COST EFFICIENT TRU WASTE PACKAGING AND A SAFER AND FASTER METHOD OF REMOVING TRU WASTE FROM GLOVEBOXES

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ABSTRACT

Transuranic (TRU) waste packaging from a glovebox has been done for years using bags as the primary containment. Bag operations, i.e. connecting and disconnecting from a glovebox are tedious and require explicit controls to perform safely. The bag operation itself takes good operators a minimum of 20 minutes per drum out performed.

Multiple resistance factors come into play with the Transuranic Package Transporter-II (TRUPACT-II) and its governing document, the TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) due to bag layers. Multiple bag layers along with the 90mil liner, all lower the fissile Decay Heat Limit (DHL) for the drum, in most cases, leaving the 55 gallon drum partially filled, thus a large amount of empty drum space is being characterized, shipped to, and buried at the Waste Isolation Pilot Plant (WIPP) site. A Safer, more efficient method of packaging more TRU waste per drum is the focus of this paper.

A well known containment systems company by the name of la Calhene adapted its proven material transfer technology, the Double Port Transfer Exchange (DPTE™), to the application of Transuranic (TRU) waste management. The DPTE™ Bagless Transfer System [2] is a double door system mounted on the bottom of a glovebox and allows the loading of a standard 55-gallon Department of Transportation (DOT) 7A, Type A drum without the need for bags or sleeves to maintain leak-tight containment. A flanged container replaces the 90-mil liner and all bag layers in the standard 55-gallon drum. DPTE™ system interlocks eliminate inadvertent containment breach, protecting operators from Alpha (α) and Beta (β) radiation exposure. The operator never has to get close to the waste path during the drum connect or disconnect operation, minimizing As Low As Reasonably Achievable (ALARA) levels due to Gamma (γ) radiation exposure.

The DPTE™ drum container flange connects to the glovebox flange very quickly and easily. The entire connect and disconnect of the drum takes less than two (2) minutes. The efficiency of DPTE™ operations will greatly increase throughput in both legacy repackaging operations and generated waste packaging operations with no increase in footprint or labor force. The DPTE™ drum liner, itself, maintains containment of fluorescence tracer within the liner after numerous DOT 7A, Type A certification drops. This reduces the risk of contamination in the event of an accidental drum breach.

The DPTE™ drum liner is the only layer of confinement inside the drum and has a very high diffusion coefficient filter. When coupled with a high diffusion drum bung filter, the combination provides a major increase in DHL per drum for most TRU waste types when compared with bagged waste drums. Large debris inorganic TRU waste can be directly packaged in a Stainless Steel (SST) DPTE™ container and qualify for the DHL available in the TRAMPAC. Increased DHL per drum means fewer drums or less space used to package the same amount of waste.

Finally, a TRU waste packaging solution that is Safer, Faster, Better, and much more cost effective. This paper will show how the DPTE™ Drum System can save the National TRU waste program millions of dollars per year by improving packaging operations, and minimizing the number of drums being characterized, shipped to, and buried at the WIPP.

INTRODUCTION

Removing Transuranic (TRU) waste from a glovebox is typically performed using a plastic bag as the primary containment through a process known as a "bagout" [1]. Although bagouts are an industry standard and are performed safely, there have been numerous near misses and exposures to operators and facilities while performing waste removal through bagouts. Successful bag operations require well-trained operators following detailed procedures. Connecting the bag, removing the old remnant bag, preparing waste items for loading, loading; twisting, tying, cutting, and taping the bags is a lengthy and complicated process. In addition to the complexity of the task, bagout operations are usually performed beneath a glovebox making the process more difficult and uncomfortable. Los Alamos National Laboratory has evaluated other bagless transfer systems for drumouts in the past; however none were able to meet the containment and safety requirements of the site.

