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MLM-3446

Draft for Review

Safety Analysis Report for Packaging (SARP): Model AL-M1 Nuclear Packaging (DOE C of C No. USA/9507/BLF)

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1. GENERAL INFORMATION

1.1. Introduction

This Safety Analysis Report for Packaging (SARP) satisfies the request of the U.S. Department of Energy for a formal safety analysis of the shipping container identified as USA/9507/BLF (DOE-AL), also called AL-M1, configuration 5. This report makes available to all potential users the technical information and the limits pertinent to the construction and use of the shipping containers. It includes discussions of structural integrity, thermal resistance, radiation shielding and radiological safety, nuclear criticality safety, and quality control. Much of the information was previously presented in two Safety Analysis Reports for Packaging (SARP) [1,2].

A complete physical and technical description of the package is presented. The package consists of an inner container centered within an insulated steel drum. The configuration-5 package contains tritiated water held on sorbent material. There are two other AL-M1 packages, designated configurations 1 and 3. These use the same insulated outer drum, but licensing of these containers will not be addressed in this SARP.

Design and development considerations, the tests and evaluations required to prove the ability of the container to withstand normal transportation conditions, and the sequence of four hypothetical accident conditions (free drop, puncture, thermal, and water immersion) are discussed. Tables, graphs, dimensional sketches, photographs, technical references, loading and shipping procedures, Monsanto Research Corporation-Mound experience in using the containers, and a copy of the DOE/OSD/ALO Certificate of Compliance are included. An internal review of this SARP has been performed in compliance with the requirements of DOE 1540.2.

1.2. Package Description

1.2.1. Packaging

1.2.1.1. General. The AL-M1 configuration 5 is illustrated in Figure 1-1. The sealed inner container is the primary containment vessel for shipments of sorbed, tritiated water in configuration 5. The appropriate Monsanto Research Corporation (MRC) drawing numbers are given in Table 1-1.

Drawings detailing the safety features considered in this analysis, including the welding and inspection requirements for carbon steel, are included in the Appendix, section 1.3. Chapter 8 contains drawings detailing the welding and inspection of 300 series stainless steel containers (see section 8.3.3).

1.2.1.2. Steel Drum. The outer container is one of two alternative 55-gal, open-head, steel drums. See Figure 1-2. The alternatives are a DOT Specification 17C drum with rolled or swaged rolling hoops or a DOT Specification 6C drum with I-bar rolling hoops. Both of these drums have 16-gauge steel in the body and head. A vent is provided through the center of the lid to permit vapors to escape. A metal identification plate is welded to the outside of the drum body. A bolted skirt provides additional fastening strength for the closure ring of the drum lid.

Figure 1-1. Package AL-M1, configuration 5.

TABLE 1-1

APPLICABLE MRC DRAWING NUMBERS FOR CONFIGURATION 5

Insulating Drum Assembly	AYD 740425 or AYD 870859
--------------------------	-----------------------------

Configuration 5

Assembly	AYD 870870
Insulating Spacer	AYD 760626
Inner Container	AYE 740198

Figure 1-2. Outer container - package AL-M1.

1.2.1.3. Insulation. Drum assemblies made prior to 1973 utilized a combination of 2 in. of Superex and 1 in. of Thermobestos (Johns-Manville) insulation to line the 55-gal drum. The insulation protected the inner containers against impact and heat. It was held in place within the 55-gal drum with stainless steel sheet and was completely covered internally with stainless steel sheet to form a 15-in. diameter x 25-in. high cylindrical cavity. The Superex (Johns-Manville) layer was located adjacent to the drum wall and the Thermobestos layer was located adjacent to the internal cavity. The maximum service temperature for Superex was 1900°F and the thermal conductivity at 500°F was 0.71 BTU in./ft²/°F/hr. Thermobestos has a maximum service temperature of 1200°F and a thermal conductivity at 500°F of 0.50 BTU in./ft²/°F/hr.

Because of its asbestos content, the Thermobestos product became obsolete, and in 1977 the design was changed to provide an alternative. The alternative consists of Superex-2000, formed and glued to fill the entire space formerly filled by the two types of insulation. The stainless steel insulation spacers were eliminated, but the stainless steel cavity liner was retained. This alternative arrangement is considered to provide a slight improvement in both protection from hypothetical accident fire conditions and dissipation of steady internal heat loads.

1.2.1.4. Spacer

An insulating spacer is used in configuration 5 to center and protect the inner container. The insulating material in this spacer was Firedike (Johns-Manville) prior to 1977, when this material became unavailable. Auratone Firecode (U.S. Gypsum) and Superex insulation have been approved as substitutes for Firedike. These materials have thermal conductivity, density, fire resistance, and mineral fiber content comparable to Firedike.

1.2.1.5. Inner Container

The configuration-5 inner container is a cylindrical vessel nominally 6 5/8-in. o.d. by 23 7/8-in. overall height with a minimum wall thickness of 0.12 in. See Figure 1-3. The container is made of 316 stainless steel and has a top cap sealed with O-rings, which protects and provides secondary tritium containment for bellows valves, fittings, and a pressure transducer. The primary containment vessel is normally loaded with molecular sieve pellets or other material for sorption of tritiated water. The container is designed for assay of contents by insertion in a calorimeter and for loading-unloading by direct connection to external tritium systems in order to thermally regenerate the sorbent bed.

1.2.2. Operational Features

The configuration 5 inner container has four penetrations: two are sealed by Cajon VCR blind glands and Nupro bellows valves, one is sealed by a Cajon VCR blind gland, and one is sealed by a Precise Sensors pressure transducer. The two bellows valves are used for loading and unloading of tritiated contents. The penetration sealed by a blind gland contains a corrosion coupon. This coupon, while not representative of conditions throughout the inner container, is useful in indicating the condition of the metal in one area of the container. These four penetrations are covered by an O-ring sealed cap. The cap is penetrated by two Swagelok quick-connect fittings.

Figure 1-3. Inner container - AL-M1, configuration 5.

These can be used to adjust the atmosphere inside the cap, or to sample for tritium leakage.

1.2.3. Contents of Packaging

1.2.3.1. General. It is necessary to prove that the contents of the containers will not cause the inner containers to be breached during normal transportation or accident test conditions.

The material which is to be packaged (loaded) in the inner container of configuration 5 is limited to tritiated water or tritiated water contaminated with organic compounds, i.e., solvents, not to exceed 1% of the water content. The tritiated water is immobilized on a sorbent, such as a molecular sieve, and meets the transport criteria for a "solid." These materials are described and evaluated in section 1.2.3.2.

Section B (page 3) of the ALO SARP Guide suggests certain criteria which should be considered in describing the contents. Information concerning the applicable criteria are given in this section. The criteria are the following:

1. Quantity of isotopes.
2. Maximum amounts of radioactivity.
3. Chemical and physical form.
4. Material density.
5. Moderating ratios.
6. Configurations as required for nuclear safety evaluations.
7. Maximum amount of decay heat.
8. Maximum pressure buildup.
9. Leak tests.
10. Loading restrictions and limitations.

1.2.3.2. Tritium. The quantity of tritium to be shipped in each configuration-5 container is arbitrarily limited to a maximum of 100,000 Ci or about 10 g of tritium. This quantity does not generate enough heat from radioactive decay (3.3 W) to cause any significant temperature rise in the inner container. It should not be assumed that quantities of tritium greater than 100,000 Ci would be hazardous, but no attempt has been made in this SARP to evaluate such larger quantities.

In addition to this limitation on total tritium, the quantity of tritiated water is also limited. For three common materials evaluated as sorbents, the allowed maximum quantities of water are shown in Table 1-2. The column labeled "sorbent quantity" indicates the minimum weight of sorbent which should be loaded into the inner container. The column labeled "maximum allowed water loading" represents quantities which ensure that no free liquid will exist within the container. In actual tests, equivalent quantities resulted in loaded sorbents that did not cling to container surfaces and retained the normal free-flowing properties of dry granular solids. None of these materials in itself constitutes a hazard to the container (e.g., corrosion, combustion, pressure) under any of the normal or hypothetical accident conditions.

The quantity of water to be shipped is determined by weight difference of the filled and unfilled package. Other types of solid sorbent material may be used provided that the user carefully evaluates the water sorbing capacity of the material. No free liquid is allowed. The user must also determine that

TABLE 1-2 •

WATER LOADING LIMITS FOR THREE SORBENTS

<u>Sorbent Material</u>	<u>Sorbent Quantity (kg)</u>	<u>Maximum Allowed Water Loading (g)</u>
Molecular Sieves 4A, 5A, or 13 x	5.6	2000
Silica Gel	6.4	2000
Commercial Clay Absorbent ^(a)	4.2	3000

(a) A typical montmorillonite clay, Florco, Floridin Company, Pittsburgh, Pa., was tested.

any such sorbent material will not in itself become a hazard to the container under any of the normal or hypothetical accident conditions.

The heat load from tritium decay to helium-3 for the maximum amount of tritium is 3.3 W. The formation of helium-3 from natural tritium decay amounts to a generation rate of <4 L/yr for 100,000 Ci of tritium. With a void volume of 20% in the sorbent, the pressure in the 10-liter inner container would thus rise only about 30 psi in 1 yr.

The tritium must be in the form of tritiated water (HTO); organic compounds, e.g., solvents such as alcohol, which are used in surface decontamination, must not be present in amounts >1% of the water content of the package. This limitation ensures that excessive pressure buildup due to radiolysis will not occur over long storage periods. No unsafe pressure increase will occur at these specified concentration levels of tritium and organic compounds.

The internal pressure buildup due to radiolysis is an increase toward an equilibrium partial pressure of hydrogen formed by dissociation of water due to energy absorbed from the emissions of radioactive tritium. The magnitude of this pressure buildup is a function of time and organic compound contaminant type and concentration. It is not expected to exceed 40 psi and will typically be 10 psi or less after several months when organic compound contaminant levels are below 1%, as suggested above.

Thus, the total pressure in the configuration-5 inner container several months after loading and sealing will (at normal conditions) be roughly the sum of three partial pressures. These are 1) air or inert gases trapped in the container at the time of loading, 2) helium-3 decay product, and 3) hydrogen from radiolysis. At that time the pressure could be expected to be 15 to 20 psig.

During hypothetical accident fire conditions this pressure would rise for two reasons. First, the heating of the gaseous contents to 277°F will

the vapor pressure of the sorbed water would become significant at the elevated temperature. The vapor pressure of free liquid water forms an upper limit for the vapor pressure of sorbed water. At 277°F this is 46.9 psia.

In summary, a configuration-5 container that is loaded and sealed and then subjected to hypothetical accident fire conditions several months later is expected to have a maximum internal pressure of substantially less than 100 psig. The exact magnitude of this pressure depends upon several variables. Therefore, safe practice dictates:

1. Content of organic compounds, such as alcohol, below 1% of water content;
2. Loading at one atmosphere or less;
3. Normal shipment within 30 days after loading; or,
4. If shipment is not made within 30 days, the internal pressure must be measured (i.e., using the built-in pressure transducer). If at that time the pressure is >10 psig, then steps must be taken to reduce the pressure to a maximum of one atmosphere prior to shipment;
5. Occasional monitoring of internal pressure during extended storage periods.

Each configuration-5 inner container is leak tested with helium for a leakage rate of less than 10^{-6} cm³/sec at time of manufacture. A tritium check by ionization monitoring is used by the shipper and receiver to ascertain that a filled container is free of leaks.

The configuration-5 inner containers are made of 316 L stainless steel to provide maximum resistance to corrosion. However, they are not intended to contain corrosive agents, and the user must ensure that none are introduced. In particular, halogen compounds, e.g., decontamination and degreasing solvents, are to be avoided. These include (but are not necessarily limited to) halogenated hydrocarbons, such as Freon propellants and solvents like trichloroethylene. Hence, halogenated compounds that can be introduced into water or decomposed should not be used in systems that will generate tritiated water to be loaded into these containers.

Loading and unloading procedures are given in Chapter 7.

UNLESS OTHERWISE SPECIFIED, ALL DIMENSION
ALL ITEMS TO BE AS SPECIFIED OR APPROVE
FOR EXPLANATION OF DIMENSIONS, TOLERANCE
ANSI Y14.5M-1992.

UNLESS OTHERWISE SPECIFIED, DIMENSIONAL
TEXTURE DESIGNATIONS APPLY AFTER PLATING.
FINISHED SURFACES AS NOTED OR 125 AA MAX.
MFG SPEC.

