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**Acceptable TRU Packaging for Interim
Storage and/or Terminal Isolation:
FY-1977 Final Report**

Jay W. Doty and J. Bruce Peterson

February 17, 1978



Monsanto

MOUND FACILITY

Miamisburg, Ohio

operated by

MONSANTO RESEARCH CORPORATION

a subsidiary of Monsanto Company

for the

U. S. DEPARTMENT OF ENERGY

Contract No. EY-76-C-04-0053

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Abstract

Monsanto Research Corporation, originally funded for FY-1977-78 by DoE/DWPR, was conducting a program at Mound Facility leading to definition and demonstration of acceptable waste packages for defense transuranic waste for interim storage and terminal isolation. During FY-1977, a Contractor Questionnaire was used to gather pertinent data and to assess contractor concerns. This information was integrated into basic application data in the form of a checklist. Conceptual Container Design Specifications were developed by analyzing and evaluating the application data against Federal Regulations and interim/terminal storage constraints.

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 Division of Waste Management (DWM) planning 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 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.

Survey of current TRU waste storage program

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 in Appendix I.

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)/WPR 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 ft³ compared to the 4,856 ft³ of intermediate-level TRU waste generated during the same period.

Onsite storage containment systems are of varied configurations, primarily because contractors developed container systems to fit their unique environmental storage requirements. Only 57.5% (107,542 ft³) of the low-level TRU waste generated (187,144 ft³) 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 ft³), 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 ft³) is stored onsite by contractor generators.

Accuracy in accounting for the combustible waste volume will 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. Therefore, each responding ERDA (DoE) 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 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.

Repackaging costs will continue to escalate unless containers are defined, proven, and available as soon as possible. Contractor need for a standardized TRU containment system is immediate. If packaging of TRU wastes continues in nonstandard containment systems, based on the

present WIPP Acceptance Criteria, the contractors, along with interim storage sites, will be required to repackage stored wastes prior to placing these wastes in a terminal isolation mode.

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. Highlights of the meeting are outlined in Appendix II. At the meeting, contractors and the WIPP representative 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. A brief letter of request was mailed to over 4000 container manufacturers asking for information in the form of container cost that they were currently producing. The form letter survey achieved a variety of interesting results. However, none of the container manufacturers that responded are producing a container which can meet the handling, shipping and storage requirements of TRU radioactive waste materials for terminal isolation.

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. Common packaging criteria might also relieve commercial users as well as defense contractors from the unenviable position of buying small quantities of unique container systems from several small vendors.

Experience has shown that purchases dealing with small quantities of shipping containers that are nonstandard (nearly state-of-the-art to container manufacturers) are difficult to monitor in terms of vendor quality control and quality assurance programs. The vendor's ability to comply with the vigorous specifications required for radioactive waste packages has proved to be a time consuming and frequently frustrating experience for contractor quality control staffs.

It is extremely important to note that no significant improvement can be made in the quality of low-level waste containers until clearly defined container specifications are developed and until vendors are dealing in large enough quantities of containers. Furthermore, until vendors are enticed with orders large enough to warrant their investment in quality assurance, the risk of substandard containers reaching waste generators will continue to exist. OWI representatives agreed that standardization of both container quality and design specifications would reduce these 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 compatibility 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 Interrelationship, 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

Philosophy of Specifications

More than 16 different packaging configurations are being used for interim storage of TRU wastes. The acceptability of these configurations for direct shipment and isolation in the WIPP is still in question. 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. An attempt to carry through the responsibility of conceptual design of 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 Waste Acceptance Criteria, "It (conceptual design criteria) is in no sense an attempt at unilateral rule-making." However, through Mound's study of TRU waste packaging and resulting comparisons of the Basic Application Checklist (shown in Appendix I, Tables 17 and 18) to the transportation and isolation requirements, a set of conceptual design specifications was assembled for the waste container which is defined as follows:

WASTE CONTAINER

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.

Conceptual Container Design

Specifications

STRUCTURAL DESIGN

The structural design of all low-level TRU waste containers must meet the minimum requirements of a Type A package 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, is not suitable for surface burial, but which exhibits sufficiently low radiation levels (<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 transportation and are acceptable in the WIPP in limited quantities. Therefore, the choice of materials, or combinations thereof, can be made from the above group. However, choice will be influenced by the waste form, container design, economics, and, most important, 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/ft³ (2000 kg/m³). 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 in storage. The

cylindrical container has a packing efficiency of ~0.69 and the void space will be 31 ft³ for every 100 ft³ of waste in terminal isolation. The cylindrical container, up to 8 ft³, 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 1 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 requirements of DoE Manual Chapter 0511, WIPP, and DOT Type A have costs ranging from \$3.57/ft³ (4x4x7 ft fiberglass reinforced polyester resin box) to \$18.19/ft³ (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.

