REUSE OF CARGO CONTAINERS FOR LOW LEVEL WASTE SHIPMENTS TO NTS

by

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ABSTRACT

There are over 800 cargo containers at the Rocky Flats Environmental Technology Site (RFETS) that are used for storage of waste or supplies. For site closure, all cargo containers and their contents will ultimately require disposition. Most of these cargo containers will be disposed of as waste or sold for salvage value. However, in lieu of these options, the Customer Service Organization (CSO) of Rocky Mountain Remediation Services, L.L.C. (RMRS) has begun an initiative to reuse the cargo containers for shipping waste to the Nevada Test Site (NTS). RFETS has experienced both quality control and production rate problems in the purchase of new containers for waste packaging. These problems have impacted waste shipping, and accordingly, site closure activities. The CSO is exploiting the availability of used cargo containers generated from Site closure activities in order to provide a readily available, alternative low cost waste packaging for Low Level Waste (LLW) shipped to NTS. Concurrently, the CSO is participating in the procurement of used cargo containers from off-site sources.

49 CFR provides the requirements for radioactive material packagings based on the classification of the material. In accordance with 49 CFR Section 173.427(c)(1), Low Specific Activity-I and Surface Contaminated Object-I (LSA-I and SCO-I) material can be shipped in DOT strong, tight packagings, if it is shipped in bulk and the conveyance is exclusive use. Cargo containers are bulk packagings, and shipments of low level waste to NTS are their exclusive use.

In order to utilize used cargo containers as packaging for LSA-I and SCO-I waste destined for NTS, the CSO accomplished the following tasks:

1. Developed an inspection procedure to verify that used cargo containers meet DOT strong tight packaging requirements.
2. Developed an Item Specification for procurement of used cargo containers from off-site vendors
3. Received approval from the on-site NTS representative (Waste Certification Official) for their reuse as waste packagings.
4. Identified, inspected, and repaired, as necessary, used cargo containers.
5. Began loading waste in used cargo containers and shipping the waste to NTS in the fall of 1999.

To date, 80 used cargo containers have been utilized to ship SCO-I waste to NTS. The cost savings to the government exceeds $500,000. The anticipated cost savings to the government through site closure is estimated at $13,000,000. Relative to using drums,

this is a minimum savings that does not included significant cost reductions related to radioassay, Real Time Radiography, and packing labor associated with package closure and documentation.

INTRODUCTION

It appears most sites within the DOE complex purchase new containers for packaging and shipping Low Level Waste (LLW) to the Nevada Test Site (NTS) or another commercial low level waste disposal facility. Until recently, the Rocky Flats Environmental Technology Site (RFETS) adhered to this practice. However, in the Spring of 1999 when waste packaging demand was high, low production output from the vendors and quality control problems began to adversely affect performance of waste generating projects. Projects most impacted where those involving Decontamination and Decommissioning (D&D), which generate large volumes of LLW from equipment stripout and demolition activities.

In order to meet the challenge of procuring sufficient waste packagings for the site, the Customer Service Organization (CSO), which amongst other functions is responsible for the procurement of waste commodities, investigated alternative packaging types that could be utilized at RFETS. Research on the subject indicated that Lawrence Livermore National Laboratory (LLNL) and the Mound Plant had used refurbished cargo containers to ship LLW to the NTS. Upon review of the Department of Transportation (DOT) regulations, it became apparent that it was unnecessary to utilize new or even refurbished cargo containers to ship most types of LLW, i.e., a used cargo container meeting the requirements of a DOT strong, tight packaging would be adequate.

There are over 800 cargo containers at RFETS that are used for storage of waste or supplies. For site closure, all cargo containers and their contents will ultimately require disposition. A current performance measure for the site is to identify, document, and remove 500 cargo containers and their contents from RFETS by June 30, 2000. Because these cargo containers are an alternate source of waste packagings, it became incumbent upon the CSO to "piggy back" on this performance measure by identifying those cargo containers suitable for shipping waste to the NTS before they were sold or removed from the site as waste. In addition, in order to meet the high demand for waste packagings, the CSO also investigated offsite sources for used cargo containers. Several vendors were identified that had a ready supply of used cargo containers. In order to exploit these opportunities, it was first necessary to develop a Site Level procedure for inspecting cargo containers, and once approved, develop an Item Specification for procurement of used cargo containers based on the procedure.