REMOVE ALL BURRS AND SHARP EDGES EXCEPT

W O NO P21162

CLASS	DET	QNTY OR SHRT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
	1	AYD870667	DOT 6C DRUM 55 GAL	1	STD	WELDMENT
	2		GASKET	1	NEOPRENE	SEE NOTE 6
	3	AYD760659	COVER	1	STD	WELDMENT
	4	AYD760658	LOCKING RING	1	STD	WELDMENT
	5	AYD770331	INSULATION	4	SEE NOTE 3	SEE NOTE 1 AND 2
	6	AYD740528	CYLINDER WELL	1		WELDMENT
	7	AYD770331	INSULATION	20	SEE NOTE 3	SEE NOTE 1 AND 2
	8	AYD770331	INSULATION	4	SEE NOTE 3	SEE NOTE 1 AND 2
	9		WASHER-FLAT	8	STD	.50 NOM.
	10		BOLT-HEX HEAD	8	STD	.50-13 UNC X .62

TES

1. DETS *5 AND 7 - J-M SUPEREX 2000 FLAT BLOCK INSULATION - 5" THICK. (SEE DWG. AYD770331)
DET *8 - J-M SUPEREX 2000 FLAT BLOCK INSULATION - 3" THICK (STOCK SIZE). (SEE DWG. AYD770331)
-THICKNESS OF STOCK MATERIAL FROM WHICH INSULATION PIECES ARE CUT CAN VARY, PROVIDED THAT THE OVERALL DIMENSIONS OF THE GLUED INSULATION ASSEMBLY DO NOT VARY. (SEE NOTES 5 & 7)
2. INSULATION, DETS *5, 7, & 8 MAY BE PROCURED FROM: JOHNS-MANVILLE, GREENWOOD PLAZA, DENVER, CO. 80217.
3. COMPONENTS - DETS* 1, 2, 3 & 4 MAKEUP A COMPLETE DRUM - DRUM SPECIFICATIONS ARE AS FOLLOWS: FULL REMOVABLE COVER WITH 12GA. BOLT TYPE RING (LOCKING RING) WITH .625-11 UNC X 4.00 BOLT & NUT - CONSTRUCTION OF DRUM TO BE 16GA. AND OTHER PARTICULARS PER DOT SPECIFICATION 6C.
4. TACK WELD DET *6 TO DET *1 AT ASSEMBLY. AFTER WELDING COMPLETELY SEAL JOINT WITH G.E. (RTV) SILICONE SEALANT.
5. NO GAPS OR SPACES IN GLUED INSULATION ASSEMBLY.
6. DET *2 TO BE APPROX. 22.50 I.D. WITH Ø.50, HALF ROUND, CROSS SECTIONAL SHAPE TO FIT UNDER LIP OF DET *3A, DWG. AYD870860.
7. USE FIBROUS ADHESIVE FOR GLUED INSULATION ASSEMBLIES, DET *5, 7 & 8 (DRUM INSULATION) AYD770331 AND DET *3L (COVER INSULATION) - DWG. AYD770304. OR MRC ENGINEERING APPROVED EQUIVALENT MFG. BY JOHNS-MANVILLE, GREENWOOD PLAZA, DENVER, CO. 80217. (ACCEPTABLE SUBSTITUTE ADHESIVES INCLUDE SODIUM SILICATE SOLUTION SUCH AS PHILADELPHIA QUARTZ CO. TYPE "O" AND BF GOODRICH-FLEXIBLE DECK ADHESIVE *CA108)

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.750 NOM.

8X TACKWELD

1 WELDMENT REQD - 1

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FOR EXPLANATION OF DIMENSIONS, TOLERANCES
ANSI Y14.5M-1982.
UNLESS OTHERWISE SPECIFIED, DIMENSIONAL &
TEXTURE DESIGNATIONS APPLY AFTER PLATING
FINISHED SURFACES AS NOTED OR 125 AA MAX
MFG SPECS.
REMOVE ALL BURRS AND SHARP EDGES EXCEPT

[illegible]

1. DRUM-DET *1A TO EE 55 GALLON-16GA. METAL-PER DOT SPEC. 6C.
2. PAINT INTERIOR OF DET *1A-ONE COAT PRIMER-ONE COAT WHITE ENAMEL.
PAINT EXTERIOR OF DET *1A-ONE COAT BRUNNING SILICONE EQUIP. & MACH. ENAMEL *96B OSHA BLUE.
3. FALSE WIRE TO BE UNDER & FORMED TO MAKE CONTACT WITH OUTER DRUM WALL.
4. DET *1D-PRESSURE SENSITIVE VINYL LOGO-"MONSANTO"-SIZE 4.5X18.

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3 WELDMENT REQD - 1

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UNLESS OTHERWISE SPECIFIED, DIMENSIONA
TEXTURE DESIGNATIONS APPLY AFTER PLA
FINISHED SURFACES AS NOTED OR 125 AA
MFG SPECS.
REMOVE ALL BURRS AND SHARP EDGES EXC

W O NO P21162

CLASS	DET	DWG OR SHT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
	3		WELDMENT			
	3A		COVER 66 GAL DOT 6C DRUM	1	STD	FULL REMOVABLE
	3B		RING-TOP	1	304L SST	20GA(0.36) X 2 X 56.25
	3C		SIDE-TOP	1	304L SST	20GA(0.36) X 2 X 56.25
	3D		RING-MIDDLE	1	304L SST	20GA(0.36) X 2 X 56.25
	3E		SIDE-BOTTOM	1	304L SST	20GA(0.36) X 1.50 X 46.50
	3F		PLATE-BOTTOM	1	304L SST	20GA(0.36) X 2 X 56.25
	3G		HANDLE	3	B.I.P.	1.125 SCH 40 X 19.00
	3H		ELBOW-90°	1	316L SST	50 O.D. TUBING
	3J		DISC-PERFORATED	1	304L SST	16GA(0.598) X 2 X 56.25
	3K		TUBE-VENT	1	304L SST	50 O.D. X 1.125 WALL X 46.50
	3L	AYD770304	INSULATION	1	SEE NOTE 1 & 2	
	3M		GUARD	3	CRS	16GA(0.598) X 1.75 X 10.00

NOTES

- 1 DET *3L - J-M SUPEREX 2000 FLAT BLOCK INSULATION 3.50 THICK-(SEE DWG. AYD770304).
- 2 INSULATION MFG. BY JOHNS-MANVILLE, GREENWOOD PLAZA, DENVER, CO.
- 3 AFTER ALTERATIONS TO COVER (DET *3A) PAINT UNDERSIDE W/ONE COAT PRIMER-ONE COAT WHITE ENAMEL. PAINT EXTERIOR OF DET *3A ONE COAT BRUNNING SILICONE EQUIP. & MACH. ENAMEL *968- OSHA BLUE.
- 4 FOR WELDING SPECIFICATIONS FOR STAINLESS STEEL-SEE MRC DWG. 1-14841-SECTIONS 2 & 3 FOR WELDING SPECIFICATIONS FOR CARBON STEEL-SEE MRC DWG. SPA 760488-SECTIONS 2 & 3.

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0	4/29/87	PRELIMINARY ISSUE	PS	RAW	MW
DWG TYPE: SCC					
PART CLASSIFICATION					
LEVEL & CAT. UNCL					
DERIVATIVE CLASSIFIER					
NAME: RAW					
TITLE					
DATE: 4/29/87					
DWG CLASSIFICATION					
LEVEL & CAT. UNCL					
DERIVATIVE CLASSIFIER					
NAME: RAW					
TITLE					
DATE: 4/29/87					
THIRD ANGLE PROJECTION					
CODE IDENT NO 14065					
DWG NO AYD870860 SHT 1 OF 1					

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AYD740425

SECTIONAL ELEVATION OF DOOR

NOTE 6

CLASS	DET	DWG OR INT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
	1	AYD740425	DRUM HEAD	1	STD	WELDMENT
	2		BRACKET	1	ALUMINUM	SEE NOTE 8
	3	AYD740425	COVER	1	STD	WELDMENT
	4	AYD740425	LOGAN'S STAND	1	STD	WELDMENT
	5	AYD770331	INSULATION	4	5" THICK	SEE NOTE 1 & 2
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17	AYD740518	CYLINDER RING	1		WELDMENT
	18		DELETED X			
	19					
	20	AYD770331	INSULATION	20	5" THICK	SEE NOTE 1 & 2
	21	AYD770331	INSULATION	4	5" THICK	SEE NOTE 1 & 2
	22		WASHER-FLAT	8	STD	1/2" X 3/8"
	23		BOLT-HEX HEAD	8	STD	1/2" X 3/8"

NOTES:

1. DETS. 5 & 20 - J-M SUPEREX 2000 FLAT BLOCK INSULATION - 5" THICK. (SEE DWG. AYD 770331)
DET. 21 - J-M SUPEREX 2000 FLAT BLOCK INSULATION - 3" THICK (SEE DET. 20). (SEE DWG. AYD 770331)
- THICKNESS OF STOCK MATL FROM WHICH INSULATION RINGS ARE CUT CAN VARY, PROVIDED THAT THE OVERALL DIMENSIONS OF THE INSULATION ASSEMBLY DO NOT VARY. (SEE NOTES 7 & 9.)
2. INSULATION MFG. BY JONAS-MANSVILLE, GREENWOOD PLAZA, DENVER, CO. 80217
3. ALL ITEMS TO BE AS SPECIFIED OR ENGINEERING APPROVED EQUAL.
4. REMOVE ALL BURRS & SHARP EDGES UNLESS OTHERWISE SPECIFIED.

5. COMPONENTS - DETS. 1-2-3 & 4 MAKE UP A COMPLETE DRUM - DRUM SPECIFICATIONS ARE AS FOLLOWS: FULL REMOVABLE COVER WITH 12 GA BOLT TYPE RING (LOCKING RING) WITH 5/8-11 X 4 BOLT & NUT - CONSTRUCTION OF DRUM TO BE 16 GA, AND OTHER PARTICULARS PER DET SPECIFICATION 17C.

6. TACKWELD DET. 17 TO DET. 1 AT ASSEMBLY AFTER WELDING COMPLETELY SEAL JOINT WITH G.E. (RTV) SILICONE SEALANT.

7. NO GAPS OR SPACES IN GLUED INSULATION ASSEMBLY.

8. DET. 2 TO BE APPROX. 22 1/2" I.D. WITH 1/2" DIA. HALF ROUND, CROSS SECTIONAL SHAPE TO FIT INSIDE LIP OF DET. 3A, DWG. AYD740425.

9. USE FIBERGLASS ADHESIVE FOR GLUED INSULATION ASSEMBLY, DETS. 5, 20 & 21 (DRUM INSULATION) - DWG. AYD770331; DET. 3A (COVER INSULATION) - DWG. AYD770304, OR INSULATION ENGINEERING APPROVED EQUIVALENT.

