CONCEPTUAL TRU WASTE CONTAINER DESIGN SPECIFICATIONS

Jay W. Doty and J. Bruce Peterson

Mound Facility*
Miamisburg, Ohio

INTRODUCTION

Monsanto Research Corporation completed a program during FY-1977 at Mound Facility specifying Conceptual Acceptance and Design Criteria for defense transuranic waste packaging for Interim Storage and/or Terminal Isolation. A contractor questionnaire was used to gather pertinent data. Site visits were made to formulate an integrated contractor consensus; a packaging meeting was held to examine, discuss, and integrate packaging philosophies; and data collected from these activities and from Task Force meetings were consolidated to provide input to the Basic Application Checklist and Criteria Checklists. Conceptual Design Criteria have now been developed from an analysis and evaluation of the application data against federal regulations and interim/terminal storage constraints.

Background

The major objective of DOE Manual Chapter 0511 is responsible technical management of radioactive wastes. With the generation of radioactive waste in DOE operations, this responsibility spans the lifetimes of the radionuclides. Close examination of the entire waste management cycle clearly indicates that a totally acceptable waste package containment system is imperative if this objective is to be realized. As presently specified in DOE Manual Chapter 0511-044d(4), solid transuranic waste packaging and storage conditions shall be such that the packages can be readily retrieved in an intact, contamination-free condition for 20 yr.

The retrievable storage site for defense transuranic wastes at the Idaho National Engineering Laboratory (INEL) has been accepting waste since November 1970, and has stored this waste in an area designated the Transuranic Storage Area (TSA). The packaging and storage conditions for the waste stored at the TSA meet the requirements that the containers be readily retrievable in an intact, contamination-free condition for 20 yr.

Current planning of the Division of Waste Management, Production and Reprocessing (DWPR) indicates continuing use of the retrievable storage areas through FY-1987 with the New Mexico Waste Isolation Pilot Plant (WIPP) facility attaining full operational status in FY-1988. According to projections, WIPP will begin receiving transuranic wastes in FY-1983. This waste will be stored so that it can be monitored to evaluate the behavior of the waste types under

*Mound Facility is operated by Monsanto Research Corporation for the Department of Energy under Contract No. EY-76-C-04-0053.

DISCLAIMER

these storage conditions. Projections indicate that the Pilot Plant phase will continue for 3 to 5 yr, after which, with retrieval demonstrated and experimentation successfully completed, the pilot plant will be converted to an operational repository for permanent disposal of wastes.

Data Collection and Analysis

A data collection and review phase involving contractor site plans, federal regulations, and a technical literature search was completed early in the program and provided the project team with all available published data.

A contractor questionnaire was transmitted to appropriate ERDA (DOE) Operations Offices and contractors by ERDA (DOE)/ALO in early February 1977, and information received on transuranic waste packaging from solicited contractors was consolidated, evaluated, and reported [1].

During April 1977, at the request of ERDA (DOE)/ALO, MRC personnel presented the contractor questionnaire data at the TRU Waste Form and Packaging Criteria Meeting at Albuquerque, New Mexico. These data represented current information directly affecting the WIPP Acceptance Criteria. MRC provided a mid-term program review at ERDA (DOE) Headquarters on May 9, 1977. This review addressed program progress to date and emphasized data derived from the contractor questionnaire. At that time, ERDA (DOE)/DWPR directed MRC to concentrate efforts to develop Packaging Acceptance Criteria for the Low-Level Transuranic Wastes, because the volume of low-level TRU waste generation for the period FY-1976 and FY-1976A was 184,144 ft^3 compared to the 4,856 ft^3 of intermediate-level TRU waste generated during the same period.

As previously reported [1], only 57.5% (107,542 ft^3) of the low-level TRU waste generated (187,144 ft^3) was shipped and stored at INEL. These wastes are packaged in containment systems satisfying both DOE Manual 0511 and Interim Storage (INEL) Criteria. A small portion, representing 1.6% of the low-level TRU waste generated (3,034 ft^3), is shipped to the Nevada Test Site for storage. The containment systems for these wastes stored retrievably are different from those used at INEL. The other portion of the waste generated (76,538 ft^3) is stored onsite by contractor generators. Onsite storage containment systems are of varied configurations, primarily because contractors developed container systems to fit their unique environmental storage requirements.