Table 1 - MAXIMUM DIMENSIONS THAT MUST BE
CONSIDERED FOR WASTE CONTAINER DESIGN

<u>Dimension</u>	<u>ATMX Railcar</u>	<u>Super Tiger</u>	<u>Iso/Cargo Container</u>	<u>WIPP Hoist Cage</u>
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)

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Appendix I
Data collection and analysis

Contractor questionnaire

The contractor questionnaire was transmitted to appropriate operations offices and contractors by ERDA/ALO in early February, 1977. The participating contractors whose data has been extracted and consolidated into this report are shown in Table 1.

Of the total low-level TRU waste generated during FY-1976A, significant differences in waste volume generation are noted at each site as illustrated in Table 2.

The TRU isotopes associated with the low-level waste are shown in Table 3. The predominant isotopes are, of course, plutonium-238 and plutonium-239. Other isotopes were reported in trace quantities; however, they are reported in the low-level waste volumes as required by ERDAM 0511.

As noted in Table 2, the contractors reported a total low-level TRU waste generation volume of 187,144 ft³ for the period FY-1976 and FY-1976A. However, of that total volume, only 21.6% of this waste is categorized as combustible (hydrogenous) TRU waste. It would appear at this time, based on this composite information, that 78.4% of the low-level TRU waste generated in the FY-1976, 1976A period, is not combustible waste and would meet the present WIPP Acceptance Criteria dated June 17, 1977.

The transportation of the low-level TRU waste generated in FY-1976, 1976A is heavily dependent upon the ATMX railcar.

Table 1 - THE FOLLOWING CONTRACTORS HAVE RETURNED THEIR TRU WASTE PACKAGING QUESTIONNAIRES TO MRC

AI	LASL
ANL-E	LBL
ANL-W	LLL
BMI	MRC
ARCHO	RI
EG&G	SRP
ORNL	

Table 2 - THE LOW-LEVEL TRU WASTE VOLUME VARIES SIGNIFICANTLY BETWEEN CONTRACTOR SITES

<u>Contractors</u>	<u>Volume (ft³)</u>
RI	89,262
ARCHO	53,988
MRC	13,286
LASL	11,700
SRP	7,000
ANL-E	4,700
ORNL	3,850
LLL	2,535
LBL	395
BMI	287
AI	134
EG&G	7
TOTAL	187,144

Table 3 - THE ISOTOPES BELOW ARE BEING GENERATED IN LOW-LEVEL TRU DEFENSE WASTE

plutonium - 238, 239, 240, 241, 242
 curium - 244
 californium - 252
 berkelium - 249
 uranium - 233
 americium - 241, 243
 neptunium - 237

As shown in Table 4, of the total 187,144 ft³ of low-level TRU waste generated, 57.5% of the waste is stored at INEL (107,542 ft³), 40.9% of the waste is stored by contractors onsite, (76,538 ft³), and 1.6% of the waste is stored at NTS (3,064 ft³). One interesting and important observation obtained from the data was the large amount of low-level TRU waste generated during this period and stored onsite. One question becomes quite apparent: "If this onsite stored waste had to be shipped, could the present transport systems accommodate the increased volumes?"

The data received also support the fact that 71% of the low-level TRU waste generated in FY-1976, 1976A was packaged in a box geometry as shown in Table 5. Regarding drums, it was noted that 48,500 ft³ of waste is contained in 55-gallon drums. However, only 28,300 ft³ of the low-level TRU waste was contained in a DOT 17C drum with a high-density polyethylene (HDPE) liner. Approximately 14,500 ft³ of waste was packaged in a DOT 17C drum, and the remaining portion of the waste was packaged in DOT 17H drums. A small volume (800 ft³) of low-level TRU waste was also packaged in DOT 17H 30-gallon drums.

In Table 6, the FY-1976, 1976A low-level TRU waste generation by type is shown. The equipment and glovebox/laboratory waste types comprise approximately 65% of the TRU waste volume generated. Waste type categories were developed by consolidation of definitions supplied by the participating contractors. The low-level TRU waste type definitions are listed in Table 7.