- MFG. BY: JONAS-MANSVILLE
GREENWOOD PLAZA
DENVER, CO. 80217

(ACCEPTABLE SUBSTITUTE ADHESIVES INCLUDE SAKURA SILICONE SEALANT SUCH AS PAKADURAN QUARTZ CO. TYPE "D" & 88 600000N-PLASTIC DECE ADHESIVE "CANON")

ISS	DATE	REVISION	BY	CHK	APPR
A	11-15-76	ORIGINAL ISSUE			
B	4-11-77	CHANGED DIM. ACC. TO 11-18-76			
C	7-11-77	CHANGED DIM. ACC. TO 11-18-76			
D	2-18-87	2008702339MD-X	SG		

DWG TYPE: JCS		SHEET	
TOLERANCES:		INCH	
3-PLACE DEC. 2.01		SHEET 1	
3-PLACE DEC. 2.01		INCH (D)	
OR AS NOTED			
FINISHED SURFACES		AS NOTED OR 125 AA	
MAX OTHER SURFACES		PER MFG. SPEC.	
PART CLASSIFICATION		PROGRAM:	
LEVEL & RAT		NUCLEAR SHIPPING CNTR.	
BY		TITLE:	
TITLE		MODEL AL-MI	
DATE		INSULATED DRUM	
		ASSEMBLY (U)	
DWG CLASSIFICATION		DRAWN: J. J. J.	
LEVEL & RAT		DATE: 11-12-76	
BY: J. J. J.		CHECKED: J. J. J.	
TITLE		DATE: 2-27-76	
		APPROVED: J. J. J.	
DATE: 11-15-76		DATE: 1-1-76	
		SCALE: HALF SIZE	
DESIGNED FOR PART NO & ISSUE		JOB NO 740425	
REFERENCE DWG & ISSUE		DWG NO AYD 740425 1 of 1	
CODE IDENT 1: 1406			

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07707L 014

NOTES:

- SEE NOTE 5*

(1D) - SEE NOTE 3

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AYD700455

CLAS	DET	DWG OR SHIT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
3A			COVER (REMOVABLE)	1	STL	FULL REMOVABLE
3B			RING-TOP	1	304L ST. ST.	2064(C056) 12 1/2 x 10
3C			SIDE-TOP	1	304L ST. ST.	2064(C056) 12 1/2 x 10
3D			RING-MIDDLE	1	304L ST. ST.	2064(C056) 12 1/2 x 10
3E			SIDE-BOTTOM	1	304L ST. ST.	2064(C056) 12 1/2 x 10
3F			PLATE-BOTTOM	1	304L ST. ST.	2064(C056) 12 1/2 x 10
3G			HANDLE	3	304L ST. ST.	1/2 x 1/2 x 1/2 (SCHED 40)
3H			ELBOW 90°	1	304L ST. ST.	1/2 x 1/2 x 1/2
3I			DISC-PERFORATED	1	304L ST. ST.	1/2 x 1/2 x 1/2
3J			FLANGE	1	304L ST. ST.	1/2 x 1/2 x 1/2
3K			INSULATION	1	304L ST. ST.	1/2 x 1/2 x 1/2
3L		AYD770304	INSULATION	1	304L ST. ST.	1/2 x 1/2 x 1/2
3M						
3N						
3P						
3Q						
3R						
3S						
3T			GUARD	3	1010 CES	1654(C0520) 12 1/2 x 10

NOTES:

1. DET. 3L - J-M SUPERK 2000 FLAT BLACK INSULATION - 3/4 THICK - (SEE DWG. AYD770304)
2. INSULATION MFG. BY JOHNS-MANVILLE, GREEN WOOD PLAZA, DENVER, COLO.
3. AFTER ALTERATIONS TO COVER (DET. 3A) PAINT INSIDE OF ONE COAT PRIMER - ONE COAT WHITE ENAMEL. PAINT EXTERIOR OF DET. 3A ONE COAT BRUNING SILICONE ENAM. 1/2 INCH ENAMEL #968 DSHA BLUE.
4. FOR WELDING SPECIFICATION IS FOR STAINLESS STEEL - SEE MRC DWG. NO. 1-14341-SECTION 15 2 1/2 FOR WELDING SPECIFICATIONS FOR CARBON STEEL - SEE MRC DWG. NO. 3FA 760 488 - SECTION 15 2 1/2.
5. REMOVE ALL BURS & SHARP EDGES UNLESS OTHERWISE SPECIFIED.

ISS	DATE	REVISION	BY	CHK	APPR
A	11-13-76	ORIGINAL ISSUE			
B	7-14-77	CHANGED PER ACD LG-2-14876-MSS			
<p>DWG TYPE: SCC SHEET 1 / 1</p> <p>TOLERANCES: 3-PLACE DEC. = .01 3-PLACE DEC. = .005 ANGLE TOL. = 15°</p> <p>OR AS NOTED FINISHED SURFACES AS NOTED ON 125 AA MAX OTHER SURFACES PER MFG SPECS</p> <p>PART CLASSIFICATION: LEVEL & CAT. BY DATE</p> <p>TITLE: COVER</p> <p>DATE: 11-13-76</p> <p>DWG CLASSIFICATION: DRAWN: J. J. L. DATE: 11-13-76</p> <p>LEVEL & CAT. BY: J. J. L. DATE: 11-13-76</p> <p>TITLE: COVER</p> <p>DATE: 11-13-76</p> <p>SCALE: HALF SIZE JOB NO 740425</p> <p>CODE IDENT NO 11085 DWG NO AYD760659 / 1</p>					

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28105192

BLANK
BE REE
DEPT

8.00

4.00

FISSILE RADIOACTIVE MAT

AUTH. GR. WT. MODEL SER
RETURN TO
Monsanto Research Corpor
MOUND FACILITY
MIAMISBURG, OHIO 45342

DETAIL No.	JOB No.	USED ON SHIPPING CONTAINER	
1B	750138	AL USA 5790/BLF	10
1B	750148	AL USA 5791/BLF	3
B	740425	AL-MI	AL
1B	760063	USA/7500/BLF(DOC-AL)	2

NOTES:
1. ENCASED IN 10 CO
2. PER RES. CAPED
3. LETTER SIZE & SP
4. BE AS SHOWN.

CLASS	DET	DWG OR SHT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
-------	-----	---------------	-------------	------	------	------------

RIAL

ion

ISS	DATE	REVISION	BY	CHK	APPR
A	8-4-76	ORIGINAL ISSUE			
B	11-18-76	ADDED AL-MI TO CHART			
C	10-31-77	ADDED 9506 TO CHART CHANGED MACHINE L&S TO MACHINE FACILITY		GAB.	
DWG TYPE:	JCC	SHEET	1 / 1 /		
TOLERANCES		ISSUE	A B C		
2-PLACE DEC ±.01		SHEET			
2-PLACE DEC ±.005		ISSUE			
ANGLE TOL ±0° 15'					
OR AS NOTED FINISHED SURFACES AS NOTED OR 125 AA MAX OTHER SURFACES PER MFG SPECS		MONSANTO RESEARCH CORPORATION MOULD LABORATORY MANNING, OHIO			
PART CLASSIFICATION		PROGRAM(S): NUCLEAR PACKAGING CNTR.			
LEVEL & CAT UNCL		TITLE: NAME PLATE			
BY N. R. Kure					
TITLE					
DATE 6-1-76					
DWG CLASSIFICATION		DRAWN J. DUNLAP DATE 5-28-76 APPROVAL			
LEVEL & CAT UNCL		CHECKED W.D./R.H.W. DATE 8-2-76 1 DLB			
BY N. R. Kure		SPONSOR [Signature] DATE 8-4-76 2 HBR			
TITLE		APPROVED [Signature] DATE 1/1/76 3			
DATE 6-1-76		SCALE FULL JOB NO A511-72 4			
CODE IDENT NO 14065		DWG NO AYC 750142 1 of 1			

TO BE
ENHANCED
TO

ART NO & ISSUE	REFERENCE DWG & ISSUE
CORPORATION AND MUST BE RETURNED TO DRAWING LIBRATED WITHOUT PERMISSION OF MOUND LABORATORY.	

REF ALL Q16

31 INSULATION - COVER (4.250")
(SEE NOTE 112)

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS
ALL ITEMS TO BE AS SPECIFIED OR APPROVED
FOR EXPLANATION OF DIMENSIONS, TO
SPAT40243 AND ANSI Y14.5.
UNLESS OTHERWISE SPECIFIED, DIMENSION
TEXTURE DESIGNATIONS APPLY AFTER
REMOVE ALL BURRS AND SHARP EDGES

WORK P-25384

CLASS	DET	DWG OR SHT NO	DESCRIPTION	RECD	MATL	STOCK SIZE
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NOTES:

1. INSULATION - SUPEREX 2000, BLOCK FORM, DET. 3L - 3/2 THICK.
2. INSULATION DETAIL 3L IS ONE-QUARTER SECTION OF SUPEREX 2000 TO BE GUARD INSIDE COVER Cavity. (SEE DWG. R10760485)
3. INSULATION MFG. BY: JOWNE-MANVILLE GREENWOOD PLAZA DRIVE, COLO. 80217
4. SEE BLUE SPECIFICATIONS - SEE CHA. R10760485, NOTES 7/9.

REV	DATE	REVISION	BY	CHK	APP
A	7-11-77	ORIGINAL ISSUE	GCM	WVD	FRV
B	2-18-87	AC0870239 MD-II	SG	RAU	FRV

DWG TYPE: SCC	SHEET 1
TOLERANCES	SIZE 13
2-PLACE DIM - .015	SHEET
3-PLACE DIM - .005	FILE
ANGLE TO - .015	

ON AS NOTED
FINISHED SURFACES
AS NOTED ON 138 AA
MAX OTHER SURFACES
PER INFO 8/2/78

MONSANTO RESEARCH CORPORATION
MOUNDS LABORATORY
MOUNDS, ILL. 61758

PROGRAM: **NUCLEAR SHIPPING CONT.**

TITLE: **(COVER)
INSULATION**

DWG CLASSIFICATION	DRAWN G.E. MATTHEWS	DATE 7-5-77	APPROVAL
LEVEL & CAT UNCL	CHECKED DUNCAN	DATE 7-12-77	1
BY	SPONSOR	DATE	2
TITLE	APPROVED J. A. [Signature]	DATE 7-5-77	3
DATE 7-12-77	SCALE ANGLE 3/2"	JOB NO 756726	4

CODE IDENT NO 14886 DWG NO R10770304 SHT 1 OF 1

IONS ARE IN INCHES.
ID EQUAL
NCES AND SYMBOLS SEE
L. LIMITS AND SURFACE
RGL
EPT AS INDICATED.

DESIGNED FOR PART NO & ISSUE	REFERENCE DWG & ISSUE
------------------------------	-----------------------

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8

85707058

④ WELDMENT
REQ'D: 1

W O N O						
CLASS	DET	DWG OR INT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
AA			LOCKING RING	1	STD	55 GAL CONDELM
BB			ENAMEL-SEAL	2	1010 CES	[125A(100) 1/4" 3/16
CC			SEAL	1	1010 CES	125A(100) 2 1/4" 6.9

NOTES:

1. FOR WELD SPECIFICATION: IS 55C HRC
DWG. NO. 3A 760488-55C HRC 2 1/3.
2. PAINT ONE COAT BRUNING SILICONE
EQUIP & MAGN ENAMEL #968 D3H BLUE
3. REMOVE ALL BURRS & SHARP EDGES
UNLESS OTHERWISE SPECIFIED.
4. E OF SLOTS IN DET. 4C TO LINE UP WITH E OF DET. 1C OF
DWG. AYD 760660 TO WITHIN ± 0.03 WHEN LOCKING RING IS
FASTENED IN PLACE AS PART OF DRUM ASSEMBLY OF DWG.
AYD 760425.

ISS	DATE	REVISION	BY	CHK	APPR
A	12-3-76	ORIGINAL 135 J2			
B	7-11-77	CHANGED PER ACID-2-14076-855	HM	WPD	TON

DWG TYPE: SCC	SHEET 1	1
TOLERANCES	ISSUE A	B
2-PLACE DEC. $\pm .01$	SHEET	
3-PLACE DEC. $\pm .005$	ISSUE	
ANGLE TOL. $\pm 30'$		
OR AS NOTED		
FINISHED SURFACES		
AS NOTED OR 125 AA		
MAX OTHER SURFACES		
PER INFO SPECS		

PART CLASSIFICATION	PROGRAMME:
LEVEL & CAT	NUCLEAR SHIPPING CNTR.
BY	TITLE:
TITLE	LOCKING RING
DATE	FOR 55 GAL CONDELM
	DOT 17 C

DWG CLASSIFICATION	DRAWN J. J. LAR	DATE 11-14-76	APPROVALS
LEVEL & CAT	CHECKED WPD / R.W.	DATE 2-7-76	1
BY	SPONSOR	DATE	2
TITLE	APPROVED W. R. L.	DATE 11-11-76	3
DATE 11-18-76	SCALE 1/4" = 1"	JOB NO 760488	4

DESIGNED FOR PART NO & ISSUE	REFERENCE DWG & ISSUE	CODE IDENT NO 14025	DWG NO AYD 760658 1 of 1
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1E001014

⑤ INSULATION - BASE PLATE (4 REQ'd)
(SEE NOTE 1 & 2)

② INSULATION - TOP PLATE (4 REQ'd)
(SEE NOTE 1 & 2)

② INSULATION - INTERMEDIATE PLATE (20 REQ'd)
(SEE NOTE 1 & 2)

UNLESS OTHERWISE SPECIFIED, ALL DIM
ALL ITEMS TO BE AS SPECIFIED OR APP
FOR EXPLANATION OF DIMENSIONS, TOU
SPA740243 AND ANSI Y14.5.
UNLESS OTHERWISE SPECIFIED, DIMENS
TEXTURE DESIGNATIONS APPLY AFTER P
REMOVE ALL BURRS AND SHARP EDGES

