storage and survey procedures.

OBSERVATIONS

The primary observations made by the EFCOG Team were as follows:

- Recent trailer contamination incidents at the NNSS have resulted primarily from removable (non-fixed) radiological contamination found on the trailers that exceeds the limits allowed by the NNSS WAC (same as 10 CFR 835, Appendix D) for releasing commercial transportation company equipment (e.g., trailers) back off site after the waste packages were unloaded.

- NNSS WAC specifies that the external contamination levels for release of the waste packages and transport vehicles shall meet the limits specified in 10 CFR 835, Appendix D. NNSS is therefore required to use the more restrictive free release limits and is prevented from releasing any transport equipment back into commerce if the outgoing surveys detect contamination above these limits.
- Although no issues were observed at NNSS that involved breech of a waste package during transportation, there was a release of contamination from the waste packages after being loaded at the generator site, which subsequently contaminated the commercial trailers.
- External contamination observed during ongoing NNSS trailer surveys could not be uniquely identified with any one particular DOE originating site location.
- Trailer histories provided by the commercial carrier showed that, in many instances, the trailers had been used at several different DOE sites as well as for various power plant shipments to commercial disposal sites.
- Some DOE sites were not performing a thorough trailer survey prior to loading DOE radioactive waste packages for subsequent transport to NNSS for disposal.
- The ES/Clive disposal site reported several documented situations where external contamination levels on incoming waste packages exceeded DOT "surface contamination release" limits. These shipments included both those that originated at a DOE site location as well as at a commercial site.
- Commercial nuclear power facilities and commercial disposal sites release transport equipment to the DOT commercial transportation limits (49 CFR 173.443 and 177.843).
- The recent increase in NNSS trailer contamination incidents is due primarily to contaminant release from improperly closed and staged soft-sided packaging, in conjunction with the mandatory application by NNSS of the lower DOE "free release" limits specified in 10 CFR 835, Appendix D. In approximately 50% of the trailer contamination incidents at the NNSS, the level of contamination on the trailers would also have made them not releasable under the DOT release limits, as promulgated in 49 CFR 173.443 and 177.843.

ASSESSMENT OF INTEGRITY FOR SOFT-SIDED PACKAGING

In view of the potential for external contamination of soft-sided packages (which was included as a possible causal factor during generator corrective action determinations), the EFCOG Team evaluated the inherent capabilities and limitations associated with soft-sided packaging. The Team reviewed the recent history for DOE site use of this type of packaging and also considered the potential for packaging failure as a contributing factor in the specific trailer contamination incidents described above. During this process, relevant packaging material and production process information was requested from Team members who were representatives from commercial vendors who specialize in providing soft-sided packaging that has been used for DOE LLW management and disposal applications.

Background and Description for Soft-Sided Packaging

For the purposes of this inquiry, "soft-sided packaging" refers to a DOT-compliant container (bag, liner, Supersack, etc.), as defined in 49 CFR 173.410 and 411, and includes both IP-1 and

IP-2 rated containers, which are manufactured from polypropylene, polyethylene, or similar materials and range from 5 to 9 cubic yards (135 to 243 cubic feet) in capacity.

Soft-sided packaging was introduced to the radioactive waste management industry over 15 years ago. Since then, many thousands of these packages have been sold and used in the United States in both commercial nuclear and government waste management applications. Soft-sided packaging is manufactured and supplied by multiple vendors, all of which have reported consistent successful results. These packages have been shipped successfully in closed van trailers, flatbed trailers, and even in the much more demanding environment of railroad gondola cars.

Flexible packaging is readily applicable to flowable, soil-like materials. Additional liners (generally a “pad” or liner of non-woven geo-textile fabric may be needed if the waste includes debris or sharp-edged material. The available lifting equipment and mode of transportation may influence the choice of a package that is lifted with integral straps or the use of a package without lifting features that requires a pallet or similar accessory.

The considerations for the design, selection, and use of flexible packaging can be different from those considerations for rigid packaging. Thoughtful evaluation of packaging design and use factors is an important aspect of waste management best practice, and is necessary to ensure the success of individual waste disposal campaigns. Proper selection of packaging materials should be based on the following criteria:

- Exterior fabric (weight, strength, finish)
- Liner (puncture strength, permeability)
- Lifting Straps (tensile strength)
- Thread (compatibility with fabrics)

One-piece packages of a bag-like construction are suitable for top-loading bulk materials. Rigid objects may require a two-piece “inverted shoebox” design where the object is easily loaded onto a shallow pan and then covered with a larger top piece. Non-woven water-resistant liners can also be used to provide additional containment assurance for higher moisture content materials; however, users must be aware that flexible packages are not designed to contain free liquids or withstand hydrostatic pressure of any kind.

Soft-sided packaging designs include IP-1 and IP-2 certified packages, and products are subjected to the physical tests (not merely design analysis) to demonstrate performance to those standards. Packages have been used successfully for load capacities ranging from 1 to 12 tons. Soft-sided packaging is constructed from engineered plastics that repel and resist water intrusion under normal circumstances; however, these packages are not inherently waterproof.

Flexible packages have been demonstrated to meet both the DOT IP-1 packaging standard and the more rigorous IP-2 standard requiring drop and stack testing. The packages can also be certified to meet the requirements of 49 CFR 173.240(c) required for hazardous materials in Packing Groups II and III. The certification and test requirements for flexible packaging are identical to those for rigid packaging. Design and manufacture of DOT-rated packages require a quality assurance (QA) program meeting the requirements of DOT 49 CFR 173.474, and an

NQA-1 program is the generally accepted standard for demonstrating that the QA requirement is met.