The physical and chemical properties of low-level TRU waste types, physical forms, and hazardous properties are shown in

Table 4 - TRANSPORTATION OF THE LOW-LEVEL TRU WASTE IS HEAVILY DEPENDENT ON THE ATMX RAILCAR

Poly Panther (truck)	4,740 ft ³
Supertiger (truck)	3,351 ft ³
ATMX Railcar	100,508 ft ³

Table 5 - SEVENTY-ONE PERCENT OF THE LOW-LEVEL TRU WASTE IS CURRENTLY PACKAGED IN A BOX GEOMETRY

55-gallon Drums

DOT 17H	5,750 ft ³
DOT 17C	14,500 ft ³
DOT 17C/HDPE Liner	28,300 ft ³

Boxes

FRP	125,100 ft ³
Steel	8,200 ft ³

Others

Corrugated Metal Pipe	4,500 ft ³
30-gallon Drums	800 ft ³

Table 6 - THE FY-1976, 1976A LOW-LEVEL TRU WASTE BREAKDOWN

<u>Waste Type</u>	<u>Ft³</u>
Equipment	81,568
Combustibles	40,438
Glovebox/Laboratory	39,785
Cemented Wastes	10,765
Dry Sludges	7,832
Absorbed Liquids	6,697
Others	59

Table 8. From the abstracted data, no major chemical or physical problems exist, and no hazards are foreseen in the packaged low-level TRU waste generated by the surveyed contractors.

Table 7 - LOW-LEVEL TRU WASTE TYPE DEFINITIONS

Equipment:	Decommissioned gloveboxes, equipment replacements, process tankage, machine tools, refractories, building rubble, ductwork, metal piping.
Combustibles:	Paper, rags, clothing, fabric, tissues, rubber gloves and tubing, wood, manipulator boots, plastics, resins.
Glovebox/Laboratory:	Process hardware, metal, glass, ceramics, small process equipment, instrumentation sources, graphite, refractories, asbestos- HEPA filters, tools.
Cemented Wastes:	Oils, caustics, neutralized solutions, organics, and sludges mixed directly with Portland Cement and/or a mixture of Portland Cement and Vermiculite.
Dry Sludges:	Process sludge resulting from treatment of aqueous waste solutions by carrier hydroxide precipitation, followed by clarification, dewatering with rotary vacuum filtration and drying.
Absorbed Liquids:	Acid and caustic solution, both neutralized and unneutralized, organic solutions and oils, absorbed on diatomaceous earth, bentonite clay, and calcium silicate.
Others:	Contaminated soil.

Each waste category shown in Table 6 was expanded into greater detail as shown in Tables 9 through 15. The data represented in these Tables provide information on the generating agency, isotope, volume of generated waste, average concentration per package, storage, and transportation data.

Technical program meetings

Two meetings were sponsored by Mound Laboratory as part of our objective of achieving low-level TRU waste generator consensus on the TRU waste package acceptance criteria.

On May 4, 1977, Doug Turner and Bill Peachin of the Office of Waste Isolation visited Mound for a mutual exchange of information in relation to ERDA and Commercial TRU

Low-Level Wastes. The meeting was informative, and from the discussions the following list of areas of mutual interest and concern was completed:

- 1) Comparable TRU low-level and intermediate level package acceptance criteria for ERDA and commercial.
- 2) The immediate need to develop and fabricate a new transport system for low and intermediate TRU waste.
- 3) Desirability of implanting a control procurement policy for quality assured waste containers for both ERDA and commercial wastes.

Table 8 - PHYSICAL AND CHEMICAL PROPERTIES AND HAZARDS ASSOCIATED WITH LOW-LEVEL TRU WASTE TYPES

<u>Waste Type</u>	<u>Physical</u>	<u>Chemical</u>	<u>Hazards</u>
Equipment	Dry Solid Form Noncombustible	N/A	N/A
Combustibles	Dry Solid Form Combustible	Hydrogeneous	N/A
Glovebox/Laboratory	Dry Solid Form Noncombustible	N/A	N/A
Cemented Wastes	Solidified Liquid Noncombustible	Acidic Caustic Hydrogeneous	N/A
Dry Sludges	Dry Solid Form Noncombustible	Caustic	N/A
Absorbed Liquids	Absorbed Liquids	Acidic Caustic Organic	Oxidizing Reducing