W O N O P-25384

CLASS DET DWG OR SHY NO DESCRIPTION RECD MATL STOCK SIZE

STANDARD ASSEMBLY PER DETAIL
SCALE: 1/8" = 1'-0" (SEE DWG. 770744425)

NOTES:

1. ALL INSULATION SHOWN - SUPREX 2000 - BLUE FOAM.
2. DET. 21 - 3 THICK (STOCK #126) (275 APPROVED THICKNESS).
3. DETAILS SHOWN ARE SUGGESTED QUARTER SECTIONS OF SUPREX 2000 TO BE GLUED 1/4" GAPS PER STICKED RSTY PER DETAIL.
- SEE NOTE 1 & 3 DWG. 770744425.
3. GUM SPECIFICATIONS - (SEE DWG. 770744425 NOTE 9)
4. INSULATION APP. BY - JOHNS-MANVILLE
- GREENWIND PLAZA
- DENVER, COLO. 80577

REV	DATE	REVISION	BY	CHK	APP
A	7-11-77	ORIGINAL ISSUE	SG	APR	APR
B	2-18-87	QC0870253MD-II	SG	APR	APR

DWG TYPE: SCC	SHEET 1
TOLERANCES	FINISH
3-PLACE DIM: ±.01	FINISH
3-PLACE DIM: ±.005	FINISH
ANGLE TOL: ±.1°	FINISH
OR AS NOTED	FINISH
FINISHED SURFACES	FINISH
AS NOTED OR 1/8" AA	FINISH
MAX OTHER SURFACES	FINISH
PER MFG SPECS	FINISH
PART CLASSIFICATION	FINISH
LEVEL & SET	FINISH
TITLE	FINISH
DATE	FINISH
DWG CLASSIFICATION	FINISH
LEVEL & CAT: UNCL	FINISH
BY: GAO	FINISH
TITLE: INSULATION	FINISH
DATE: 7-11-77	FINISH
CODE IDENT NO 1408	FINISH

MONSANTO RESEARCH CORPORATION	
RESEARCH LABORATORY	
LEANSBURG, OHIO	
PROGRAM:	NUCLEAR SHIPPING CNTR (77C)
TITLE:	(DEUM)
INSULATION	
DRAWN BY: J. B. BROWN	DATE: 7/5/77
CHECKED: D. W. L. A. P.	DATE: 7/12/77
SPONGE: R	DATE: 7/12/77
APPROVED: J. B. BROWN	DATE: 7/12/77
SCALE: 1/8" = 1'-0"	JOB NO 746425
DATE: 7-11-77	DWG NO 770744425
SHEET 1 OF 1	

ALL DIMS ARE IN INCHES.
DIMENSIONS ARE TO FACE UNLESS NOTED OTHERWISE.
LIMITS AND SURFACE FINISH AS INDICATED.

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10

825047144

(17) WELL MEN
REQ'D:1

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DWG NO. AYO 740725		CODE IDENT NO. 14055	
DATE 11/18/75		REVISION NO. 1	
SCALE 1/8" = 1'-0"		BY 11/18/75	
APPROVED BY 11/18/75		DATE 11/18/75	
CHECKED BY 11/18/75		DATE 11/18/75	
DRAWN BY 11/18/75		DATE 11/18/75	
TITLE CYLINDER WELL		DWG CLASSIFICATION	
PROJECT MONSANTO RESEARCH CORPORATION		PART CLASSIFICATION	
PROGRAMS MONSANTO RESEARCH CORPORATION		REV. AND SPEC.	
SHEET 1 OF 1		TOLERANCES	
DWG TYPE: 222		SHEET 1 OF 1	
DATE 11/18/75		BY 11/18/75	
REVISION		CHK APPR	

NOTES:

- FOR WELDING SPECIFICATIONS 2 SEE MTC DWG. NO. 1-14841-SECTION 2
- CYLINDER TO BE HYDROSTATIC LEAK TESTED. FILL WITH WATER TO WITHIN 1 INCH OF TOP-LET STAND FOR 12 HOURS-ALL WELDS TO BE WATER TIGHT
- REMOVE EXCESS WELD REINFORCEMENT FROM INSIDE OF CYLINDER WELL.
- REMOVE ALL BURRS & SHARP EDGES UNLESS OTHERWISE SPECIFIED.
- FIELD FIT DET. 17A AND 17B ASSEMBLY TO DOWN I.D. (ALSO SEE NOTE C ON DWG. NO. AYO 740725)

CLASS	DET	DWG OR SHIT NO	DESCRIPTION	REQD	MATL	STOCK SIZE
17A			WELD			1/8" x 1/2" x 1/2"
17B			WELD			1/8" x 1/2" x 1/2"
17C			WELD			1/8" x 1/2" x 1/2"
17D			WELD			1/8" x 1/2" x 1/2"
17E			WELD			1/8" x 1/2" x 1/2"
17F			WELD			1/8" x 1/2" x 1/2"
17G			WELD			1/8" x 1/2" x 1/2"
17H			WELD			1/8" x 1/2" x 1/2"
17I			WELD			1/8" x 1/2" x 1/2"
17J			WELD			1/8" x 1/2" x 1/2"
17K			WELD			1/8" x 1/2" x 1/2"
17L			WELD			1/8" x 1/2" x 1/2"
17M			WELD			1/8" x 1/2" x 1/2"
17N			WELD			1/8" x 1/2" x 1/2"
17O			WELD			1/8" x 1/2" x 1/2"
17P			WELD			1/8" x 1/2" x 1/2"
17Q			WELD			1/8" x 1/2" x 1/2"
17R			WELD			1/8" x 1/2" x 1/2"
17S			WELD			1/8" x 1/2" x 1/2"
17T			WELD			1/8" x 1/2" x 1/2"
17U			WELD			1/8" x 1/2" x 1/2"
17V			WELD			1/8" x 1/2" x 1/2"
17W			WELD			1/8" x 1/2" x 1/2"
17X			WELD			1/8" x 1/2" x 1/2"
17Y			WELD			1/8" x 1/2" x 1/2"
17Z			WELD			1/8" x 1/2" x 1/2"

SEE NOTE 17.2 OF CSAC TEST

AYD870670

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS
ALL ITEMS TO BE AS SPECIFIED OR APPROXIMATE
FOR EXPLANATION OF DIMENSIONS, TOLERANCES
ANSI Y14.5M-1982.
UNLESS OTHERWISE SPECIFIED, DIMENSIONAL
TEXTURE DESIGNATIONS APPLY AFTER PLATING
FINISHED SURFACES AS NOTED ON 125 AA &
MFG SPECS.
REMOVE ALL BURRS AND SHARP EDGES EXCEPT

Technical drawing of a vertical assembly. The drawing shows a central vertical shaft with several components and dimensions. The total height is $16.00 \pm .01$. A dimension of $3.00 \pm .01$ is shown for a section of the shaft. A dimension of $.50 \pm .01$ is shown for a small feature. Callouts include 1Y REF, 1Z REF, 1BB, 1AA REF, and TYP. The drawing is a side view of a vertical assembly.

Technical drawing of a mechanical part with the following dimensions and callouts:

- Top horizontal dimension: $\varnothing .436 \pm .00$
- Top horizontal dimension: $.500-13 \text{ UNC THRD.}$
- Top horizontal dimension: $\varnothing .75 \pm .01$
- Top horizontal dimension: $.06 \pm .01 \text{ X } 45^\circ \pm .15'$
- Vertical dimension: $.94 \pm .01$
- Vertical dimension: $.68 \pm .01$
- Vertical dimension: $32/$
- Vertical dimension: $4.68 \pm .01$
- Vertical dimension: $20.18 \pm .01$
- Callouts: REF 1S, REF 1J, REF 1G
- Bottom horizontal dimension: $\varnothing .188 \pm .005 \text{ T}^{\text{H}} \text{RU}$
- Bottom horizontal dimension: $.50 \pm .01$

Technical drawing of a circular mechanical component, likely a flange or end plate, showing various dimensions and callouts. The drawing includes a central circular feature with a cross-section view. Dimensions are provided in inches, with tolerances indicated by the $\pm$ symbol. Callouts include "SECTION A-A" and "SEE NOTE 11B".

Dimensions and Callouts:

- Top horizontal dimension: $2.042 \pm .005$
- Top horizontal dimension: $1.312 \pm .005$
- Top horizontal dimension: $1.312 \pm .005$
- Left vertical dimension: $4.31 \pm .01$
- Left vertical dimension: $1.710 \pm .005$
- Left vertical dimension: $10^\circ \pm 15'$
- Right vertical dimension: $1.710 \pm .005$
- Right vertical dimension: $10^\circ \pm 15'$
- Callout: SECTION A-A
- Callout: SEE NOTE 11B

This technical drawing shows a cross-section of a mechanical assembly, labeled "SECTION AA". The drawing includes numerous callouts pointing to specific parts and features:

- Top Callouts:** REF, SEE NOTE 2, REF.
- Left Side Callouts:** 3, 8, 9, 10, 1S, 11, 1R, 6, 7, 5, 1P, 4, 1N, 3, 1M, 1L, 2, 1K, 1J, 1H, 1G, 1F, 1E, 1D, 1C, 1B, 1A, I, 1A.
- Right Side Callouts:** 3, 12, 13, 14, 1T, 1U, .75±.01, 1Y, 1Z, 1M, 3, 1V, 1W, 1X, 1AA.
- Dimensions and Notes:**
 - "SURFACE X" (SEE NOTES 9 & 16)
 - FILL VOID WITH WELD & GRIND FLUSH
 - .50±.01
 - (3.50)
 - 18.75±(11.75)
 - (1.25)
 - .12 MIN
 - 46.625±.868
- Other Labels:** TYP, SEE NOTES 4 & 13, SEE NOTE 2, SEE NOTE 8, SEE NOTE 2, SEE NO., SEE NO., REF.

SECTION AA

72707LOAN

FOR SHIPPING CONTAINER
ASSEMBLY SEE MEC
DWG. NO. AYC 740425

11 GA
(120)

CLEARANCE FOR NUT

FOR INNER CONTAINER
SEE MEC DWG. NO. AYC 740130

2500
REF.

24.50

11-4

4.85
2.75
DIA.

11-4

SEE NOTE 1

SECTION A-A

ACD 870449 MD
8/3/87

PLATE	DET	QWS OR DET NO.	DESCRIPTION	QWS	MATL	STOCK SIZE
	1		GLUED ASSEMBLY	1		GLUED ASSEMBLY
	1A		DISC	1	304L ST. 316	1/2" DIA
	1B		RING	32	304L ST. 316	1/2" DIA
	2		CYLINDER WALL	1		W/FLANGE
	2A		BOTTOM	1	304L ST. 316	1/2" DIA
	2B		CYLINDER	1	304L ST. 316	1/2" DIA
	2C		HEAT NUT	2	316 ST. 316	1/2" DIA
	2D		RING	1	304L ST. 316	1/2" DIA
	3		PAD-SHOUL	3	CERAMIC	1/2" DIA
	4		PAD-SHOUL	1	CERAMIC	1/2" DIA

NOTES

1. GLUE DET. 1A TO DET. 2A-USE ADHESIVE AS SHOWN IN NOTE 2.
2. USE B.F. GOODRICH-FLEXIBLE DECK ADHESIVE #BA10B FOR GLUED ASSEMBLY-DET. #1
3. USE JONAS-MANVILLE-FIREDIKE #4000-FOR GLUED ASSEMBLY-DET. #1 & 1B.
4. USE JONAS-MANVILLE-CERAMIC (DENSITY 3.60/G/CM³) FOR DETS. #3 & 4
5. DETS. #3 & 4 WILL COMPRESS TO APPROX. 1/2 OF ORIGINAL THICKNESS AT FINAL ASSEMBLY.
6. AFTER WELDING DET. 2D TO BE FLAT WITHIN .030 T.I.E.
7. REMOVE ALL BURS & SHARP EDGES UNLESS OTHERWISE SPECIFIED
8. NO GAPS PERMISSIBLE IN GLUED ASSEMBLY DET. 1 OR IN GLUED DET. 1 TO DET. 2.