In any information-gathering effort, not all the information provided is complete and, therefore, each reporting contractor site was visited to ensure understanding of the questionnaire data, investigate significant program concerns, and obtain contractor consensus on TRU waste packaging. Throughout the site visits it was evident that varying levels of compliance with Manual Chapter 0511 exist. This is particularly true with reference to separation of combustible and noncombustible waste materials. Although the questionnaire data received reflect that only 21.6% of the low-level TRU waste generated during FY-1976 and FY-1976A was combustible, a reasonable doubt in the accuracy of this composition must be noted. An inaccuracy in the combustible waste volume could affect both the application of future incineration technology as well as the combustion-loading requirement of the WIPP facility during the pilot plant development phase.

An analysis of the information exchanges with the contractors dictates that both a drum configuration and a box geometry (preferably a modular concept) are needed. This analysis and mutual packaging consensus are based on the following contractor requirements and waste generation history:

1. Present Material Handling Systems
2. Current and Future Waste Processing Systems
3. Present Material Assay Systems
4. Available Modes of Transportation
5. 71% of the low-level TRU waste generated in FY-1976 and FY-1976A was packaged in box geometry

Cost of any new packaging system is extremely important to the contractors, and their request was that the new system be lower and/or comparable to the present packaging economics. This cost conservation is not only based on future generation of low-level TRU wastes at the contractor sites,

but also strongly influenced by known and planned decontamination and decommissioning projects at Mound, Rocky Flats, LASL, Atomics International, LBL, and Oak Ridge, where substantial increases in low-level TRU wastes are projected.

The contractor need for a standardized TRU containment system is immediate. If packaging of TRU wastes continues in nonstandard containment systems, it is probably safe to assume, based on the present WIPP Acceptance Criteria and supported by the Final Report of the Task Force on WIPP Criteria Interrelationships, that contractors, along with interim storage sites, will be required to repackage stored wastes prior to placing these wastes in a terminal isolation mode. The repackaging costs, however, would be less expensive if standardized containers are defined, proven, and available as soon as possible.

Following conversations with contractors generating transuranic waste, a meeting was held at Mound Facility on June 2, 1977, for the specific purpose of discussing proposed criteria for an acceptable TRU waste package for application in both interim storage and terminal isolation. Results of this meeting have been previously reported [1]. At the meeting, contractors and the WIPP representatives requested that the project team initiate a survey of container manufacturers to determine whether any commercially available packaging/containers are applicable for the shipment and storage of low-level TRU waste. Information has been received from manufacturers on container types, materials of construction, sizes, shapes, internal volume, weight, closures, DOT certification (if applicable), and unit cost. Performance data relating to materials of construction have also been received and evaluated.

To ensure that acceptable TRU packaging is developed for defense wastes that is consistent with packaging being developed for commercial wastes, representatives from ORNL Office of Waste Isolation (OWI) visited Mound Facility on May 4, 1977. At the meeting, packaging acceptance criteria, package/containment systems standardization, central procurement, and transportation of the wastes for interim and terminal storage were discussed. The OWI position, at that time, was that packaging criteria and TRU packages developed should be conservative and that cost of the packages to users/generators was not important. MRC and OWI agreed that the packaging acceptance criteria should be consistent for both defense and commercial TRU wastes, since both types of generators produce essentially the same types of waste. OWI representatives agreed that standardization of both container quality and design specifications would reduce the environmental risks.

At the request of ERDA (DOE)/ALO, Mound representatives attended the Task Force Meeting on WIPP Criteria at ERDA (DOE)/ALO on August 2, 1977. The specific role of Mound personnel was one of providing technical information on present packaging systems and their compatability to the WIPP Criteria. Information was supplied to the Task Force as requested during the meeting. Based on the combustibility and radiolysis requirements as written in the WIPP Acceptance Criteria, it was concluded that present TRU packaging does not meet the criteria for all types of wastes. In the final report of the Task Force on the WIPP Interrelationships, a recommendation was made that a standardized container system designed to optimize space, provide fire barrier, and limit gas generation during storage should be developed. The Acceptance Criteria for TRU Waste Packaging for Interim and/or Terminal Isolation developed through this program are directed toward accomplishing this recommendation.