CURRENT SYSTEM

The existing practice of removing and introducing materials or waste into or from a glovebox is analyzed in a LANL Hazard Control Plan (HCP) for operations and maintenance of gloveboxes and process enclosures [2]. Although ergonomic and radiological hazards are identified, sufficient controls are used to reduce the risk and consequence of those hazards to acceptable levels. According to the HCP three hazards exist including exposure to ionizing radiation, loss of containment of radioactive materials and ergonomics. The first hazard is the ionizing radiation associated with handling TRU waste items without shielding. In order to minimize the hazard bagouts are planned to minimize the time in contact with any unshielded material. The second hazard is the potential loss of containment of radioactive materials during the bagout process. At some point during the removal of an item, the laboratory atmosphere is exposed to contaminated surfaces. Use of wet cheesecloth and high-efficiency particulate air (HEPA) filter vacuums and the facility ventilation system minimizes the chance of contamination during bagouts. The ergonomic hazards associated with glovebox work are well known and include constrained movement, a reduction in the ability to handle heavy items, repetitive motion and working in awkward positions. Proper training, following procedures, wearing Personal Protective Equipment (PPE) and radiological monitoring help reduce the risks of the bagout process. \

LA CALHÈNE DPTE™ BAGLESS TRANSFER SYSTEM

The DPTE™ Bagless Drumout System is a double door system mounted on the bottom of a glovebox and allows the loading of a standard 55-gallon DOT 7A, Type
A drum without the need for bags or sleeves to maintain leak-tight containment. The DPTE™ Bagless Drumout System features a medium-density polyethylene (MDPE) or stainless steel (SST) liner with a flanged top. The DPTE™ liner is placed inside a standard 55-gallon drum and functions as the drum liner. The 55-gallon drum using the DPTE™ liner has only one layer of confinement, the filtered liner, in addition to the vented drum. The waste can be directly loaded into the DPTE™ container without any additional containment. The drum can be disconnected and re-connected until the drum is full, this is not possible with bagout drums. Analyses on decay heat limits for this configuration were performed with respect to transportation requirements for shipping TRU waste to the Waste Isolation Pilot Plant (WIPP) [3]. In addition, the usefulness of the DPTE™ System to selected operations at Los Alamos National Laboratory (LANL) was examined.

The DPTE™ system interlocks do not allow a breach of containment, protecting operators from α and β radiation exposure. The operator never has to get close to the waste path during the drum connect or disconnect operation so ALARA levels due to γ radiation exposure are minimized. The DPTE™ container flange connects to the glovebox flange very quickly and easily. The entire connect and disconnect of the drum takes less than two (2) minutes. The speed of operation and numerous other operational savings will greatly increase throughput in both Legacy repackaging operations and generated waste packaging operations with no increase in the operations footprint or labor force. The DPTE™ container itself is leak tight further reducing the risk that the TRUPACT II gets to the WIPP contaminated even if the drum seal is breached. Table I compares the DPTE™ Bagless Drumout System with the conventional bagout process.

Table I Operational comparison of the DPTE™ bagless drumout system with the conventional bagout process

Conventional Drumout/Bagout	DPTE™ Bagless Transfer System
Drumout/Bagout is 2 person job	DPTE™ ™ Drumout can be performed by one person
10 Step procedure for replacing Bagout Bag	3 Step Procedure for connecting DPTE™
22 Step Procedure for Bagging out waste	6 Step Procedure for drumming out waste
Work performed under the glovebox in awkward position	Work performed by operator in upright position
Respirators required for all activities involving bagout bags.	Respirators may not be required.
Radiation exposure of 20 – 30 minutes per bagout	Radiation exposure reduced to 3-5 minutes per drumout
Twisting and taping of bag requires repetitive motion	Repetitive motion is reduced or eliminated
Bagout drum can only be loaded once	The DPTE™ Bagless Transfer System allows the drum to be connected, disconnected, and re-connected for filling as many times as needed.
Plastic bags, tape, and ties, become part of the waste stream	Plastic bags are not used
Waste accumulate in gloveboxes awaiting sufficient personnel and time to perform bagout process	Waste can be removed as they are generated
Bagout port is sealed with a bagout bag	Glovebox is sealed with a DPTE™ door.
Bagout bag hangs beneath glovebox when not in use.	Space beneath glovebox is open for storage
Bagout port can be used for introducing items into the glovebox through a bagin.	Multiple size DPTE™ containers are available for introduction of items through the drumout port.
Sharps have to be taped before loading into the bag to prevent puncture	Sharps can be directly loaded without possibility of puncture

DECAY HEAT LIMIT ANALYSIS

Multiple resistance factors come into play in the TRAMPAC due to bag layers when calculating Total Resistance as part of the Shipping Category for a drum. Multiple bag layers along with the 90mil liner, all used for containment and/or safety, all lower the DHL for the drum, in many cases leaving the 55 gallon drum only partially filled, thus a large amount of empty drum space is being characterized, shipped to, and buried at the WIPP. In the recent past many steps have been taken to increase the DHL for bagged waste drums including cutting and puncturing inner bag layers. When old drums do not meet the WIPP criteria, they must be repackaged. The DPTE™ Drum system is a safe, fast, method for maximizing the repackaged drum load where wattage is the issue, due to the increased DHL of the DPTE™ package.