REV	DATE	REVISION	BY	CHK	APPR
1	12/15/76	DESIGNED FOR 13346			
2	8-6-77	DESIGNED FOR ACID ID-2-14876-M43	GER	LD	

QWS TYPE: 13346	SHEET 1
TOLERANCES	SIZE A
3-PLACE DEC. 3.00	SIZE B
3-PLACE DEC. 3.00	SIZE C
ANGLE TOL. 30.00	
ON AS NOTED	
FINISHED SURFACES	
AS NOTED ON 13346	
MAX. OTHER SURFACES	
PER MFG. SPEC.	
QWS CLASSIFICATION	
LEVEL 1 & 2	
BY	
DATE	
QWS CLASSIFICATION	
LEVEL 1 & 2	
BY	
DATE	
QWS CLASSIFICATION	
LEVEL 1 & 2	
BY	
DATE	

DESIGNED FOR PART NO. & REVISION		REFERENCE QWS & SHEET
CODE 13346		QWS NO. AYD760626 / 81

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TABLE OF CONTENTS

SECTION

1	Scope
2	Welding
3	Visual Examination
4	Dye Penetrant Examination
5	Helium Leak Test
6	Certification

A

1. S C O P E.

- 1.1 This specification defines requirements for welding, visual and dye penetrant examinations of the welds, helium leak testing to assure leak tight welds, fittings and closures and certification to assure that all requirements have been met. This specification applies to carbon steel containers and is a supplement to the container drawings.
- 1.2 All sections of this specification must be compiled with unless specifically exempted in writing. Compliance with this specification does not relieve the supplier of the responsibility for quality results.

2. W E L D I N G.

- 2.1 Welding process to be used:
- a. Shielded Arc (Straight Stick Electrode).
 - b. Gas Metal Arc (GMA, was called Metal Inert Gas or MIG).
- 2.2 Welding filler material -- AWS-A5.18-69 Class E70S-2 (Linde 65).
- 2.3 Welds - The fillet weld shall have continuous complete fusion at the root of the weld joint. The butt weld shall have continuous complete penetration through the tube wall. (Standard AWS welding symbols have been used on the drawing.)
- 2.4 Welding operator qualification - It shall be the responsibility of the vendor to assure that the assigned welding operators are competent, experienced and qualified to perform welding on carbon steel.

3. V I S U A L E X A M I N A T I O N S.

- 3.1 A detailed visual inspection of each entire weld shall be made using magnifying equipment with a 4X to 20X magnification reading glass. Any defect greater than those listed in 3.2 to 3.7 shall be cause for rejection:
- 3.2 Cracks - There shall be no cracks in the welds or in the adjacent base metal.

- 3.3 Surface Pores - There shall be no surface pores greater than .012" diameter.
- 3.4 Surface Contour - The surface of the weld shall be uniform in appearance.
- 3.5 Weld Size - The fillet weld shall be gaged to assure that it meets or exceeds the drawing requirement.
- 3.6 Cold Overlaps - There shall be no cold overlaps.
- 3.7 Undercuts - There shall be no undercuts.

4. D Y E P E N E T R A N T E X A M I N A T I O N .

- 4.1 A detailed fluorescent dye penetrant examination of each entire weld shall be made. Any defect greater than those listed in 4.2 and 4.3 shall be cause for rejection.
- 4.2 Cracks - There shall be no crack indications in the welds or adjacent base metal.
- 4.3 Surface Pores - There shall be no surface pores greater than .012" diameter.

5. H E L I U M L E A K T E S T .

- 5.1 The container shall be successfully helium leak tested in the presence of an MRC representative.
- 5.2 The vendor will establish that he can obtain the services of a qualified, experienced operator and the equipment to conduct the helium leak test.
- 5.3 All welds and fittings must have no detectable leak greater than 1×10^{-5} (STP) cc/sec and a metal o-ring seal (or similar metal to metal seal) must have no detectable leak greater than 1×10^{-5} (STP) cc/sec. The entire container must not leak more than 1×10^{-5} (STP) cc/sec when sealed with a Viton or equivalent o-ring or 1×10^{-5} (STP) cc/sec when sealed with a metal o-ring or similar metal to metal seal.
- 5.4 The leak detector used for the test must be standardized just prior to the test against a standard leak tube in the appropriate range.

2. STRUCTURAL EVALUATION

2.1. Structural Design

2.1.1. Discussion

The 9507 configuration 5 package is illustrated in Figure 1-1 in Chapter 1. It utilizes a 55-gal steel drum outer container, either DOT specification 6C or 17C, lined internally with 3 1/2 in. of insulation to protect the inner container from impact and fire. The drum is fabricated of 16-gauge carbon steel. A vent is provided through the lid of the drum for release of any vapors. The drum cover is secured by a modified drum locking ring. A metal skirt is welded to the locking ring, which is in turn bolted to the drum body. This prevents separation of the drum cover if the package is dropped. Security seals are fastened to the closures during shipment.

Configuration 5 has an inner container designed to contain tritiated water adsorbed on a solid and consists of a 6 5/8-in. o.d., 0.12-in. minimum wall thickness stainless steel cylinder with valves and fittings. This cylinder is designed for calorimetric assay of contents and bakeout for reuse. It has a top cap, sealed with a threaded nut and O-rings, which provides secondary tritium containment for bellows valves, fittings, and a pressure transducer. Neoprene O-rings are used. In the assembled package, an insulating spacer protects the inner container and centers it within the insulating outer drum assembly.

2.1.2. Design Criteria

The internal pressure capability of the package at various temperatures was thoroughly evaluated. The pressure capability of the inner container is sufficiently high to contain the pressures that would result from heating the air trapped during packaging operations (at 1 atm) to the temperatures reached during normal shipment and hypothetical accident conditions. Maximum allowable internal pressures for the container are summarized in Table 2-1. Details of the internal pressure calculations are given in the appendix, section 2.10.1.

TABLE 2-1

MAXIMUM ALLOWABLE INTERNAL PRESSURE FOR INNER CONTAINERS

<u>Configuration</u>	<u>Inside Diameter</u> <u>(in.)</u>	<u>Internal Pressure</u> <u>at 300°F</u> <u>(psig)</u>
5	6.357	218 290

When regarded as a simple beam supported at its ends along any major axis, the shipping container must be capable of withstanding a static load, normal to and uniformly distributed along its length, equal to five times the fully loaded container weight without generating stresses in any material of the container in excess of the yield strength of that material.

The outer drum is shown schematically in Figure 1-2. The drum material is low alloy steel with a minimum yield stress of 27,000 psi, as specified per ASME Pressure Vessel Code [1].

The calculation of the maximum bending stress is detailed in the appendix, section 2.10.2. The maximum bending stress is 503 psi. Since the material yield stress of 27,000 psi is 54 times as great as the calculated results, the 9507 container satisfies the load resistance requirement.

2.2. Weights and Centers of Gravity

The weights of the package and individual subassemblies are tabulated in Table 2-2. The centers of gravity, shown in the same table, were calculated both on the basis of an empty inner container, and a container loaded with the maximum contents weight. For most shipments, the contents weight will be insignificant compared to the weight of the container. The centers of gravity are shown in Figure 2-1.

2.3. Mechanical Properties of Materials

Mechanical properties of the stainless steel and carbon steel used in the inner and outer containers are summarized in Table 2-3. Properties of the O-ring seals used in the inner container are shown in Table 2-4.

2.4. General Standards for All Packages

2.4.1. Minimum Package Size

10 CFR 71.43, part (a) states that the smallest overall dimension of a package must not be <10 cm (4 in.). For the 9507 package, the smallest overall dimension is the outer diameter, which is 22.5 in. Therefore, this condition is satisfied.

2.4.2. Tamperproof Feature

Seals are secured to the drum closures during shipment to deter unauthorized opening of the package. The unbroken seal also serves as evidence that the package has not been tampered with during shipment.

2.4.3. Positive Closure

Positive closures, bolts or screwed threads, are used on both the inner and outer containers to prevent accidental opening.

2.4.4. Chemical and Galvanic Reactions

It is necessary to prove that the contents of the containers will not cause the inner containers to be breached during normal transportation or accident test conditions. The contents include the radioactive tritiated water as well as the packaging materials, such as granular solid sorbents. All of these are stable as initially packaged, and their stability is not known to be altered by impact, vibration, or below-ambient temperatures. Thus, the scope of the contents analysis is limited to establishing what changes would be expected to occur at 300°F and the consequences of these changes. The 300°F temperature is selected as the maximum temperature of

TABLE 2-2

WEIGHTS OF PACKAGES AND COMPONENTS

<u>Assembly</u>	<u>Weight (lb)</u>	<u>Center of Gravity^(a) (in.)</u>
Outer Container	272	17.4
<u>Configuration 5</u>		
Inner container	37.2	15.9
Spacer	51.3	12.5
Total package (empty)	360.5	17.7
Contents (maximum)	4.4	
Total package (fully loaded)	364.9	17.8

(a) Measured from outside bottom.

Figure 2-1. Centers of gravity for AL-M1 configuration 5:
 (■ - inner container, ▲ - outer container, ● - overall package).

TABLE 2-3

MECHANICAL PROPERTIES OF MATERIALS
AT NORMAL TEMPERATURE

<u>Material</u>	<u>Yield Strength (ksi)</u>	<u>Charpy Impact Strength (ft lb)</u>	<u>Modulus of Elasticity, E (10⁶ psi)</u>	<u>Maximum Allowable Stress (ksi)</u>	<u>Density (lb/in³)</u>	<u>Coefficient of linear thermal expansion (μin/in°F)</u>	
						<u>-100°C to 20°C</u>	<u>20°C to 800°C</u>
Carbon Steel	27.0 ^(a)	34 ^(b)	29.5 ^(c)	15.0 ^(d)	0.284 ^(e)	5.73 ^(f)	7.78 ^(f)
Stainless Steel						<u>0 to 100°C</u>	<u>0 to 538°C</u>
- 316L	25.0 ^(h)	55 ^(b)	28.0 ^(g)	15.7 ⁽ⁱ⁾	0.29 ^(g)	8.8 ^(g)	9.7 ^(g)

(a) Reference 1, p.208

(b) Reference 2, p.19

(c) Reference 3, p.217

(d) Reference 1, p.211, -20 to 650°F

(e) Reference 3, p.205

(f) Reference 3, p.207

(g) Reference 4, Vol. 3, p.34

(h) Reference 1, p.280

(i) Reference 1, p.280, -20 to 300°F; 15.5 up to 400°F; 14.4 up to 500°F

TABLE 2-4

O-RING PROPERTIES

<u>Material</u>	<u>Normal Temperature</u>		<u>High Temperature</u>		<u>Low Temperature</u>
	<u>Hardness, Shore A (pts)</u>	<u>Tensile Strength (psi)</u>	<u>Hardness, Shore A (pts)</u>	<u>Tensile Strength (psi)</u>	<u>Hardness, Shore A (pts)</u>
Neoprene Rubber	69(b)	2125(b)	67(c)	2117.7(c)	92(a)

(a) Reference 5, p. A3-10; -40°F

(b) Reference 6

(c) Reference 6, heat-aged 70 hr at 212°F

the materials under accident fire test conditions. It is sufficiently higher than the actual known temperatures during the fire tests to provide an adequate margin of safety.

Tritiated water is the contained material in configuration 5. The pressure at 300°F, as evaluated in sections 2.1.2 and 2.10.1, will not cause the inner container to be breached. Corrosive impurities in the water contents are a long-term threat even to this 316L stainless steel container since it is reusable. Thus, users must ensure that corrosive impurities are not inadvertently loaded into the container.

2.5. Lifting and Tiedown Standards for all Packages

2.5.1. Lifting Devices

It is required that lifting devices that are an integral part of the package be capable of lifting three times the weight of the package and any attachments without generating stress in any material of the package in excess of its yield strength.

No lifting devices, as such, are provided on these shipping containers. The drum covers and inner containers are generally removed manually and do not require any special devices. The assembled containers are commonly lifted with a fork lift by positioning the forks either beneath the bottom of the drum as shown in Figure 2-2 or, in the case of 6C Drums with I-bar rolling hoops, under the upper rolling hoop as shown in Figure 2-3. The 17C drums with swaged rolling hoops should not be lifted by the rolling hoops. The

Figure 2-2. Lifting drum from bottom with fork lift.

Figure 2-3. Lifting a 6C drum at rolling hoop with fork lift. This lifting method is not to be used on 17C drums.

following evaluations show that, using these prescribed lifting methods, supporting three times the weight of the packages will not generate stresses in excess of the yield strength of the mild steel drums.