WASTE TYPE – DOT PACKAGING RELATIONSHIPS

The DOT specifies the types of packagings that can be utilized for interstate transportation of normal form Class 7 radioactive materials based on the shipping category that is assigned. These relationships are discussed in order to provide perspective on the types of material that can be packaged in a used cargo container.

DOT Shipping Categories

The DOT defines several shipping categories of Class 7 radioactive material based on physical characteristics and radioactivity. The shipping categories germane to most RFETS wastes, and their physical characteristics are as follows:

Shipping Category	**Physical Characteristics**
Limited Quantity (LQ)	None specified
Low Specific Activity (LSA) I and II	Radionuclides distributed throughout the matrix
Surface Contaminated Object (SCO) I and II	Radionuclides distributed on the surface of a non-radioactive object.
Radioactive Material (RAM), n.o.s., Type A Quantity	None specified
Radioactive Material (RAM), n.o.s., Type B Quantity	None specified

LQ, LSA and RAM n.o.s are categorized by an activity limit for normal form Class 7 material known as an A_2 value (Table 1). The A_2 value is derived based on the radionuclides present in the waste, and represents the maximum activity for a Type A quantity of the radioactive material. Radioactive material with a total activity greater than A_2 represents a Type B quantity. Radioactive material contents less than 10^{-3} A_2 are a LQ. LSA I and II are defined by specific activities (activity per unit mass) based on the A_2 value, LSA II representing the higher specific activity. There is no relation between an A_2 value and SCO-I and II. SCO-I and II are defined by limits for removable and fixed activities per unit area of a contaminated object as shown in Table 1.

At RFETS, both low level (<100nCi/g) and transuranic (>100nCi/g) wastes will be generated during closure activities. Low level (LLW) and transuranic (TRU) are DOE designations for radioactive waste, and the specific activity limits are for transuranic elements with half lives greater than 20 years. From FY99 through FY06 (closure), 245,000 cubic yards (yd^3) and 20,000 yd^3 of LLW and TRU wastes will be generated, respectively. Of the LLW, approximately 75,000 yd^3 is expected to be LSA-I, half of which is contaminated soil from environmental restoration, and the balance is HEPA filters, papers, plastics, and wood. The remaining 170,000 yd^3 of LLW is SCO-I; however, it is estimated that 20% of this waste will be classified as RAM, n.o.s. (SCO-I – 136,000 yd^3; RAM, n.o.s. – 34,000 yd^3). The classification of the waste as RAM, n.o.s. allows the generator to not characterize the waste to determine compliance with the SCO limits, but it also restricts the generator to an A_2 quantity for the waste package and requires the generator to use a relatively expensive Type A package (discussed later). Although some TRU waste could meet LSA-II and SCO-II DOT shipping categories, all TRU waste is destined for disposal at the Waste Isolation Pilot Plant and will be shipped there in TRUPAC-IIs, a Type B package. TRU waste is accordingly classified as RAM, n.o.s. Type B quantity.

Package Types

As shown in Table 2, there are various DOT package types that are suitable for a given shipping category of Class 7 radioactive material. The package types, in descending order of structural integrity, and thereby costs, are as follows:

DOT Package Type	Specific Package(s) Used at RFETS
Type B	TRUPAC-II
Type A	Standard Waste Box, or IP-1 drum with a rigid liner)
Industrial Package (IP) – 2	Metal Box, or Cargo Container
IP-1	IP-1 Drum without a rigid liner, or Cargo Container
Strong, tight	Plywood Box or Cargo Container

With the exception of a strong, tight or IP-1 packaging, the structural integrity of these DOT packages is measured through performance testing. A Type B package must be capable of withstanding accident conditions as well as pass a water spray test, free drop test, stacking test and a penetration test. Although it need not withstand accident conditions, the Type A package must also pass these test. The IP-2 package must pass the drop test and stack test. There are no performance tests associated with an IP-1 packaging, but as with these other packagings, it must be designed to meet the requirements at 49 CFR 173.410 (minimum factor of three on lifting attachments, withstand acceleration and vibration under conditions normal to transportation, etc.) Strong, tight packagings must only meet the general requirements for DOT packagings at 49 CFR 173.24, i.e., they must prevent leakage of their contents under conditions normal to transportation.