End users accustomed to rigid packages must be aware that flexible packages are subject to UV degradation after extended periods of exposure during outdoor storage. Tarps or other secondary covers can be used to address this issue. Also, unlike rigid packages that typically sit on fork pockets or ISO corners, the entire bottom surface of a flexible package contacts the surface on which it is stored or transported. Care must be taken that this surface does not promote cross-contamination and does not accumulate water. Like rigid packages, flexible packages must be properly closed and secured in accordance with the manufacturer's instructions, so that rainwater has no intrusion path into the packaged waste.

Many users of flexible packages have stored materials outdoors for weeks or months in various extremes of weather with no reported degradation of the packaging or release of contents. There is no storage requirements unique to flexible packaging that do not apply equally to metal drums or boxes, with the exception of protecting the packages from long-term UV exposure, as described in the packaging vendor specifications. It is not good practice to store any radioactive materials package in standing water (rigid or flexible).

Standard flexible packages are not designed to contain free liquids. Improper closure, including failure to properly close the weather flap on a flexible package, can provide paths for in-leakage of rainwater. Users who do not completely secure the weather protection flap on flexible packaging are not following the vendor's written closure instructions, as proper closure of the weather protection flap is vital to ensuring the overall integrity of the package.

Successful Utilization of Soft-Sided Packaging

Soft-sided packaging has proven to be a cost-effective and reliable alternative to traditional wood and metal packaging in a wide variety of LLW transportation and disposal situations, as demonstrated on the following projects:

- Savannah River Depleted Uranium Oxide Drum Project – 2,400 IP-1 4-drum overpacks shipped to NNSS with no issues
- Berkeley Bevatron Facility D&D – over 1,200, 6.8 cubic meter (9 cubic yard) IP-1 bags containing debris waste to NNSS with no issues
- Argonne Bldg 330 D&D – over 1,300, 6.8 cubic meter (9 cubic yard) IP-1 bags to NNSS with no issues
- Los Alamos Remediation – over 1,500, 6.8 cubic meter (9 cubic yard) IP-1 bags to Clive with no issues
- Separations Process Research Unit (SPRU) Remediation – over 3,000, 6.8 cubic meter (9 cubic yard) IP-1 bags to Clive with only one minor issue

  SPRU stored the filled bags onsite before shipping, and the bags were freezing into a block. When bags were lifted, the straps were not straight vertically, and they pulled out away from the top of the bag, putting significant stress on the stitching around the zipper, and causing the thread to break. The vendor worked with SPRU contractors and DOE to fix the problem and wrote a protocol that specified removal of the straps from the "belt loops" around the top of the bag before lifting. Even though some bags did come open

due to broken stitching, the duffle served as an interior closure and there was no release of material.

- B&W Y-12 – 2,000 bags to Oak Ridge onsite disposal cell with no issues
- NNSS Environmental Restoration Projects – 835 lift-liners and 200 burrito bags to Area 5 disposal site with no issues
- West Valley Demonstration Project – 3,100 IP-2 6-drum overpacks shipped in rail gondola cars and transferred to trucks for NNSS delivery with no issues

Recent Incidents at NNSS and Clive

Evaluation of incidents during shipment campaigns involving DOE debris wastes in Supersacks being sent to both NNSS and ES/Clive resulted in the following observations:

- Over 200 shipments (containing more than 700 bags) were received at the NNSS with no issues.
- A total of 13 trailers failed to meet DOE free-release survey limits specified in 10 CFR 835, Appendix D (after being unloaded) and were subsequently retained for decontamination at NNSS.
- No external contamination was found on bags during off-loading at NNSS.
- Subsequent shipments of Supersacks to ES/Clive experienced both trailer and bag contamination issues.
- The DOE generator sites conducted a comprehensive evaluation of incidents and implemented effective corrective actions to prevent recurrence:
  - All waste packages were relocated to a secure area with adequate weather protection.
  - Generator performed enhanced surveys of incoming trailers and waste packages prior to loading, including a 100% survey on all accessible load-bearing surfaces.
  - Generator provided and documented additional package-specific training given to operations personnel, including detail on revised procedures.

PACKAGING BEST PRACTICES

The Team members examined a wide range of factors that would affect the integrity for soft-sided packaging, based upon past project experience. The following best practices were identified as those being relevant to successful performance of the soft-sided packaging:

- Use packaging appropriate for the waste matrix and content.
- Consider hydrostatic pressure effects on bags containing soil-like waste with moisture content > 25%.
- Incorporate light polyethylene liner and approved absorbent media to control moisture content.
- Adjust lifting straps for load shift or deformation, as required.
- Use common sense when loading/closing/lifting/storing flexible material.
- Do not stage or store bags (empty or filled) with no protection from the elements or in areas of poor water drainage or pooling.
- Train user personnel to manufacturer’s specific use/care instructions.

- Monitor dust suppression during bag fill and closure operations to minimize water intrusion.

CONCLUSIONS –PACKAGE INTEGRITY

Based upon the summary review conducted by all participants, the following basic observations led to the overall conclusion that soft-siding packaging remains appropriate for use during LLW management and disposal—subject to the proper conditions of use:

- There has been a successful history of soft-sided packaging use for over 15 years in LLW management applications.
- Multiple vendors and customer users have reported consistent satisfactory performance during multiple applications.
- Soft-sided packaging provides viable, cost-effective alternatives to the use of wooden and metal containers.
- Packaging must be appropriate for the LLW content/media being managed under controlled environmental conditions.
- Compliance with manufacturer storage, handling, filling, lifting, and related instructions is essential to ensure proper packaging performance.
- Consistent training of site operations personnel to manufacturer requirements will ensure maximum packaging performance.
- Filled waste packages must be staged and stored properly to minimize water intrusion and structural integrity.
- Use of appropriate and adequate absorbents and liners will minimize adverse effects associated with higher moisture content.

ACKNOWLEDGMENTS

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