The maximum gross weight of the 55-gal container is taken to be 550 lb and three times this weight is 1650 lb. In lifting from the bottom, this load is reacted at points as shown in Figure 2-2. Each fork is typically 4 in. wide and the drum wall is 0.0598 in. thick. The maximum stress in the drum is found by dividing the required load by the total cross-sectional area as follows:

$$S = \frac{1650 \text{ lb}}{(4 \text{ places})(4 \text{ in.})(0.0598 \text{ in.})}$$

$$= 1725 \text{ psi.}$$

The calculated stress is less than the 27,000 psi yield strength of the mild steel drums.

In lifting 6C drums by positioning the forks beneath the outer flange of the rolling hoop, the load is reacted at two points as shown in Figure 2-3. The maximum bending stress occurring in the hoop is determined in the following manner. Assume that the section of the web A-B resists the 825-lb load alone and the load carrying capability of the flange is neglected. The flange is assumed to distribute the load along the edge of the web. The maximum bending stress in the hoop is given by

$$S_{\max} = 6M/bt^2,$$

where $S_{\max}$ = the maximum bending stress (psi),

M = the bending moment, $M = (825)(0.95) \text{ in.-lb}$

b = engagement length, $b = 9.70 \text{ in.}$, and

t = web thickness, $t = 0.15 \text{ in.}$

Thus

$$S_{\max} = \frac{6(825)(0.95)}{(9.70)(0.15)^2} = 21,500 \text{ psi.}$$

The maximum shear stress in the web is given by

$$S_{\max} = W/A$$

where W is the weight and A is the area ($b \times t$).

Thus

$$S_{\max} = \frac{825}{A} = \frac{825}{(0.15)(9.7)} = 567 \text{ psi.}$$

Both of these values are conservative since the resisting action of the flange was not included. The minimum yield stress of the ring material is 27,000 psi, as specified by the ASME Code [1]. The I-bar rolling hoop is prevented from slipping due to the corrugation in the drum body.

2.5.2. Tiedown Devices

10 CFR 71 specifies that the tiedown devices which are a structural part of the package must be capable of withstanding simultaneously 10 g longitudinal, 5 g lateral, and 2 g vertical loads without exceeding the yield strength of the material.

No tiedown devices are used on the 9507 packages. They are normally retained in place within the transport vehicle by other packages or are strapped in place.

2.6. Normal Conditions of Transport

2.6.1. Heat

2.6.1.1. Summary of Pressures and Temperatures. Pressures and temperature, calculated for conditions of normal transport in Section 3.4, are summarized in Table 2-5.

2.6.1.2. Differential Thermal Expansion. As stated in section 3.4.5., temperature differences within the package under normal conditions of transport are small, and the stress due to differential thermal expansion is negligible.

2.6.1.3. Stress Calculations. Differential thermal expansion under normal conditions of transport is small. Therefore, the resulting stresses are insignificant. In addition, the inner containers were heated during the steady-state tests to temperatures higher than those that will be reached in direct sun, as reported in section 3.4.2. No degradation of package performance was detected in these tests.

TABLE 2-5

LIMITING TEMPERATURES AND PRESSURES^(a) FOR NORMAL CONDITIONS OF TRANSPORT

Config- uration	Maximum Contents	Max. Temp. in Shade			Max. Temp. in Sun			Maximum Pressure in Sun (psig)
	Heat Load (W)	(°F)			(°F)			
		Inside	Inner	Drum	Inside	Inner	Drum	
		Inner Cont.	Cont. Surface		Cont.	Cont. Surface		
5	3.3	125 ^(b)	116 ^(b)	100	161 ^(b)	152 ^(b)	136	7.0 ^(c)

(a) Calculated at 100°F ambient, loaded with maximum contents heat load at -40°F.

(b) Add 2.5°F for Firecode insulation in insulating spacer.

(c) Add 0.1 psi for Firecode insulation in insulating spacer.

2.6.1.4. Comparison with Allowable Stress. Stresses under normal conditions of transport will be negligible compared with the design criteria of section 2.1.2.

2.6.2. Cold

The cold test requires evaluation or testing at an ambient temperature of -40°F in still air and shade. It was concluded that this temperature will not decrease the effectiveness of the packages.

Even if the package is empty, and the temperatures of both the inner and outer containers fall as low as -40°F, brittle fracture will not be a problem. The impact strength of stainless steel actually increases from ambient temperature to -40°F, as shown in Table 2-3. Brittle fracture can be a problem for carbon steel, of which the outer containers are constructed. However, it is recognized that a large margin of safety exists for steel of less than 0.19-in. thickness [7]. Therefore, the 16-gauge (0.0598-in. thick) outer containers are safe from the effects of brittle fracture.

2.6.3. Reduced External Pressure

Reduced atmospheric pressure of 3.5 psia is well within the capability of the inner container. This is equivalent to an increased internal pressure of 11.2 psi above the maximum normal operating pressures calculated in section 3.4.4. The resulting internal pressures are summarized in Table 2-6. These pressures are well below the design criteria as determined in section 2.1.2.

TABLE 2-6

EQUIVALENT PRESSURES RESULTING FROM REDUCED
EXTERNAL PRESSURE OF 3.5 psia*

<u>Configuration</u>	<u>Maximum Contents Heat Load (W)</u>	<u>Maximum Internal Pressure in Direct Sun (psig)</u>	<u>Equivalent Pressure Rise at 3.5 psia Ambient (psi)</u>	<u>Equivalent Internal Pressure (psig)</u>
5	3.3	7.0	11.2	18.2

*Inner containers at ambient temperature of 100°F.

2.6.4. Increased External Pressure

The containment vessel must be capable of withstanding an external pressure of 25 psi without any loss of contents; that is, no leaks or failure will occur due to yielding. Thus, the configuration-5 container is analyzed in the following to determine that 25 psi external loading will not produce stress that exceeds the yield stress at 300°F.

This inner container is made of 316L stainless steel. From the ASME Code Section UG-28(c) [1], we have for the main body cylinder of length, $L = 19$ in.; diameter, $D_o = 6.625$ in.; and thickness, $t = 0.134$ in.;

$$L/D_o = 19/6.6 = 2.9$$

$$D_o/t = 6.625/0.134 = 49.4.$$

Using Figure UHA-28.4 (P-305), we find the factor, B, is

$$B = 9900 \text{ psi (up to } 100^\circ\text{F)}$$

$$= 7500 \text{ psi (} 300^\circ\text{F)}.$$

Then, the allowable pressure, P, is

$$P = B/D_o/t = 9900/49.4$$

$$= 200.4 \text{ psi up to } 100^\circ\text{F}$$

$$= 7500/49.4 = 152 \text{ psi at } 300^\circ\text{F}.$$

These values are considerably above the required pressure of 25 psi; thus, the cylinder is adequate.

The dished top and bottom heads will be analyzed under section UG-33 "Formed Heads. Pressure on Convex Side," ASME Code [1]. For this case, reference is back to UG-28(d) with the appropriate length factor, L_i , and head thickness, t_h , having values of

$$L_i = 6 \text{ in.}$$

$$t_h = 0.124 \text{ in.}$$

Then

$$L_i/t_h = 48.4$$

$$L_i/100t_h = 0.484$$

From chart, Figure UHA-28.4, p. 305, the factor, B, is

$$B = 14500 \text{ psi at } T = 100^\circ\text{F}$$

$$B = 11000 \text{ psi at } 100^\circ\text{F} < T < 300^\circ$$

and the allowable pressure, P, is

$$P = B/(L_i/t_h) = 14500/48.4$$

$$= 300 \text{ psi at } T = 100^\circ\text{F}$$

$$= 11000/48.4$$

$$= 227 \text{ psi at } 100^\circ\text{F} < T < 300^\circ\text{F}.$$

Because the inner cylinder and end caps can safely withstand the required pressure, the container meets the standard for external pressure.

2.6.5. Vibration

The vibration test requires the packaging be capable of withstanding vibration normally incident to transport. The capability of the AL-M1 containers to withstand normal vibration is well documented as a result of special tests and routine use. A complete AL-M1 package, including nonradioactive contents, was subjected to laboratory tests that included both lateral and axial shake, rattle, and roll tests for ensuring the product quality of the contents under severe conditions. An actual road test was then performed from Livermore, California, to Miamisburg, Ohio. The road test confirmed that the laboratory tests were more severe than actual road conditions.

Since 1968, approximately 150 shipments over various road conditions have been successfully completed. Neither the special tests nor routine use provides any evidence of damage caused by vibration.

2.6.6. Water Spray

A water spray sufficiently heavy to keep the entire exposed surface of the package, except the bottom, continuously wet during a period of 30 min will not damage any of the packages in any way or have any effect, other than slight cooling, on the contents.

2.6.7. Free Drop

A free drop through a distance of 4 ft onto a flat, essentially unyielding surface, striking the surface in a position for which maximum damage is expected, would not reduce the effectiveness of the packaging, as this test was performed for a 55-gal package by the University of California [8] with only minor damage to the drums. In addition, when the 9507 package was subjected to the 30-ft drop test described in section 2.7.1, the subsequent water immersion test for fissile material (section 2.7.4) resulted in no water in-leakage to the inner containers. These drop-tested containers were also pressurized with helium and reassembled using the original O-rings (section 2.7.6). Helium leak testing showed no leaks greater than 1×10^{-6} std cm^3/s for configuration 5. It is concluded that there would be no loss of radioactive contents greater than 10^{-6} A_2/hr , no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the packaging under these hypothetical accident test conditions; therefore, the package will also meet these requirements under the less destructive normal conditions of transport.

2.6.8. Corner Drop

This test requires a free drop into each corner of the package in succession or, in the case of cylindrical package, onto each quarter of each rim, from a height of 1 ft onto a flat, essentially unyielding, horizontal surface. This test applies only to packages that are constructed primarily of wood or fiberboard and do not exceed 110 lb gross weight and to all Fissile Class II packagings.

This test is not applicable for the configuration-5 container; however, as discussed above, these packages satisfied the requirements for normal

conditions of transport even after being subjected to the sequence of four hypothetical accident tests. It is concluded that they would meet these requirements after the 1-ft corner drop.

2.6.9. Compression

Not applicable.

2.6.10. Penetration

It is necessary to evaluate the impact of the hemispherical end of a vertical steel cylinder, 1 1/4 in. in diameter and weighing 13 lb, dropped from a height of 40 in. onto the exposed surface of the package that is expected to be most vulnerable to puncture. This test causes minor damage to drum surfaces but does not penetrate them. This was demonstrated by a test performed at Mound [9]. This test was actually more stringent than required, as a weight of 13.2 lb was dropped from a height of 66 in. onto both the lid and the curved surface of a 55-gal drum of 0.0478-in. wall thickness. This wall thickness is thinner than the 0.0598-in. wall thickness of the specified DOT 17C or 6C drum.

Figure 2-4 shows the rod suspended 66 in. above the drum lid. In Figure 2-5, the rod is shown impacting the drum lid. The rod is suspended 66 in. above the curved surface of the drum in Figure 2-6. In Figure 2-7, the rod is approaching the drum surface. In all tests; deformation of the drum surface was less than 3/8-in. and penetration did not occur. Consequently, the 9507 packages fulfill the requirements of this test.

Similar 10-gal and 30-gal packages were also tested by Dow Chemical Company [10,11]. In every case, the test caused only minor damage to the drum and no penetration. The adequacy of the 55-gal drum was further substantiated by an engineering evaluation that compares the stress imposed by the dropped rod striking the drum to the ultimate strength of the drum material [12].

In this analysis, the impact velocity of the rod was compared to the ballistic limit velocity. The ballistic limit velocity (V_1) is defined as the lowest striking velocity that will result in perforation of the target with zero residual velocity. It can be estimated using the following equation [13]:

$$V_1 = \frac{A_0}{\sqrt{W_s}} A_p^m (t \sec \theta)^n$$

where A_0 , m , and n are empirical constants and:

W_s = striking weight,

A_p = fragment area presented to plate,

t = plate thickness,

θ = angle of obliquity.

Figure 2-4. Rod suspended above drum lid for penetration test.

Figure 2-5. Steel rod impacts drum lid during penetration test.

Figure 2-6. Rod suspended above curved surface of drum for penetration test.

Figure 2-7. Rod approaches curved surface of drum in penetration test.

The length of the dropped rod is 38.14 in. Therefore, the length to diameter ratio, L/D, is 30.5. Then, from Table 6.11, page 6-88 of Ref. 13, for penetration of mild steel plates by compact steel fragments, $A_0 = 1261$, $m = 0.427$, and $n = 0.647$.