Table 9 - LOW-LEVEL TRU WASTE WASTE CATEGORY - EQUIPMENT

<u>Agency</u>	<u>Isotope</u>	<u>ft³</u>	<u>Waste (nCi/g)</u>	<u>Storage</u>			<u>Transport</u>			
				<u>INEL</u>	<u>Onsite</u>	<u>NTS</u>	<u>ATMX</u>	<u>VAN</u>	<u>Supertiger</u>	<u>Polypanther</u>
ARHCO	Pu-239	43,368	325		X					
RI	Pu-239	32,500	35,000	X			X			
LASL	Pu-239	2,000	600		X					
MRC	Pu-238	200	< 100	X				X		
MRC	Pu-238	1,500	700,000	X			X			
SRP	Pu-239	<u>2,000</u> <u>81,568</u>	5,000		X					

1. Percent of total waste 43.58% equipment in total waste volume
2. Isotope percentage Pu-239 (98%) Pu-238 (2%)
3. Average Content per package Pu-239 (325-10,000 nCi/g waste)
Pu-238 (<100-700,000 nCi/g waste)
4. Storage distribution INEL (41.9%) Onsite (58.1%)
5. Transport system ATMX (41.7%) Van (0.2%)

Table 10 - LOW LEVEL TRU WASTE
WASTE CATEGORY - COMBUSTIBLE

Agency	Isotope	ft ³	Waste (nCi/g)	Storage			Transport			
				INEL	Onsite	NTS	ATMX	Van	Supertiger	PolyPanther
ORNL	Pu-239	1925	1,000		X					
ARHCO	Pu-239	8689	2,880		X					
AI	Pu-239	67	8,100			X			X	
LLL	Pu-239	1500	21,000			X			X	
LLL	Pu-239 (U-233)	1035	4,500			X			X	
LBL	Pu-239	185	550			X			X	
RI	Pu-239	13,000	125	X			X			
LASL	Pu-239	4,000	600		X					
ANL-E	Pu-239	4,000	70	X						X
BMI	Pu-239	287	5,550	X					X	
MRC	Pu-238	380	520,000	X			X			
MRC	Pu-238	1,600	< 100	X				X		
SRP	Pu-238	2,100	> 10			X				
SRP	Pu-238	1,400	< 100			X				
		<u>40,438</u>								

- Percent of total waste 21.60% Combustible in total waste volume
- Isotope percentage Pu-239 (86.5%) Pu-238 (13.5%)
- Average content per package Pu-239 (70-21,000 nCi/g waste)
Pu-238 (>10-520,000 nCi/g waste)
- Storage distribution INEL (48.3%) Onsite (44.9%) NTS (6.8%)
- Transport system ATMX (33.1%) Polypanther (10.5%) Supertiger (7.6%) Van (3.9%)

Table 11 - LOW-LEVEL TRU WASTE
WASTE CATEGORY - GLOVEBOX/LABORATORY

Agency	Isotope	ft ³	Waste (nCi/g)	Storage			Transport			
				INEL	Onsite	NTS	ATMX	Van	Supertiger	PolyPanther
ORNL	Pu-239	1,925	1,000		X					
ARHCO	Pu-239	1,872	1,080		X					
AI	Pu-239	30	8,100			X			X	
LBL	Pu-239	185	550			X			X	
EG&G	Pu-239	7	12,630	X				X		
RI	Pu-239	32,500	10,000	X			X			
LASL	Pu-239	800	100,000		X					
ANL-E	Pu-239	480	70	X						X
MRC	Pu-238	336	800,000	X			X			
MRC	Pu-238	200	< 100	X				X		
SRP	Pu-238	900	> 10			X				
SRP	Pu-238	600	< 100			X				
		<u>39,785</u>								

- Percent of total waste 21.25% Glovebox/Laboratory in total waste volume
- Isotope percentage Pu-239 (92.9%) Pu-238 (7.1%)
- Average Content per package Pu-239 (70-12,600 nCi/g Waste)
Pu-238 (>10-800,000 nCi/g Waste)
- Storage distribution INEL (84.1%) Onsite (15.4%) NTS (0.5%)
- Transport system ATMX (82.5%) Polypanther (1.1%) Supertiger (0.5%) Van (0.5%)