As indicated in the list of packaging types, cargo containers can be designed to meet DOT IP-2, IP-1 or strong, tight requirements. A used cargo container can not meet the requirements of an IP-1 unless a design is available demonstrating that the requirements at 49 CFR 173.410 are met. A used cargo container will meet the requirements of a strong, tight packaging if it is demonstrated that it meets the general requirements at 49 CFR 173.24. This demonstration is the subject of an inspection process that was developed for used cargo containers at RFETS, which is discussed subsequently in this paper.

As shown in Table 2, any DOT package type can be used to package LSA and SCO material, which would suggest that the least costly strong, tight packaging always be used. This would be the case if it were not for the A_2 quantity limitation imposed when packing LSA/SCO-II material in a strong tight (or IP-I) packaging, or packing LSA/SCO-I in a non-bulk strong, tight packaging. The A_2 quantity for weapons grade plutonium is 0.0645gms (0.0109 Ci). When packing LSA/SCO-II material, the A_2 limitation is a constraint on the quantity of waste that can be put in a drum, and a severe constraint on the quantity of waste that can be placed in a plywood box or a cargo container. This forces the generator to use the more expensive IP-2 or Type A package to achieve a high radioactive material packing efficiency. Fortunately, most waste at RFETS is SCO-I, and

as shown in Table 2, a bulk strong, tight package is suitable without an A_2 quantity limitation as long as the conveyance is exclusive use (49 CFR 173.427(c)(1). Used cargo containers are bulk packagings, and shipments of low level waste to NTS are their exclusive use.

DOT STRONG TIGHT AND OTHER PACKAGING REQUIREMENTS

As previously mentioned, used cargo containers must meet the requirements of a DOT strong, tight packaging in order to be utilized for shipping LSA-I and SCO-I material. In accordance with the regulations, a DOT strong, tight packaging must simply meet the general requirements for DOT packagings at 49 CFR 173.24:

- Under conditions normally incident to transportation, there will be no identifiable (without the use of an instrument) release of hazardous material to the environment (49 CFR 173.24(b)(1)).
- The effectiveness of the packaging shall be maintained for the minimum and maximum temperatures encountered during transportation (49CFR 173.24(b)(2)).
- Closures on the packagings shall be designed and closed so that there will be no identifiable release of hazardous material to the environment from the opening to which the closure is applied under conditions normally incident to transportation (49CFR 173.24(f)(1)(i)).
- The closure is secure and leakproof under conditions normally incident to transportation (49CFR 173.24(f)(1)(ii)).

Because the waste will be shipped to NTS, the loaded cargo container must also meet the NTS Waste Acceptance Criteria (NTSWAC). The NTSWAC requires lifting appurtenances on waste packages (e.g., handles, lifting rings, etc.) be designed with a 5:1 safety factor. However, cargo containers do not have these types of lifting appurtenances, and the current NTS practice is to move cargo containers with a fork truck. Therefore, only cargo containers with fork lift pockets are selected for potential reuse.

The NTSWAC also requires that waste packages meet applicable DOE Orders as well as federal regulations. DOE Order 460.2 addresses radioactive material transportation but it does not provide additional requirements beyond the federal regulations for inter-facility transportation of the material. Also, the Site Safety Analysis Report (SAR) (DOE Order 5480.21) does not impose other packaging requirements for LSA/SCO transported on Site.

PROCEDURE DEVELOPMENT

At RFETS, as at any government facility, a procedure must be developed to provide detailed steps and necessary information to perform a task or activity in a consistent and safe manner. Accordingly, a procedure was prepared for the inspection and acceptance of used cargo containers as DOT strong tight packagings. The procedure addresses the

"who, what, why, and how" of inspecting used cargo containers. The process that was developed, i.e., the "who and how", is summarized below.