This gives for the ballistic limit velocity:

$$V_1 = \frac{1261}{\sqrt{13.2 \text{ lb}}} [\pi \times (0.625 \text{ in.})^2]^{0.427} \\ \times [(0.0598 \text{ in.}) (\sec 0^\circ)]^{0.647} \\ = 61.22 \text{ ft/s.}$$

The final velocity (V_f) of a steel rod dropped from a height of 40 in. is calculated by the equation:

$$V_f^2 = V_i^2 + 2ah$$

where V_i - initial velocity,
 a - acceleration of gravity,
 h - height of drop.

Then

$$V_f = \sqrt{2 \times 32.2 \frac{\text{ft}}{\text{s}^2} \times \frac{40}{12} \text{ ft}} \\ = 14.65 \text{ ft/s.}$$

The actual final velocity is smaller than the ballistic limit velocity by a factor of 4.2. Therefore, penetration of the drum will not occur.

2.7. Hypothetical Accident Conditions

10 CFR 71 requires satisfactory performance of packaging when the shipping container is subjected to a series of four tests simulating accident conditions. Escape of radioactive materials must be below defined limits, and the package must remain subcritical. The free drop, puncture, thermal, and water immersion tests must be performed in the listed sequence.

A full-scale container was subjected to the complete series of four tests. The inner container of the configuration-5 package was loaded with 5700 g of 1.16-in. diameter Linde 4A molecular sieve pellets, and 2 L of water were in turn sorbed onto the molecular sieve material. The container was then helium leak checked at 10 psig using a sniffer probe technique. No leaks were

detected and it was estimated that no leaks greater than 1×10^{-6} std cm³/s were present before the accident tests. For the two drop tests, 164 lb of lead weights were fastened to the outside of the drum to bring the package weight up to 550 lb. Before the fire test, thermocouples were placed at six locations -- five within the assembled package (see Figure 2-8) and one on the outer surface of the drum.

2.7.1. Free Drop

The adequacy of the 9507 package under the conditions of the 30-ft drop test is demonstrated by a combination of analysis, prototype testing, and comparison to similar packages. This package is typical of many cylindrical packages that have been tested and approved for shipment of Type B and fissile radioactive material, as well as spent fuel. At Mound, the 9507 packages have been drop tested only in the corner orientation, but a large volume of data from tests performed elsewhere indicates that this is the most damaging orientation.

Casks for spent fuel, in particular, have been extensively tested to determine the drop orientation that produced the most damage. At Oak Ridge, 1.3-ton and 6-ton steel-shelled, lead-filled cylindrical casks were dropped in several orientations [14]. The investigators concluded that corner cask drops onto welded zones produced the most damaging impact results. This is because the effects are localized and the maximum stress occurs at points that may be weaker than the surrounding metal plate. They found that weld cracks appeared for drops of 15 ft or greater.

A study performed by the Franklin Institute Research Laboratories also concentrated on identifying more vulnerable impact attitudes for shipping casks [15]. One-tenth scale models of 15-ton steel-shelled, lead (or steel) filled cylindrical casks were tested at impact velocities and energies of approximately 30 mi/hr and 1000 ft-lb.

The results of this study agreed well with the testing of full-scale models at Oak Ridge. Once again, impacts on edges and corners were found to cause more extensive deformation than impacts on end or side walls. An impact on the edge of the closure region proved to be particularly damaging. However, even though impact energies in tests with partial-cask models reached values much higher than those specified in government regulations, in no case was there an obvious cask failure.

More comparable to the 9507 packages are several drum-type packages tested for shipment of Type B quantities. An example is the DOT 17H, 30-gal package tested at the Rocky Flats Plant [16]. This package passed the 30-ft drop test in upright, flat, and corner orientations.

At Lawrence Livermore Laboratory, a drum with 28 3/4-in. o.d. and 28 1/4-in. high was tested in both 14-gauge and 16-gauge wall thickness [8]. Both drums were dropped on their rims for the 30-ft drop test. The locking rings and rims of both drums were noticeably dented after the drop test. In addition, the ring on the 16-gauge package popped off because of insufficient tightening. The 9507 packages employ a modified closure in which the locking ring is fastened to the drum body by means of a bolted skirt, to avoid this problem.

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Figure 2-8. Package assembly, configuration 5, after the drop tests and prior to the fire test.

In another report, researchers at Rocky Flats concluded that drum-type packages are most likely to break open if the impact is on the rim of the cover at the locking ring joint [11]. Four 55-gal DOT 17C drums with 16-gauge wall thicknesses were tested in this fashion, and all remained intact. Additionally, a 30-gal DOT 17H drum was dropped on its side, reducing its effective diameter by less than 1/4 in.

Lawrence Livermore Laboratory also tested a steel drum, 25 in. o.d. by 55 in. high, of 16-gauge wall thickness [17]. Five packages were dropped on the edge of the covers, one on the side, and one on both the edge and the side. The edge drop caused a 3-in. dent, but none of the drops impaired the leak-tightness of the containment vessel.

At Savannah River Plant, drums of 30, 35, and 55 gal capacity, with 18-gauge wall thickness, were drop-tested on the bottom and the edge [18]. Researchers concluded that a drop on the edge of the closure region was most damaging. When dropped in this orientation, a 3 3/4-in. deformation was produced, but the package remained intact.

At Oak Ridge National Laboratory, three packages based on a 55-gal DOT 17H container of 18-gauge wall thickness were tested [19,20,21]. In the free drop test, the edge striking the surface was deformed, the ring clamp was dented, but the package remained intact. Package volume was reduced by about 1%.

Other packages tested at Oak Ridge include a 20-gal DOT 37A container of 20-gauge wall thickness [22], two 30-gal DOT 17H drums [23,24], and two packages fabricated from two 55-gal DOT 17H drums of 16-gauge wall thickness, welded together bottom to top. In every case, when these packages were drop-tested, damage was minimal and the packages remained intact.

2.7.1.1. End Drop. The end drop test was not performed for this package, as the corner drop test was determined to be the most damaging. In addition, a similar 30-gal DOT 17H package passed this test when performed at the Rocky Flats Plant [16]. Both 30-gal and 55-gal packages passed this test at Savannah River Plant [18] and at Oak Ridge National Laboratory [20,24].

2.7.1.2. Side Drop. The side drop test was not performed for this package as the corner drop test was determined to be the most damaging. In addition, a similar 30-gal DOT 17H and a similar 10-gal DOT 6C package passed this test when performed at the Rocky Flats Plant [8,14]. Also, a 25-in. o.d. by 55-in. high package of 16-gauge wall thickness passed this test at Lawrence Livermore Laboratory [17].

2.7.1.3. Corner Drop. A specially designed, 50-ft high, drop tower was equipped with a 2-ton hoist to drop the container from a height of 30 ft onto a steel-covered concrete drop pad. A chain sling was fashioned, and the container was oriented upside down at a 45° angle so that the bolt on the bolt ring would strike the pad first as shown for a configuration-1 package in Figure 2-9. Figure 2-10 shows the container at the required 30-ft height just prior to manual actuation of the quick release hook.

Figure 2-11, taken just prior to impact, shows that the container was dropped in precisely the initial orientation since no twisting motion was imparted to it on release.

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T.O.P.

Fig 2-9 ↓

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Fig. 1

Figure 2-9. Free drop test angle, configuration 1. The container was oriented upside down at a 45° angle to obtain maximum damage.

Figure 2-10. Free drop test height, configuration 1. The container is seen suspended at the required 30-ft height.

fig 2-11

Top

1000/6

Figure 2-11. Free drop test, configuration 1. Just prior to impact, the container is still oriented at the proper angle.

Configuration 5 was tested with a DOT 6C outer container. The alternate is a DOT 17C outer container. This type of package was previously tested at Mound for another SARP [25].

2.7.1.4. Oblique Drops. Oblique drop tests were not performed for this package, as the corner drop test was determined to be the most damaging.

2.7.1.5. Summary of Results. NRC Regulatory Guide 7.9 requires, at a minimum, that drop orientations be considered in which the center of gravity is directly over the point of impact. In the corner drop tests performed at Mound, the shipping containers were dropped at an angle of 45°. This angle did not exactly position the center of gravity over the point of impact. The angle, α , at which the center of gravity is directly over the point of impact has been calculated, and is larger than 45°.

The effect of having this low angle of impact is to reduce the force of impact to:

$$F = \cos (\alpha - 45^\circ) F_{\max}$$

where F is the actual force and $F_{\max}$ would be the force if the center of gravity were directly over the point of impact. As shown in Table 2-7, the force is reduced by a very small amount. Table 2-7 also shows the equivalent weight of a package dropped with its center of gravity over the point of impact, that would fall with the same force.

TABLE 2-7

EQUIVALENT WEIGHT OF PACKAGE DROPPED WITH
CENTER OF GRAVITY OVER POINT OF IMPACT

<u>Config- uration</u>	<u>Tested Weight (lb)</u>	<u>Angle to Position Center of Gravity over Point of Impact (α) (°)</u>	<u>Fraction of Maximum Impact Force at 45°</u>	<u>Equivalent Weight at α (lb)</u>
5	550	54.9	0.99	542

The 30-ft free drop caused obvious minor damage to the exterior drum surface, but did not damage the inner container in any way that would decrease the containment capabilities. Figure 2-12 was taken immediately following the free drop and puncture tests for a configuration-1 package. It shows that the drum closure ring at the point of impact was displaced, relative to the upright position, a distance of 3 in. vertically and 1 in. horizontally. Figure 2-13 taken with the lid removed shows the damage after the fire test. Figure 2-14 shows the damage to the configuration-1 inner container and spacer because the insulated drum assembly was slightly out of round. The configuration-3 and configuration-5 drum assemblies sustained essentially the same damage as the configuration-1 drum assembly.

Fig 2-12

72

Fig 2-13

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Figure 2-12. After drop and puncture, configuration 1. The dent at the top left resulted from the 30-ft drop and the circular dent at the center resulted from the puncture test.

Figure 2-13. Free drop damage to drum, configuration 1.

Figure 2-14. Free drop damage to lid, configuration 1.

A careful visual examination did not reveal any additional damage. Subsequent successful water immersion and helium leak tests, which are discussed in sections 2.7.4 and 2.7.6, support the conclusion that no other damage was sustained.

In the test of the 17C outer container, a 304-lb package was tested [25]. This package successfully passed the corner drop test, sustaining a 4-in. dent to the rim. The modified locking ring secured the drum cover.

2.7.2. Puncture

This test requires a free drop through a distance of 40 in. striking, in the position maximum damage is expected, the top end of a vertical, cylindrical, mild-steel bar mounted on an essentially unyielding horizontal surface. The bar will have a 6-in. diameter, with the top horizontal and its edge rounded to a radius of not more than 1/4 in., and of such a length as to cause maximum damage to the package, but not less than 8 in. long. The long axis of the bar shall be perpendicular to the unyielding horizontal surface.

This test was conducted in a manner similar to the free drop test. A horizontal attitude was believed to be the orientation that would cause maximum damage. Figure 2-15 shows the container impacting on the cylinder.

The 40-in. drop on the 6-in. diam cylinder slightly dented the exterior drum surfaces but caused no observable damage internally. Displacement for the configuration-5 drum was approximately 1 in.

A separate, undamaged configuration-1 container was also tested in a vertical orientation. The package was suspended so that the center of the lid, containing the vent pipe, would impact the steel cylinder, as shown in Figure 2-16. The first drop in this orientation resulted in an off-center impact on a single radial guard, missing the vent. The guard was bent to one side, breaking one of the welds that attach it to the lid, as shown in Figure 2-17.

For the second drop, the damaged guard was partially straightened, and the drum was dropped squarely on the vent pipe. All three guards were partially bent, as was the vent pipe. (See Figure 2-18.) The center bottom of the lid assembly appeared to have bowed out ~1/2 in. (See Figure 2-19.) Light scratches on the bottom of the lid assembly showed where the lid rubbed the handle of the configuration-1 inner container, but the inner container was undamaged. It was concluded that the vertical orientation was no more damaging than the horizontal orientation.

2.7.3. Thermal

2.7.3.1. Summary of Pressures and Temperatures. Limiting temperatures and pressures during the thermal accident test, as determined in section 3.5, are summarized in Table 2-8.