Table 12 - LOW-LEVEL TRU WASTE
WASTE CATEGORY - CEMENTED WASTES

Agency	Isotope	ft ³	Waste (nCi/g)	Storage			Transport			
				INEL	Onsite	NTS	ATMX	Van	Supertiger	PolyPanther
LBL	Pu-238	25	550			X			X	
RI	Pu-239	640	400	X			X			
LASL	Pu-239	4,900	1,000		X					
MRC	Pu-238	5,200	200	X			X			
		<u>10,765</u>								

1. Percent of total waste 5.75% cemented waste in total waste volume
2. Isotope percentage Pu-238 (48.6%) Pu-239 (51.4%)
3. Average content per package (Pu-238 (200-550 nCi/g Waste)
Pu-239 (400-1000 nCi/g Waste)
4. Storage distribution INEL (54.3%) Onsite (45.5%) NTS (0.2%)
5. Transport system ATMX (54.3%) Supertiger (0.2%)

Table 13 - LOW-LEVEL TRU WASTE
WASTE CATEGORY - DRY SLUDGES

Agency	Isotope	ft ³	Waste (nCi/g)	Storage			Transport			
				INEL	Onsite	NTS	ATMX	Van	Supertiger	PolyPanther
Ri	Pu-239	7832	3500	X			X			
		<u>7832</u>								

1. Percent of total waste 4.18% dry sludges in total waste volume
2. Isotope percentage Pu-239 (100%)
3. Average content per package Pu-239 (3500 nCi/g Waste)
4. Storage distribution INEL (100%)
5. Transport system ATMX (100%)

Table 14 - LOW-LEVEL TRU WASTE
WASTE CATEGORY - ABSORBED LIQUIDS

Agency	Isotope	ft ³	Waste (nCi/g)	Storage			Transport			
				INEL	Onsite	NTS	ATMX	Van	Supertiger	PolyPanther
AI	Pu-239	37	8,100			X				X
RI	Pu-239	2790	1,260	X			X			
MRC	Pu-238	3870 6697	25,000	X			X			

1. Percent of total waste 3.57% absorbed liquids in total waste volume
2. Isotope percentage Pu-238 (57.8%) Pu-239 (42.2%)
3. Average content per package Pu-238 (25,000 nCi/g Waste)
Pu-239 (1260-8100 nCi/g Waste)
4. Storage distribution INEL (99%) NTS (1%)
5. Transport system ATMX (99%) Supertiger (1%)

Table 15 - LOW-LEVEL TRU WASTE
WASTE CATEGORY - MISCELLANEOUS

Agency	Isotope	ft ³	Waste (nCi/g)	Storage			Transport			
				INEL	Onsite	NTS	ATMX	Van	Supertiger	PolyPanther
ARHCO	Pu-239	59	14,000 (Soil)		X					

1. Percent of total waste 0.03% soil in total waste volume.
2. Isotope % Pu-239 (100%)
3. Average content per package Pu-239 (14,000 nCi/g Waste)
4. Storage distribution onsite
5. transport system

On June 2, 1977, MRC hosted a low-level TRU ERDA waste packaging meeting at Mound Laboratory. The meeting was attended by representatives of LASL, SLA, and OWI; it provided the opportunity for each representative to share pertinent packaging information and data in a form which was most useful in establishing preliminary TRU container acceptance criterion for application in both interim storage and terminal isolations. The results of this meeting are included in Appendix II.

Basic application checklist

The basic application checklist (Tables 16 and 17) was completed after receiving the waste packaging questionnaires from the ERDA waste generators and subsequent site visit follow-up for additional information. The checklist was developed to compile the low-level TRU waste shipping and storage containers for interim and onsite storage; it has 16 different packaging configurations currently in use for TRU waste storage. Plywood boxes covered with fiberglass-reinforced plastic and metal drums account for 92% of the total waste placed in interim storage for FY76-76A. The checklist includes the approximate total waste volumes (ft³) stored in each package configuration. The configurations vary due to onsite storage environments, limited size-reduction facilities, lack

of standards, and costs. Wastes packaged as noncombustibles inside metal drums (checklist items 1 thru 7) and metal bins (item 14) could be readily acceptable to the terminal isolation facility. The remaining packaging configurations will be required to meet DOT shipping regulations or be shipped inside a reusable overpack meeting DOT shipping regulations. The configurations must also meet the design specifications of the terminal isolation facility which presently include, but are not limited to size, weight, % combustible, and handling.