The Customer Service Organization (CSO) of Rocky Mountain Remediation Services, L.L.C., amongst other responsibilities, controls the forecasting, specification development, and quality assurance functions for procurement of waste commodities at RFETS. The CSO conceived of the concept of reusing cargo containers to ship RFETS LLW to NTS, and considering its procurement responsibilities, the CSO was a logical choice to administer the program. As shown in Figure 1, the CSO is responsible for identifying used cargo containers that are considered excess, arranging for inspection, and then overseeing the process of conducting repairs (if necessary), soliciting a quality assurance review, and final acceptance. The repair of cracked welds, tears, fractures, and holes is limited to $2,000 of labor and material costs, otherwise it is not cost effective to reuse the container. Inspection is performed by the Receipt, Certification, and Inspection (RC&I) group of Rocky Flats Closure Site Services (RFCSS). The inspectors must be NQA-1-89 Level II or III Inspectors with a current American Welding Society (AWS) Certified Welding Inspector Certification. Repairs that may be required are performed by RFCSS Maintenance or by the end user organization. RMRS Quality Assurance provides the final review to ensure the procedure was followed. The CSO maintains records and a database for tracking the inspection and acceptance process. A "RFETS Reuse Release Number" is marked on the used cargo container once it has been accepted. Because multiple organizations implement the procedure, the procedure was drafted as a Site Level 1 document.

The procedure also addresses safety during inspection as the used cargo containers may have been used to store radioactive and mixed wastes, and there are other physical hazards inherent to the inspection process. To protect against normal work place hazards, it is mandated that personal protective equipment be worn by inspection personnel (at a minimum hard hat, safety glasses, and safety boots**).** The procedure also specifies obtaining cargo container environmental/hazard information prior to inspection. This data is supplied by RMRS Health and Safety to demonstrate that internal chemical and radiological contamination is either not present, or if present, that it poses an acceptable human health risk without the use of personal protective equipment. The data is also necessary to demonstrate that external surfaces meet the RFETS free release limits.

The heart of the procedure is the inspection checklist that is used to verify that the cargo container meets the requirements of a DOT strong, tight packaging. Table 3 provides an abbreviated version of the checklist that highlights the attributes that were assigned to a DOT strong, tight packaging, i.e., those features that would ensure that the packaging does not leak its contents under conditions normal to transportation. As can be seen from Table 3, special attention is drawn to the integrity of welds, the presence of fractures or holes, and the depth of rusting. Because the closure must be secure and leakproof under conditions normally incident to transportation (49CFR 173.24(f)(1)(ii)), the door seals must be in near new condition, which in most cases, requires that they be replaced on a used cargo container. As a further check on the integrity of the welds, the door seals and overall structure of the cargo container, the container is inspected from the inside, during daylight and with the doors closed, to verify no light penetration.

ITEM SPECIFICATION DEVELOPMENT

The high demand for cargo containers at RFETS necessitated that alternative sources of used cargo containers also be identified. Upon investigation, it was determined that there are many vendors of used cargo containers who purchase the containers from steam ship companies for resale or rental. A field reconnaissance of several vendors indicated that most of the used cargo containers for resale or rental have been used multiple times and over many years, and their condition was unacceptable as a DOT strong, tight container without repair. In effect, the cargo containers were similar to most of the containers that already exist at RFETS. Although an item specification that includes the requirements listed in Table 3 could be developed for their procurement (in a repaired condition, if required), there was concern that the quality of the containers from various vendors, or even the same vendor, would vary considerably.

In order to establish a sound basis for evaluating vendor quotes, and at the same time procure a relatively high quality product, the item specification was prepared for purchase of "once used" cargo containers. During the investigation of off-site sources of used cargo containers, it was discovered that "once used" cargo containers were also available from these vendors. The "once used" cargo containers are purchased by the vendors from steam ship companies after transport of goods overseas to the U.S. Inspection of samples of these cargo containers revealed they were in "near new" condition. The item specification prepared for these containers reflected the strong, tight attributes defined by the procedure, and also included:

- Outer surface painted, no markings.
- Any vents sealed on the inside by affixing a plate (welded on or attached using machine screws and caulked).
- Near new condition, i.e., only minor cosmetic deficiencies (scratches, dents, and rust on less than 5% of the original painted exterior surface, excluding the bottom rails).
- Previous use limited to one time transport of goods and materials.

Because most cargo containers are vented, the specification for sealing vents was included to clarify that vents represent holes, which are unacceptable for a strong tight packaging.

COST ANALYSIS

There are four types of packages commonly used to pack LSA-I and SCO-I wastes at RFETS:

- IP-1 drums
- IP-2 metal boxes

- IP-1 cargo containers
- Strong, tight cargo containers

IP-1 drums are the most commonly used waste packaging; however, IP-2 metal boxes and cargo containers are being increasingly used due to the favorable economics associated with larger packagings. IP-2 metal boxes have the additional flexibility to be used for LSA/SCO-II material without an A_2 limit, but as previously mentioned, most waste is LSA/SCO-I.