The DPTE™ drum liner is the only layer of confinement inside the drum and has a very high diffusion coefficient filter. When coupled with high diffusion bung filters on the drum lid, the combination provides a major increase in DHL per drum for most TRU waste types compared with bagged waste drums. The DPTE™ SST drum container qualifies packaging of inorganic material to the maximum DHL and FGE allowable for a drum. For higher wattage (i.e. Pu238 contaminated) large item inorganic debris waste, this will maximize the fissile content per drum and greatly reduce the number of drums being assayed, reviewed by Real Time Radiography (RTR), Documented, and sent to the WIPP.

A decay heat limit analysis was performed for the packaging configurations (various filter specifications) described in Table II. Each packaging configuration consists of one inner layer of confinement, which is the DPTE™ container or a filtered Inner Bag. Packaging configurations 1 and 2 use the actual release rates of the filters on the DPTE™ liner and the 55-gallon drum lid. Packaging configuration 3 uses the allowed release rates listed in Appendix 5.4 of the TRAMPAC, Revision 19c [4].

Table II Packaging Configurations for Decay Heat Analysis

DPTE™ Packaging Configuration	1	2	3
Total Release Rate of Filtered 55-Gallon Drum (mol/s/mol fraction)	1.11E-04 (One model 9460 filter)	1.29E-04 (One model 9460 filter and one model 9500 filter)	9.25E-05 TRAMPAC 19c listing
Total Release Rate of la Calhène Filtered MDPE Container (mol/s/mol fraction)	1.48E-04 (One model 0360HD filter)	1.48E-04 (One model 0360HD filter)	7.94E-05 TRAMPAC 19c listing
Bagged Packaging Configuration			3
Total Release Rate of Filtered 55-Gallon Drum (mol/s/mol fraction)			9.25E-05 TRAMPAC 19c listing
Total Release Rate of 1 Filtered Inner Bag in an open 90mil liner (mol/s/mol fraction)	5.375E-05 (One NF Bag Filter)		5.375E-05 TRAMPAC 19c listing

Using assumptions described below, shipping categories and DHLs for the packaging configurations in Table II were determined by following the methodology described in Appendix 5.4 and 5.5 of the TRAMPAC, Revision 19c.The first step in determining the shipping category is to determine the release rate and associated resistance factor for each layer of confinement. The actual release rates of the filters were rounded down to the current allowable release rates in Table 5.4-3 of the TRAMPAC, Revision 19c [4] thereby conservatively determining equivalent layers of confinement shown as packaging configuration 3. For example, the model 036HD filter on the DPTE™ filtered container has a release rate of 1.48E-04 mol/s/mol fraction corresponding to a resistance factor of 68. Analysis performed demonstrates that a punctured 90-mil standard rigid liner with a 0.375-inch hole most closely represents the DPTE™ container; the allowable resistance factor is 126 (7.94E-05 mol/s/mol fraction). For comparison, shipping categories and associated DHLs for packaging configuration 3 are shown in Table III for Waste Types I and III as well as some FY2003 LANL waste categories where the DPTE™ container would have greatly affected loading.

Table III Decay Heat Limits Based on TRAMPAC Filter Specifications

Packaging Configuration 3					
	Bagged		DPTE™ PE Liner		
Waste Type	Shipping Category	Decay Heat Limit (watts)	Shipping Category	Decay Heat Limit (watts)	% DHL Increase
I.1	1001600168	0.1797	1001600075	0.4020	223%
I.2	1001300168	0.2212	1001300075	0.4948	227%
I.3	1000400168	0.7189	1000400075	1.6081	223%
III.1 [a]	3003400110	0.129	3003400074	0.1917	148%
LANL 2003 Example Waste Category					
III.1 [a]	3003400280	0.0507	3003400074	0.1917	378%