CONCEPTUAL TRU WASTE CONTAINER DESIGN SPECIFICATIONS

More than 18 different packaging configurations are being used for interim storage of TRU wastes. Of these configurations only the DOT 17C (17H) steel drum is readily acceptable for direct shipment and isolation in the WIPP. The proliferation of waste packages currently in use is a direct result of efforts of the waste generators to package their unique TRU wastes into containers able to meet the 20-yr retrievability requirements under the differing environmental conditions of onsite storage. Completing the conceptual design for a family of standardized TRU waste containers will be difficult without established parameters with regard to waste form and interim storage environment. In the selection of materials for construction of a particular packaging system, it is important first to consider the characteristics of the system, giving special attention to extraneous factors that may influence decomposition. Since these factors would be peculiar to a particular system, it may be impractical to offer hard and fast rules that would cover all situations. As stated in one of the Sandia early rough drafts of TRU

Table 1 - BASIC APPLICATION CHECKLIST

Package Number	TRU Low-Level Waste Package Description	Volume ft^3/m^3	Approx. Unit Cost
1	55-gallon steel drum, DOT 17H, zinc dipped, polyethylene (PE) bag liner	7.42 0.21	$32.00
2	55-gallon steel drum, DOT 17H interior and exterior painted, PE bag liner	7.42 0.21	$34.00
3	55-gallon stainless steel drum, DOT 17H, PE bag liner	7.42 0.21	$135.00
4	55-gallon steel drum, DOT 17C, interior and exterior painted, PE bag liner	7.42 0.21	$20.00
5	55-gallon steel drum, DOT 17C interior and exterior painted, 90 mil high density polyethylene (HDPE) liner when lead shielded $60.00 additional	7.42 0.21	$60.00
6	55-gallon steel drum, DOT 17C zinc dipped, 90 mil HDPE liner	7.42 0.21	$60.00
7	30-gallon stainless steel drum, PE bag liner	4.01 0.11	$70.00
8	30-gallon steel drum, interior and exterior painted PE bag liner, 2 each inside concrete cask	8.02 0.22	$300.00
9	Corrugated metal pipe, zinc dipped, 2 1/2" diameter x 20' long	98 2.78	$250.00
10	55-gallon steel drum, zinc dipped, 90 mil HDPE liner, inside concrete culvert	7.42 0.21	$60.00
11	Welded steel box, 1/8" thick, PE bag liner, random sizes, will fit inside supertiger	Random	$1000.00
12	Fiberglass reinforced polyester (FRP) plywood box, 4'x4'x7', PE bag liner	112 3.17	$400.00 $800.00
13	FRP plywood box, random sizes, PE bag liner	8-1500 .23-43	$100.00 $1000.00
14	Steel bin, 4'x5'x6', 12-gauge, 55 gallon DOT 17H steel drums or 1/2" thick plywood box placed inside	120 3.40	$500.00
15	FRP plywood box, random, steel drums inside	Random	$2900.00
16	FRP plywood boxes, cold rolled steel boxes, inside concrete culvert	Random	$1320.00 $8000.00

Table 2 - BASIC APPLICATION CHECKLIST

Package Number	Waste Generator													Total Volume Per Waste Package Type
	RI	ARHCO	MRC	LASL	SRP	ORNL	ANL-E	LLL	LBL	BMI	AI	EG&G	ANL-W	
1								X	X					1430 ft^3 40.5 m^3
2									X	X	X			421 ft^3 11.9 m^3
3						X								1925 ft^3 54.5 m^3
4		X		X										14561 ft^3 412.4 m^3
5	X		X	X								X		23314 ft^3 660.3 m^3
6					X									3000 ft^3 85.0 m^3
7						X								1925 ft^3 54.5 m^3
8				X										800 ft^3 22.7 m^3
9				X										4500 ft^3 127.4 m^3
10					X									2000 ft^3 56.6 m^3
11								X						1500 ft^3 42.5 m^3
12	X		X											79700 ft^3 2257.2 m^3
13				X										2000 ft^3 56.6 m^3
14							X							4700 ft^3 133.1 m^3
15		X												43368 ft^3 1228.2 m^3
16					X									2000 ft^3 56.6 m^3
											Total Volume			187,144 ft^3 5,300 m^3

Waste Acceptance Criteria, "It (conceptual design criteria) is in no sense an attempt at unilateral rulemaking." However, through Mound's study of TRU waste packaging and resulting comparisons of the Basic Application Checklists (see Tables 1 and 2) to the transportation and isolation requirements, a set of conceptual design specifications was assembled.

Waste Container Definition

The box or drum, including any associated liner and/or shielding material, that immediately surrounds (and is considered to be an integral, disposable part of) the waste material.

Structural Design

The structural design of all low-level TRU waste containers must meet the requirements for Type A packages as outlined in 49CFR173.398b. Low-level TRU waste is any solid waste material, other than high-level waste, which is contaminated with long-lived alpha emitters to the extent that, under the provisions of DOE Manual chapter 0511, it is not suitable for surface burial, but which exhibits sufficiently low radiation levels ($\leq$500 mrem/hr) that it is amenable to handling by "contact" methods. This minimum structural design requirement shall be required for all TRU waste packages to assure safety to personnel during handling, loading, and unloading operations. During shipment, the Type A containers may be placed inside a reusable Type "B" overpack. The Type "B" container must meet more rigorous structural design requirements and tests than Type A containers to provide for maximum safety during shipment. Cost effective packaging and transportation of TRU waste materials will require the single use Type A packages to be relatively inexpensive but capable of meeting the requirements of contamination control from the time the containers are filled until they are backfilled inside the WIPP facility.