Of the four commonly used waste packagings, used cargo containers are clearly the least costly. Table 4 compares the unit cost per cubic meter of waste shipped to NTS for these packagings. The costs include labor, equipment, materials, and transportation. The cost of air locks/soft-sided containments are included for the cargo containers in order to account for the additional expense to transfer wastes from a contaminated area (CA), through a radioactive buffer area (RBA), and into a cargo container staged near the building. The cost of a 25 ton fork truck, which the RFETS currently lacks, to move loaded cargo containers is also included.

As can be seen by Table 4, the high costs of packing wastes in drums is largely due to the labor and equipment to close up the package and label it, complete the paperwork, verify and certify the package, and assay and inspect it (Real Time Radiography [RTR]). These unit costs do not vary amongst the various types of packages, but represent significant total costs for low capacity drums because of the relatively high number of packages required to pack a given volume of waste. The cost impact is approximately an order of magnitude less for an IP-2 metal box (approximately an order of magnitude larger volume than a drum), and another order of magnitude less for a cargo container (yet another order of magnitude increase in volume). The difference between the unit costs per waste shipped for new (IP-1) and used cargo containers is reflected soley in the capital cost for the packaging. The cost for a used cargo container is based on a recent quote from an off-site vendor. The cost of reusing existing on-site cargo containers would be somewhat less even when factoring in salvage value, minor repairs and inspection costs.

The maximum and minimum unit costs to package and ship LLW for the various package types varies by a factor of 20. The difference in unit costs between a drum ($\$5{,}500/m^3$) and a used cargo container ($\$270/m^3$) is $\$5{,}230/m^3$. If half of the LLW (LSA-I and SCO-I) expected to be shipped to NTS during closure of RFETS ($211{,}000/2 = 105{,}500\ yd^3$ [$80{,}800m^3$]) were shipped in used cargo containers instead of IP-1 drums, RFETS would potentially $420,000,000. Recognizing the cost analysis is very sensitive to the Assay/RTR costs, even when these costs are ignored, it is estimated RFETS would still save approximately $60,000,000.

RESULTS

At the time of this writing, the procedure for reuse of cargo containers on site has been approved, and 80 "once used" cargo containers have been purchased from an offsite

vendor. The reuse of cargo containers on site has moved forward at a slower pace than the purchase of used cargo containers because RFETS had an immediate and large demand for cargo containers. The demand was most driven by the Decontamination and Decommissioning of Building 779 that was on a fast track schedule for completion, and delivery of cargo containers was on a critical path. Purchase of new cargo containers was being delayed by deficiencies in first articles of inspection and production ramp up. Reuse of cargo containers on site may have supplied a few cargo containers but the process of dispositioning their contents as excess property, inspecting them for DOT strong, tight acceptance, and repairing them as necessary could not be accelerated to meet the demand. However, the process of writing the item specification, placing the purchase order, evaluating the bids, and receiving the first 6 used cargo containers from an off-site vendor took place in the course of 2 ½ weeks. Receipt of the cargo containers narrowly prevented shut down of the D&D project, which would have had an estimated cost impact of $1,000,000/day.

The purchase of used cargo containers in lieu of new IP-1 cargo containers is a significant cost saving measure for site closure. The cost difference between new and used cargo containers is approximately $6,000 per container. As present earlier, if only half of the LLW (LSA-I and SCO-I) expected to be shipped to NTS during closure of RFETS were packaged in cargo containers, this would amount to 80,800m^3. If used cargo containers were used in lieu of new ones, the cost savings based on purchase price alone would be approximately $13,000,000.