[a] Dose Criteria Not Satisfied (watt*year < 0.012)

VOLATILE ORGANIC COMPOUNDS (VOCs)

To determine the role of the MDPE DPTE™ filtered container with volatile organic compounds (VOCs), preliminary calculations were performed to determine the amount of time necessary for VOCs to reach their steady state concentrations in the container headspace. The 55-gallon drum filter has a model 9460 filter (release rate of 1.11E-04 mol/s/mol fraction). The single inner layer of confinement, the DPTE™ filtered container, has a 036HD filter (release rate of 1.48E-04 mol/s/mol fraction). Assuming debris waste and toluene as the VOC, VOCs in the package are within 10% their steady state concentration in approximately 6 days.

The DPTE™ MDPE filtered container can be expressed in terms of an equivalent confinement layer with respect to VOCs, which would be a rigid drum liner with a minimum diameter hole of 0.375-inch. Using same test criteria, the VOCs in this theoretical equivalent packaging configuration in a standard 55-gallon drum reach 90% their steady state concentration in approximately 28 days.

APPLICATION TO LANL TRU WASTE

The Nuclear Materials Technology (NMT) Division conducts and provides support for scientific research and development on strategic nuclear materials the Plutonium Facility [Technical Area (TA)-55-PF4] and the Chemistry and Metallurgy Research (CMR) Facility (TA-3, Building SM-29). Although not currently installed, the DPTE™ drumout system was compared to the existing waste "bag out" process at TA-55-PF4.

TRU waste materials, process chemicals, equipment, supplies, and some Resource Conservation and Recovery Act (RCRA) materials are introduced into the Radiological Control Areas (RCA)s in support of the programmatic mission. All materials being removed from gloveboxes must be multiple-bagged to prevent the spread of contamination outside the glovebox. Currently, all material removed from gloveboxes is considered to be TRU waste. Large quantities of waste, primarily solid combustible materials such as plastic bags, cheesecloth, and protective clothing, are generated as a result of contamination avoidance measures taken to protect workers, the facility, and the environment. TRU solid wastes are accumulated, characterized, and assayed for accountability purposes and then packaged for disposal in metal 55-gallon drums, standard waste boxes (SWBs), and oversized containers. The percentage breakdown of that TRU waste by weight for Fiscal Year (FY) 2003 is shown in Fig. 1.

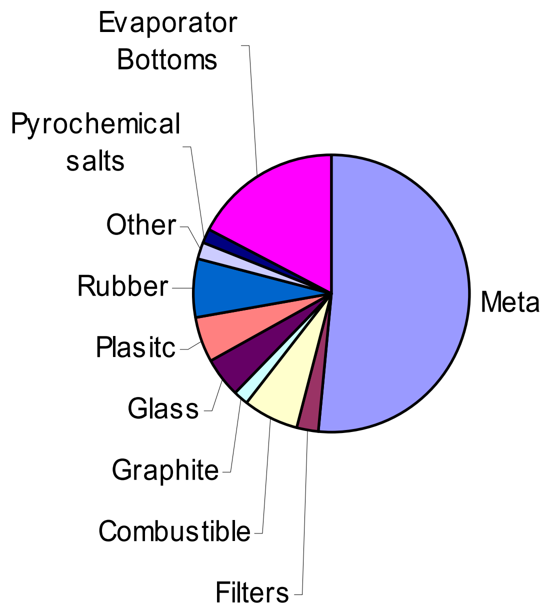

Fig. 1 Composition of Solid TRU waste from NMT Division for Fiscal Year 2003.

From October 1, 2002 through September 30, 2003 LANL produced 116.5 cubic meters (m^3) of transuranic (TRU) and mixed transuranic (MTRU) waste from operations at the PF-4 and CMR. As can be seen from Figure 1 the majority of the TRU wastes generated at TA-55 are non-actinide metals including pumps, piping, machinery, etc. Due to the actinide concentration of these waste items only a few can be packaged in each drum before the Special Nuclear Material (SNM) limit of the drum is reached. Although the volume of the actual waste is quite small, the volume of the shipping container (Drum or Standard Waste Box (SWB)) is used to calculate waste volume. Thus a few small waste items are reported as a volume of $0.208m^3$ (55-gallons) of waste while a large percentage of the "waste volume" is air. In addition some waste items are being packaged in 55-gallon Pipe Overpack Containers (POCs) to reduce the dose rate to levels acceptable for shipping and storage. Packing inside a POC limits the waste volume to approximately $1/6^{th}$ of the actual container volume.