Survey of container manufacturers

A survey of container manufacturers was initiated in June 1977 to determine if any commercially available containers are applicable to the shipment and storage of low-level TRU waste. The survey will provide an overview of current packaging technology and availability. A marketing information center has supplied a mailing list of 4191 National Manufacturers in seven major container categories who are currently engaged in the manufacture of containers used for packaging and shipment of various industrial commodities. The manufacturers will be contacted by mail and invited to submit technical information on: container types; size, shape, internal volume; weight; closures; DOT certification (if applicable); performance data; unit and quantity cost.

Table 16 - 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 17 - BASIC APPLICATION CHECKLIST

Package Numbers	RI	ARHCO	MRC	LASL	SRP	ORNL	ANL-E	LLL	LBL	BMI	AI	EG&G	ANL-W	Total Volume Per Waste Package Type
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	

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Appendix II

Waste packaging meeting

Monsanto

MOUND LABORATORY

Operated for the United States Energy
Research and Development Administration

June 22, 1977

Mr. Robert Lowery
U. S. Energy Research and
Development Administration
Post Office Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Lowery:

On Thursday, June 2, 1977, a meeting was held at Mound Laboratory, Miamisburg, Ohio, for the specific purpose of discussing proposed criteria for an acceptable TRU waste package for application in both interim storage and terminal isolation. A list of meeting attendees is shown in Attachment I.

Based on conversations and personal contacts with waste generators on our recent site visits, the agenda for the meeting was established (Attachment II), which provided the initial thrust for examining and discussing specific differences in the Wipp Criteria (Attachment III) and feelings shared by the contractors in relation to the criteria (Attachment IV).

The topics covered during the meeting stimulated interesting discussions by all attendees, and, after thoroughly reviewing each point with available factual data, a proposed, agreed upon definition and/or criteria acceptance was established (Attachment V) by the attendees. As you will notice, a definition for Low Level TRU Waste was proposed as was an associated definition of acceptable dose rate. These establish criteria for design of low level TRU waste containers. Combustibles were also defined. Under the proposed definition, the Fiberglass-reinforced Polyester Plywood Box (FRP) qualifies as a noncombustible package system.

Monsanto Research Corporation

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a subsidiary of Monsanto Company

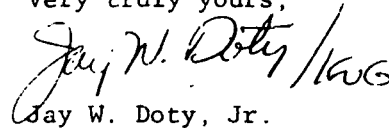
Mr. Robert Lowery

June 22, 1977

All generators of low level TRU waste expressed concern about the packaging of combustible (hydrogenous) materials. A definition of Gas Generating Materials was proposed, which will permit packaging of hydrogenous solid waste in noncombustible containers under the restrictions of 0.0695 curies/liter of total TRU isotope concentration per volume of the waste container. At this concentration, gas generation (radiolysis) in the short term (20-120 yrs.) will not cause any terminal isolation facility pressure problems. This value may increase as additional experimentation is completed to provide factual documentation on the behavior of low level TRU waste in the salt environment.

Other decisions were proposed and adopted at the meeting as noted in Attachment V, however; the most important are those previously described. A complete composite of the entire meeting should be available for transmittal within the next few weeks, and will provide you with the specific information upon which these proposals were adopted.

Very truly yours,


Jay W. Doty, Jr.

JWD:wd
Attachments

cc: G. H. Daly, ERDA/DWPR
R. Glenn Bradley, ERDA/DWPR
B. L. Kelchner, Rockwell International

ATTACHMENT I

Attendees

TRU PACKAGING MEETING

Mound Laboratory
June 2, 1977

James D. Anderson	ARHCO	FTS 444-2670
H. A. Zweifel	ARHCO	FTS 444-2840
Gerald Maestas	LASL	FTS 843-7391
Dean Nelson	LASL	FTS 843-7391
John L. Warren	LASL	FTS 843-7391
Paul O'Brien	Sandia	FTS 475-9160
Bert Blanke	ERDA/DAO	FTS-774-3486
Dick Blauvelt	Mound	FTS 774-3698
J. W. Doty	Mound	FTS 774-3296
Joseph M. Garner	Mound	FTS 774-3465
Keith Gilbert	Mound	FTS 774-7239
Bernie Kokenge	Mound	FTS 774-3581
Howard Kreider	Mound	FTS 774-3309
Marshall Ledford	Mound	FTS 774-3230
Bruce Peterson	Mound	FTS 774-7288