Design Life (Decomposition)

The design life of all TRU low-level waste containers for contamination-free retrieval shall be 10 yr minimum when stored in a noncorrosive atmosphere (pH 7-8), 60% relative humidity, and 100°F. The design life parameters may suggest a change in DOE Manual 0511 from 20-yr intact contamination-free retrievability to a 10-yr intact contamination-free retrievability concept. Life of the shipping container will start from the time the container is manufactured until backfilled in the WIPP. The 10-yr life is based upon the forecast that the WIPP will be fully operational for TRU waste containers in 1988. Life cycle of the container will include manufacturing, delivery, storage, transmittal into the WIPP, analysis, and backfilling. This life cycle should be approximately 5 yr; however, it could approach 10 yr because the backlog of interim stored wastes will be in direct competition with freshly packaged waste for isolation space in the Isolation Facility. All filled waste containers must be protected from environmental conditions that could significantly reduce the design life of the waste containers to less than 10 yr.

Materials of Construction

Materials of construction shall be based on design life and structural design requirements. Ferrous and nonferrous metals, plastics, reinforced plastics, fiberboard, corrugated fibers, wood, and concrete have been considered for container materials. All these materials can meet the requirements for hazardous materials packaging and are acceptable in the WIPP. Therefore, the choice of materials, or combinations thereof, can be made from the above group.

Difficulty of choice will be influenced by the waste form, design, economic interests, and final WIPP TRU Waste Acceptance Criteria.

Maximum Weight of Container and Contents

The weight of a single container filled to 98% capacity is limited to 25,000 lb (11,400 kg) based on a contents density of 125 lb/ft^3 (2000 kg/m^3). This design weight is based on the 25,000 lb (11,400 kg) maximum capacity of the WIPP low-level hoist cage.

Shape

The container family shall be modular, having a shape which will provide maximum packing efficiency. The cylindrical container has a packing efficiency of ~0.69 and the void space will be 31 ft^3 for every 100 ft^3 of waste in terminal isolation. The cylindrical container, up to 8 ft^3, is readily mass produced and available in metal, plastic, and fiberboard. However, because of the underground location for isolation of TRU wastes, emphasis must be placed on container shape with higher packing efficiencies for the waste materials.

Dimensions

Waste container dimensions shall be based on the criteria given in Table 3 to provide flexibility in mode of transportation.

Handling Appurtenances

All low-level TRU waste containers must be provided with cleats, offsets, or chimes which permit handling by fork lift.

Security Seal

The outside of each waste container must incorporate a feature such as a seal that is not readily breakable and that, while intact, will be evidence that the package has not been illicitly opened.

Cost

Current low-level waste packages which can meet the reqirements of DOE Manual Chapter 0511, WIPP, and DOT Type A have costs ranging from \$3.57/ft^3 (4x4x7 ft fiberglass reinforced polyester resin box) to \$18.19/ft^3 (DOT 17H, 55-gal, stainless steel drum) for the packaging materials. Cost per cubic foot of storage volume for the standardized container family should be toward the lower end of this range to be cost effective.

REFERENCES

1. J. W. Doty and J. B. Peterson, Acceptable TRU Packaging for Interim Storage and/or Terminal Isolation: FY-1977 Final Report, MLM-2489 (February 17, 1978).

Table 3 - MAXIMUM DIMENSIONS THAT MUST BE CONSIDERED FOR WASTE CONTAINER DESIGN

Dimension	ATMX Railcar	Super Tiger	Iso/Cargo Container	WIPP Hoist Cage
Inside Length	600 in. (5.24 m)	172 in. (4.37 m)	228 in. (5.79 m)	144 in. (3.66 m)
Inside Width	108 in. (2.74 m)	76 in. (1.93 m)	93 in. (2.36 m)	96 in. (2.44 m)
Inside Height	108 in. (2.74 m)	76 in. (1.93 m)	91.5 in. (2.32 m)	108 in. (2.74 m)
Door Width	Top Load	76 in. (1.93 m)	90 in. (2.29 m)	96 in. (2.44 m)
Door Height	Top Load	76 in. (1.93 m)	89.5 in. (2.27 m)	108 in. (2.74 m)