TABLE 1
RADIOACTIVE MATERIAL SHIPPING CATEGORY PARAMETERS

SHIPPING CATEGORY	ACTIVITY LIMITS		CONTAMINATION LIMITS (dpm/100cm^2)			Waste Generation at RFETS through Closure (yd^3)
	Minimum	Maximum	Removable, accessible	Fixed, Accessible	Fixed + Removable, Inaccessible	
LIMITED QUANTITY	2 nCi/gram	10^{-3} A_2/Package				Negligible
LSA-I	2 nCi/gram	10^{-6} A_2/g				75,000
LSA-II	2 nCi/gram	• 10^{-4} A_2/g (solids) • 10^{-5} A_2/g (liquids)				Negligible
SCO-I			• 22,000 (β,γ, low tox. α) • 2200 (high tox. α)	• 2.2E8 (β,γ, low tox. α) • 2.2E7 (high tox. α)	• 2.2E8 (β,γ, low tox. α) • 2.2E7 (high tox. α)	136,000
SCO-II			• 2.2E6 (β,γ, low tox. α) • 220,000 (high tox. α)	• 4.4E9 (β,γ, low tox. α) • 4.4E8 (high tox. α)	• 4.4E9 (β,γ, low tox. α) • 4.4E8 (high tox. α)	Negligible
Radioactive Material, n.o.s. Type A Qty.	2 nCi/gram	<A_2/package				34,000
Radioactive Material, n.o.s. Type B Qty.	2 nCi/gram	>A_2/package				20,000

TABLE 2
RFETS WASTE PACKAGE OPTIONS

PACKAGE TYPE	LIMITED QUANTITY	LSA-I	SCO-I	LSA-II	SCO-II	RAM, n.o.s TYPE A QTY.	RAM, n.o.s TYPE B QTY.
Type B	X	X	X	X	X	X	X
Type A	X	X	X	X	X	X[1]	
IP-2	X	X	X	X	X		
IP-1	X	X	X	X[1]	X[1]		
Strong, tight	X	X[1]	X[1]	X[1]	X[1]		
Strong, tight Bulk package[2]	X	X	X	X[1]	X[1]		

1 Package must contain less than an A_2 quantity of radioactive material.
2 Must be exclusive use shipment.

TABLE 3
CHECKLIST FOR INSPECTION OF USED CARGO CONTAINERS AS DOT STRONG TIGHT PACKAGINGS

A used cargo container that meets all of the requirements listed below **SHALL** be deemed to meet the definition of a DOT Strong Tight packaging.

	Indicate compliance by Checking each box below:
Shall not have any cracked welds or missing rivets*	
Shall not have any dents 2"or greater in depth	
Shall not have fractured or torn frames, rails or corner posts	
Shall not have torn side walls, roof, floor, or undercarriage	
Shall be stable on a level surface	
Shall not have any broken, cracked, or missing roof bows	
Shall not have fractured exterior roof reinforcements	
Shall not have any broken welds on any connected undercarriage steel member, and steel members are not twisted or disconnected form the side rails	
Forklift pockets are in good condition and shall be no less than 4-1/2" high by 14" wide	
Shall not have an interior floor that is fractured or warped	
Closure mechanisms (including hinges, door-locking bars, and hasps) are present and operable	
Door seals shall not be missing, in whole or in part, torn,or excessively abraded. The surface upon which the seals rest shall be smooth and free of obstructions to ensure the seals make a light tight connection.*	
Fractures, tears or holes in side walls, roofs, and undercarriage are either absent or repaired*	
Shall not have any rust that penetrates deeper than the surface**	

ADDITIONAL REQUIREMENTS	
*Cracked welds or missing rivets are acceptable if they do not compromise the integrity of the cargo container as a DOT Strong Tight Packaging. Although welds may be painted, the Rocky Flats Inspector **SHALL** examine the welds for gross defects, e.g., gaps and obvious cracks to make this determination. Welds connecting the rails and end frames to the corner post must be unobstructed for visual examination. All other welds **SHALL** be inspected to the extent they are unobstructed from view. As a further check on the integrity of the welds, the door seals and overall structure of the cargo container, the container **SHALL** be inspected from the inside, during daylight, with the doors closed, to verify no light penetration.	
The Rocky Flats Inspector **SHALL spot check rusted surfaces for depth of rust penetration by removal of the rust with a wire brush. If the rust is not confined to the immediate surface and/or the exposed surface is pitted, the Rocky Flats Inspector **SHALL** measure the thickness of the metal at this location following procedure QT-2017 and compare this thickness to the average of three thickness measurements surrounding this location. A metal thickness less than 75% of the average surrounding metal thickness is unacceptable.	