An analysis of the potential benefit from improved packing efficiency was performed on 371 drums of LANL TRU waste packaged in Fiscal Year (FY) 2003. Table IV provides a comparison of drums packaged by the drumout process (In-Line) and those drums packaged by bagging out the individual items and then packaging the waste into drums (Out-of-Line). The three shipping categories shown in Table IV represent 91% of the TRU waste packaged in drums during FY2003. In both shipping categories involving hydrogenous materials the TRU waste is packaged above the Wattage Limit. Matrix depletion during storage ensures these wastes will meet the allowable wattage limit prior to shipping. The non-hydrogenous metal waste in shipping category 2000000000 is limited by either the Fissile Gram Equivalent Limit or the Activity Limit well before the Wattage Limit is reached.

Comparing In-Line drums and Out-of-Line drums for the three shipping categories in Table IV shows that the In-Line Drums contain only 54% of the SNM that the Out-of-Line drums contain. Because packaging an In-Line drum is a one-shot activity, only those waste items in the glovebox at the time of the drum packaging are loaded into the drum. Out-of-Line drums are loaded with individually bagged waste items and can be opened and closed several times until they are more fully loaded. However loading an

Out-of-Line drum requires each waste item be assayed and individually managed as opposed to assaying and managing a single drum. In addition once loaded, the Out-of-Line drum must be assayed again to verify the contents. If the difference between the amount of SNM loaded in In-Line drums and Out-of-Line drums is indicative of packaging efficiency, use of the DPTE™ Drum System could reduce the number of In-Line drums by approximately 50% by making it possible to connect the same drum as many times as needed until it reaches one of the packaging limits. Although packaging options for these wastes currently exist, the DPTE™ SST Drum container has the added benefit of ensuring containment and improved ALARA during packaging operations.

Table IV LANL Fiscal Year 2003 TRU Waste Packaging

Shipping Category	Wattage Limit	In-Line Drum			Out-of-Line Drum		
		Average Wattage	Average FGE	Drums	Average Wattage	Average FGE	Drums
2000000000, Non Hydrogenous material in Metal Can	40.0000	0.2497	95.98	6	0.3033	117.39	65
3003400110, Hydrogenous Materials in 1 filtered bag	0.1290	0.2347	25.82	90	0.2780	35.74	175
3003400280, Hydrogenous Materials in 1 non-filtered bag	0.0507	0.0739	30.38	13	0.1930	71.48	22

COST EFFECTIVENESS

There are numerous costs associated with packaging a single drum of TRU waste [5]. At LANL those costs are incurred by different organizations at different points in the disposal process. Even though the DPTE™ filtered container ($1,000) cost more than a standard DOT 7A, Type A drum, liner and bag ($140), if using that container reduces the overall number of drums entering the TRU waste disposal process of packaging, characterizing, certifying, shipping, receiving, verification and disposal, the DPTE™ Drum System could significantly reduce TRU waste disposal cost. LANL's variable cost characterizing a single drum is approximately $4,200 and that cost doesn't include the fixed facility cost. WIPP is limited to a total disposed volume of 175,564 cubic meters of TRU waste [6]. Use of the DPTE™ Drum System for efficient TRU waste packaging will conserve the finite amount of disposal space available at the WIPP and greatly reduce handling costs throughout the entire process.

SUMMARY

Use of the la Calhène DPTE™ Bagless Drum System can significantly reduce both the ergonomic and radiological hazards of removing TRU waste from gloveboxes. Based on the increased DHL analysis, the DPTE™ MDPE and SST containers have been shown to be conservatively equivalent to approved confinement layers in Revision 19c of the TRAMPAC [7]. Although the initial cost of the DPTE™ filtered container is significantly higher than that of a bag and 90mil standard liner, reducing the number of TRU waste drums managed through the extensive TRU waste disposal process would make up the difference and save the site and the National TRU Waste Program thousands of dollars for each drum avoided. Use of the DPTE™ MDPE filtered container for packaging waste destined for disposal at WIPP will require approval from the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission.

REFERENCES

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