ATTACHMENT II

AGENDA

LOW LEVEL TRU WASTE PACKAGE
PRELIMINARY CRITERIA

June 2, 1977

OS-206

- A. Welcome
- B. Definition of Low-Level Waste
- C. Dose Rate - Maximum Acceptance Value
- D. Isotope Restriction in Combustible Waste
- E. Combustible Percent in Package Material of Construction
- F. Fire Retardants - Flame Spread
- G. Absorbed Liquids
- H. Packaging Criteria - Short Term Until 1983
Long Term 1983 - On
- I. Waste Currently Stored
 - 1. Relationship to above problems
 - 2. Percentage of INEL waste that would be acceptable under conditions above
- J. WIPP Retrievable Concept - Time Period
- K. Closing Remarks

ATTACHMENT III
WIPP ACCEPTANCE CRITERIA

DEFINITIONS

A. Low-Level TRU Waste

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 ERDAM Chapter 0511, it is not suitable for surface burial, but which exhibits sufficiently low radiation levels that it is amenable to handling by "contact" (as opposed to remote) methods.

B. Dose Rate

The dose rate from penetrating radiation at the surface of an individual waste package may not exceed 500 millirem/hr averaged over the waste packages in a given shipment, the surface dose rate may not exceed 200 millirem/hr.

C. Restriction in Combustible Waste

1. Combustibles

For the purpose of these criteria combustibles are defined as those materials which can be ignited in 15 minutes or less when exposed to a temperature of 1300°F (700°C) in atmospheric air. The intent of this definition is to differentiate readily incinerable materials (such as graphite) which can be incinerated only by extraordinary means.

(GAS GENERATION)
(PYROLYSIS)

2. Combustible Percent in Package Material of Construction

Waste shipments to the WIPP will be coordinated on an ERDA-wide basis so that the total amount of combustibles stored in a single storage room does not exceed 20% by volume. In the context of this criterion, the wood used in the fabrication of DOT 19A and similar containers is considered to be combustible.

D. Fire Retardants-Flame Spread

Measures which can be taken to reduce fire hazards:

1. Fireproof waste containers
2. Immediate backfill of storage rooms
3. Automatic (foam) fire extinguishers, etc.
4. Non-combustible envelope

E. Adsorbed Liquids

Waste-containing free liquids will not be accepted for storage at the WIPP. Process sludges must either be dried by heating or mixed homogeneously with an appropriate drying agent; in either case, the liquid of the product should be limited to that required to minimize dispersal of the waste in a handling accident.

G. Additional Discussion Topics

1. Packaging Criteria -

- a. Short-Term until 1983
- b. Long-Term 1983 - on

2. Waste currently stored

- a. Relationship to above problem
- b. Percentage of INEL waste that would be acceptable under conditions above

3. WIPP retrievable concept-time period

4. Closing remarks

ATTACHMENT IV

CONTRACTOR OPINION OF CRITERIA

DEFINITIONS

A. Low-Level TRU Waste

Wastes contaminated with TRU nuclides to levels greater than the proposed level of 10nCi of alpha activity per gram of waste, requiring no shielding for personnel protection, with radiation levels less than 500 millirem/hr measured at the package surface.

B. Dose Rate

1. Common Carrier

a. All radioactive materials must be packaged in suitable packaging (shielded if necessary) so that at any time during the normal conditions incident to transportation the radiation dose rate does not exceed 200 millirem/hr at any point on the external surface of the package and 10 millirem/hr at three feet.

b. Sole Use Vehicle

- i. 1000 millirem/hr at 3 feet from the external surface of the package (closed transport vehicle only);
- ii. 200 millirem/hr at any point on the external surface of the car or vehicle (closed transport vehicle only);
- iii. 10 millirem/hr at 6 feet from the external surface of the car or vehicle; and
- iv. 2 millirem/hr in any normally occupied position in the car or vehicle, except private carriers.

C. Isotope Quality Restriction in Combustible Waste

Hydrogenous waste packaged in a 210 liter drum (550gallon Dot 17c), FRP Box, etc., will contain less than 0.0695 curies/liter of TRU isotope.

(GAS GENERATION)

D. Combustible Percent in Package Material Construction

Date indicate that the fiberglass reinforced 19A boxes will self extinguish after 15 minutes at 700°C in air.

E. Fire Retardants-Flame Spread

1-4 agreement with terminal criteria

F. Absorbed Liquids

Will WIPP accept acids, caustics, organics (oils)?

ATTACHMENT V

PROPOSED DEFINITIONS

Consensus of Meeting Attendees

DEFINITIONS

A. Low-Level TRU Waste

Any solid waste material, other than high activity waste, which is contaminated with long-lived alpha emitters to the extent that, under the provisions of ERDAM 0511, it is not suitable for surface burial and which exhibits a maximum of 500 millirem/hr surface dose rate.