_____ **DATE** _____

RC&I Inspector

TABLE 4
COST COMPARISON OF LLW PACKAGINGS

Cost Elements	IP-1 Drums* 165/shipment 34.6m^3/shipment 44.8K lbs/load	IP-2 metal box* 11/shipment 34.9m^3/shipment 44.6K lbs/load	IP-1 Cargo Container* 1/load 36.2m^3/load 44.7K lbs/load	Used Cargo Container* 1/load 36.2m^3/load 44.7K lbs/load
Packaging [1]	$5,600	$15,400	$10,000	$4,000
Waste Packing Labor[2]	$16,500	$1,100	$100	$100
Verification/Certification[3]	$8,250	$550	$50	$50
Assay/RTR[4]	$157,000	$10,500	$950	$950
Air Lock Construction[5]	N.A.	N.A.	$700	$700
Cargo Handling Equip. [6]	N.A.	N.A.	$550	$550
Shipping cost to NTS[7]	$3,400	$3,400	$3,400	$3,400
Total cost/ shipment	$190,750	$30,950	$15,750	$9,750
Total cost/m^3 of waste shipped	$5,500	$890	$440	$270

*Waste shipment basis - Given approximately 75% of loaded plywood boxes weigh 2500 lbs, and conservatively assuming the other 25% weigh the RFETS limit of 5,000 lbs, the average loaded plywood box weight is 3,125 lbs. Given a capacity of 112 ft^3 per box, this equates to a density of 27.9 lbs/ft^3, which is used to determine the gross waste shipping weights for the packagings. Empty drums, metal boxes, and cargo containers weigh approximately 65 lbs., 930 lbs., and 9,000 lbs., respectively. Their capacities in ft^3 (m^3) are 7.4 (0.21), 112 (3.17), and 1,280 (36.2), respectively. The number of packagings (and the waste volume) per waste shipment is limited by the DOT weight limit for the truck (80,000 lbs gross vehicle weight; 45,000 lbs gross load).

1. Recent purchase prices: IP-1 Drum - $34; IP-2 Metal Box - $1,400; IP-1 Std. Cargo Container (includes blocking and bracing system and tie down accessories) - $10,000; used Cargo Container - $4,000 (includes blocking and bracing system and tie down accessories).
2. 2 man-hrs/package at $50/man-hr. Includes WEMS entry, W/R Traveler preparation, labeling the package, and closing the package. Does not include the labor for placing the waste in the containers as the unit cost for this activity is similar for each alternative. However, it is recognized that the costs of preparing waste for packing may be significantly different for the various packaging options, e.g., size reduction activity would be significantly greater to prepare waste for loading into a drum or even an IP-2 metal box relative to a cargo container.
3. Verification and certification each require 0.5 man-hrs/package at $50/man-hr.
4. An IP-2 metal box or IP-1 drum can be run through NDA and RTR whereas waste placed in a cargo container must be precharacterized (sampling/analysis for LSA; smears and surveys for SCO) and the loading operation requires 100% inspection. Waste placed in a metal box or drum can also be precharacterized and 100% inspected. Regardless, assume NDA and sampling/radiological analysis are similar costs, and 100% inspection and RTR are similar costs. NDA and RTR costs are as follows: NDA - $700/container, RTR - $250/container.
5. If waste is not surveyed out of a CA (surveying is labor intensive), then a soft-sided containment must be constructed to get the waste from the CA to the cargo container. Conservatively assume 100 liner feet of containment is required for a building and it would take a 6 man crew 1 week to build it (240 man-hrs). At $50/man-hr, this equates to $12,000. Adding in materials and design cost, assume a soft-sided containment will cost $20,000. If 4 different containments are required per building, the total cost per building is $80,000. The number of cargo containers projected for use in Buildings 771 and 779 is 240, or 120/building. The cost of soft-sided containment per cargo container (i.e., shipment) is 80,000/120 = $700.
6. The RFETS existing 21,000 lb. fork truck has inadequate capacity to move full cargo containers. The cost of a 25 ton fork truck is approximately $200,000, which is $28,600/yr over 7 years (no interest). At 50 shipments per year, this equates to ~$550/shipment. Fork trucks with adequate capacity currently exist at NTS.
7. High end of vendor quotes for shipping cost per truckload (roundtrip).

N.A. Not Applicable

FIGURE 1 Process Flow Diagram for Inspection and Acceptance of Used Cargo Containers