B. Dose Rate

The dose rate from penetrating radiation at the surface of an individual waste package may not exceed 500 millirem/hr. The surface dose rate may not exceed 200 millirem/hr averaged over the waste packages in a transport vehicle.

C. Combustibles and Gas Generating Materials

1. Combustibles

For the purpose of these criteria combustibles are defined as those materials which will sustain combustion when exposed to a temperature of 1300°C (700°C) for 15 minutes or less in atmospheric air. The intent of this definition is to differentiate readily incinerable materials (such as paper, plastics, and pyrophoric materials) from materials (such as graphite) which can be incinerated only by extraordinary means.

2. Gas Generating Materials

Packaged hydrogenous waste will be limited to a maximum of 0.0695 curies/liter of total TRU isotope concentration per volume of the waste container.

D. Combustible Percent in Package Material of Construction

The first portion of this definition could not be related or discussed since it affects the long-term storage problems associated with terminal isolation storage. The percent value will be established after experimentation is completed which will provide information on gas generation (corrosive effect of the salt on containers), toxicity and gas permeation. A standard DOT 19A wooden box is combustible by the definition proposed, however, the FRP box by the proposed definition is now agreed to be a noncombustible container.

E. Fire Retardants-Flame Spread

No agreement was achieved in relation to this criterion. It was suggested that operations in the isolation facility be designed and implemented to reduce fire hazards to the minimum risk level. Also, engineering and construction design should be considered to reduce to the minimum risk level the possibility of water intrusion into the mine during the operation phase (35-40 years) and for long-term storage.

F. Adsorbed Liquids

Concrete waste forms cannot be excluded from storage in the isolation facility, primarily due to the quantity of this waste form already generated and stored in an interim mode. Adsorbed liquids will also be permitted, provided the waste form is totally adsorbed and the package contains no free liquids. Acid and caustic solutions were not addressed by the WIPP criteria, but the work group proposed that both acid and caustic liquid wastes be neutralized to reduce the corrosion of the waste container. If neutralized and solidified, other alternative packaging systems could be considered; e.g., elimination of the High-Density Polyethylene liners.

In relation to the subjects of explosives, pyrophorics, and toxic agents in the waste, the working group proposed that the WIPP criteria state that the generators ensure through administrative operating controls that each of these items be eliminated from the packaged low-level TRU waste containers. The TRU Packaging Questionnaire data supports the fact that generators are not packaging explosives, pyrophorics, or toxic materials in their waste.

G. Additional Discussion Topics

1. Package Criteria

Short-Term Versus Long-Term Problems

At the present time, generators of waste are in a middle situation being bound by ERDAM 0511 (intact, contamination-free for 20-year retrievability) and INEL interim storage criteria. These constraints are not required for terminal isolation, and therefore, waste packages presently used to meet interim will impose an economic disadvantage to the generator over the next 3-5 yr.

It was proposed at the meeting that data are required to characterize material types generally acceptable for construction of waste packaging containers. The materials (metal, plastic, fiberglass, fiberboard, etc.) could then be evaluated on the basis of gas generation, general strength, thermal effects, corrosion in salt, chemical resistivity and other properties in relation to significant storage parameters. Mound Laboratory will perform this study utilizing LASL and RFP data as part of the TRU Packaging Study. OWI is sponsoring a similar study for commercial waste and information can also be extracted from their efforts in container-type acceptability.

2. This item was eliminated from discussion because of the Task Force assigned to examine these parameters.
3. WIPP criteria do not specify the time of the retrievable mode concept. SLA position is that 5 yr is maximum for determining how the low-level TRU waste will behave in the salt environment.

Distribution

EXTERNAL

TIC, UC-70 (267)

W. A. Brobst, ETC

J. A. Chacon, DoE/DAO (2)

R. I. Chitwood, DoE/DWMPR (2)

D. Davis, DoE/ALO (2)

R. K. Flitcraft, MRC

T. C. Jones, DoE/ALO

D. W. King, DoE/ALO (2)

R. Y. Lowery, DoE/ALO

G. Oertel, DoE/DWPR

INTERNAL

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W. H. Bond

W. T. Cave

J. W. Doty (16)

D. A. Edling

J. M. Garner

K. V. Gilbert

L. V. Jones

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