2.7.3.2. Differential Thermal Expansion. Based on the maximum pressures in Table 2-8, deformations and stresses were calculated on an IBM personal computer for configuration 5. The program used is called "Stresspac" [26]. These calculations are summarized in Table 2-9. The program input/output is included in the Appendix, section 2.10.3. Calculations were verified by

Fig 2-15

TOP

1 100%

Figure 2-15. Puncture test impact, configuration 1.

1-13-72

Top

1-13-72

Figure 2-16. Configuration 1 in position for puncture test in vertical orientation. The inner container is at -40°F .

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8

7-1-19

Figure 2-17. Lid damage to configuration 1 from first impact.

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Top

F-38
2-18

Figure 2-18. Lid damage to configuration 1 from second impact.

43
12/5

110

210

Figure 2-19. Inside lid, configuration 1, following two impacts.

TABLE 2-8

MAXIMUM TEMPERATURES AND PRESSURES IN
HYPOTHETICAL ACCIDENT THERMAL TEST^(a)

<u>Configuration</u>	<u>Maximum Temperature (°F)</u>			<u>Maximum Internal Pressure (psig)</u>
	<u>Drum Exterior</u>	<u>Outside Surface Inner Container</u>	<u>Inside Inner Container</u>	
5	1490	268 ^(b)	277 ^(b)	76.0 ^(c)

(a) Ambient temperature 100°F, loaded with maximum contents heat load at 40°F.

(b) Add 13°F for Superex insulation in insulating spacer.

(c) Add 0.4 psi for Superex insulation in insulating spacer.

TABLE 2-9

STRESSES AND DEFORMATIONS IN THE HYPOTHETICAL ACCIDENT
THERMAL TEST AT 100 psig FOR CONFIGURATION 5

	<u>Inner Surface of Cylinder</u>	<u>Outer Surface of Cylinder</u>
Radial Stress	100 psi	0
Hoop Stress	2360 psi	2260 psi
Axial Stress	1130 psi	1130 psi
Radial Displacement	2.75×10^{-4} in	2.71×10^{-4} in
Factor of Safety	5.54	6.03

applying equations (1) and (2) from section 2.10.1.1 and solving for stress to get the same result.

The axial deformation due to thermal expansion is listed in Table 2-10. The following equation was used for the calculation of axial deformation (Ref. 27, p. 4-7):

$$\Delta l = l_1 \alpha \Delta t$$

TABLE 2-10

AXIAL DEFORMATION DUE TO THERMAL EXPANSION
IN THE HYPOTHETICAL ACCIDENT THERMAL TEST

<u>Configuration</u>	<u>Axial Deformation (in.)</u>
5	0.1

where:

Δl - axial deformation

l_1 - original length

a - coefficient of linear thermal expansion

Δt - temperature change

Axial deformation is very small.

2.7.3.3. Stress Calculations. The stresses due to pressure are summarized in Table 2-9. Temperature differences and the resulting secondary thermal stresses within the inner containers are not excessive under the requirements of 10 CFR 71.

2.7.3.4. Comparison with Allowable Stresses. Factors of safety calculated for each configuration are listed in Table 2-9. As can be deduced from these factors of safety, all stresses are well within the maximum allowable stresses for the materials concerned. Package performance is further confirmed by successful completion of the hypothetical accident tests performed on these containers.

2.7.4. Immersion-Fissile Material

2.7.4.1. Test Procedure. This test is necessary for fissile material packages only. The test requires immersion in water to the extent that all portions of the package to be tested are under at least 3 ft of water for a period of not less than 8 hr. A permanently installed, 10-ft diam by 9-ft deep tank equipped with a 2-ton hoist was used. Prior to this test, the inner container was removed from the insulated drum assemblies. The tank was filled to a depth of 51 in. to ensure immersion of all parts of the container under at least 36 in. of water. All inner containers were immersed overnight for 20 hr, since it was not convenient to withdraw them after the required 8-hr minimum period. These tests are shown in Figures 2-20 and 2-21. Although the configuration-5 package is exempt from this requirement, it was immersion tested.

2.7.4.2. Water Immersion. Immersion of the inner container under 3 ft of water for 20 hr did not cause any water leakage into the container or damage the container in any way.

TOP

57 10-13 2-20

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Figure 2-20. Water immersion test equipment, configuration 1. The container is easily lowered into the immersion tank.

Fig. 2-21

76P

Figure 2-21. Water immersion test, configuration 1. The pole to the right was used to measure the water depth. All parts of the container were under at least 3 ft of water.

The test was more stringent than required since only an 8-hr period is required and since cold water in the immersion tank caused the pressure within the inner containers to decrease below atmospheric pressure. In configuration 5, which had been preloaded with 2 L of adsorbed water, no indication of any leakage of additional water was found.

2.7.5. Immersion-All Packages

10 CFR 71.73(c)(5) requires that an undamaged specimen of each shipping container be subjected to water pressure equivalent to immersion under 15 m. (50 ft) of water for a minimum of 8 hr. For the purposes of this regulation, a gauge pressure of 21 psi is considered to meet these conditions.

This test was performed for the A1-M1 configuration-5 package by Bowser-Morner, Inc., Product and Materials Testing Laboratory. For this test, a newly fabricated inner container was removed from the package and immersed in a pressure vessel filled with water [28]. The pressure regulator was adjusted to obtain a pressure of 21 psig, and this pressure was monitored over the next 8 hr. At the end of this time, the pressure was released, and the shipping container was removed from the pressure vessel. After air-drying, the cap was removed from the configuration-5 container, and the interior was inspected. No trace of water was found on the inside of the cap. The interior of the inner container was further examined with a flashlight, and no trace of water was found. Therefore, the configuration-5 container successfully meets the requirements of this regulation.

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2.7.6. Summary of Damage

The two drop tests caused only minor damage to the outer container, and no observable damage to the inner container. The result of the thermal test was that the paint on the drum exterior was burned off, but the inner container was undamaged. It did not bulge or deform in any way, and the drum insulation did not smolder. Following the 3-ft water immersion test, the inner container was found to be completely dry inside.

The stainless steel configuration-5 inner container was helium leak tested following the sequence of four hypothetical accident tests to obtain additional assurance that it was not damaged. A sniffer probe technique was used at 10 psig, as before the accident sequence, and it was concluded that no leaks greater than 1×10^{-6} std cm³/s were present. It was concluded that the container was leakproof and had satisfactorily met all test requirements.

In the earlier test of the 17C outer container, the drum cover remained intact and the inner container did not suffer any observable damage. The puncture test caused only a minor dent. There was no apparent damage to the inner container as a result of the fire test. The immersion test showed no evidence of water leakage into the inner container. In addition, the inner container was reassembled after the immersion test, using the same O-rings, and found to be helium leak-tight at an instrument sensitivity of 10^{-4} std cm³/s when containing 20 psig of helium pressure.

2.8. Special Form

Not applicable.

2.9. Fuel Rods

Not applicable.

2.10. Appendix

2.10.1. Internal Pressure Capability from Section 2.1.2.

The internal pressure capabilities of AL-M1 configuration 5 were evaluated in detail. This evaluation is given in the following.

The inner container for the Model AL-M1 configuration-5 assembly consists of a 12-in. long by 6-in. diam hollow pipe section with dished head elements welded to each end. A cylindrical pipe section is welded to the bottom of the assembly to support it in a vertical position. A protective capped cylinder is placed over the top cap to protect four nozzle protrusions that provide access to the interior of the container. Neither the top nor the bottom cylindrical projection significantly affects pressure containment.

At hypothetical accident conditions, the inner container will be exposed to a maximum internal pressure of 100 psi at a temperature of 300°F.

This pressure represents the sum of three partial pressures which could be developed under such conditions: (1) the vapor pressure of water, (2) hydrogen gas from radiolysis, and (3) enclosed air or inert gas. As shown in the stress analysis which follows, the inner container can safely withstand this environment with an adequate margin of safety.

The analysis of the pressure containment capability of the assembly will be performed in three parts: the main body; the capped end sections; and the nozzles that project from the top cap of the assembly.

All the structural components investigated in this section are composed of Type 316L stainless steel. This material is rated at a design strength of 15,700 psi at 300°F under Section VIII of the ASME Boiler and Pressure Vessel Code (1974 Edition), which is the basis of this analysis.

2.10.1.1. Main Cylinder Body. Reference 1 lists the following two formulas for determining the maximum allowable working pressure of a cylindrical shell exposed to internal pressure:

$$P_1 = SEt/(R + 0.6t) \quad (1)$$

and

$$P_c = 2SEt/(R - 0.4t) \quad (2)$$

where

P_1 = maximum working pressure based on circumferential stress reaching the allowable stress, S;

P_c = maximum working pressure based on longitudinal stress reaching the allowable stress, S;

S = maximum allowable stress at operating temperature (15,700 psi at 300°F);

E = joint efficiency for the welded joint connecting the main cylinder to the end caps (E = 0.65 based on Table UW-12 of Reference 1);

R = inside radius of cylindrical shell = 3.1785 in.;

t = thickness of shell body = 0.134 in.

With this terminology the equations resolve into the following working pressures:

$$P_1 = \frac{(15,700)(0.65)(0.134)}{3.1785 + 0.6 (0.134)}$$

= 420 psi at 300°F,

and

$$P_c = \frac{2(15,700)(0.65)(0.134)}{3.1785 - 0.4 (0.134)}$$

= 875 psi at 300°F.

The maximum permissible working pressure at an operating temperature of 300°F is, therefore, 420 psi in the main cylinder body. This exceeds the maximum operating pressure at that temperature (100 psi) and the resulting margin of safety is

$$MS = (420/100) - 1 = 3.20 \quad (3)$$

2.10.1.2. Capped End Sections. Section UG-32, "Formed Heads, Pressure on Concave Side," of Reference 1, lists the following formula for evaluating the allowable working pressure in a torospherical head:

$$P = SEt / (0.885L + 0.1t) \quad (4)$$

where

P = maximum working pressure, psi;

S = maximum allowable stress at operating temperature = 15,700 psi at 300°F;

t = thickness = 0.134 in.;

L = inside dish radius = 5.31 in.;

E = head-to-shell joint efficiency = 0.65.

Substituting and solving results in the following maximum working pressure:

$$P = \frac{(15,700)(0.65)(0.134)}{(0.885)(5.31) + (0.1)(0.134)}$$

= 290 psi at 300°F.

The margin of safety against failure at the 300°F operating condition is

$$MS = (290/100) - 1 = 1.90$$

which, although lower than that for the main cylinder body, demonstrates that the design is satisfactory.

2.10.1.3. Nozzle Projections. Four nozzles protrude from the top cap of the container assembly. The nozzles are used for filling and emptying the container and for monitoring the contents. All four nozzles are 1/2 in. o.d.; the wall thicknesses are, in sequence, 0.047, 0.047, 0.065, and 0.156 in. Three nozzles extend to the interior of the container; the fourth nozzle penetrates the end cap only.

The allowable weld stress permitted for nozzles attached by fillet welds is listed in Reference 1 as 49% of the shear stress of the vessel material. The shear stress, in turn, is equivalent to 0.577 times the allowable effective stress, which is 15,700 psi at 300°F. The permissible fillet weld strength is then

$$\begin{aligned} S_{wf} &= (0.49)(0.577)(15,700) \\ &= 4439 \text{ psi at } 300^{\circ}\text{F} \end{aligned}$$

where

$$S_{wf} = \text{allowable shear stress in fillet weld, psi.}$$

The allowable weld stress for nozzles attached by groove welds in shear is listed in Reference 1 as 60% of the shear stress of the vessel material. The permissible groove weld strength is then

$$\begin{aligned} S_{wa} &= (0.60)(0.577)(15,700) \\ &= 5435 \text{ psi at } 300^{\circ}\text{F} \end{aligned}$$

where

$$S_{wa} = \text{allowable shear stress in groove weld, psi.}$$

For convenience, the nozzles will be grouped by wall thicknesses in the following investigation of their load capacity.

2.10.1.3.1. Nozzles with 1/2-in. x 0.047-in. Wall. Figure 2-22 shows a typical nozzle attachment to the top cap of the container. The nozzle is attached to the container by a groove weld in shear. The thickness of the groove weld will be taken as the thickness of the top cap (0.134 in.).

Figure 2-22. Typical nozzle attachment at end cap.

The strength of the groove weld, F_{wa} , is determined by multiplying the allowable shear stress, S_{wa} , by the weld thickness and the circumferential length of weld. This gives

$$F_{wa} = 5435(0.134)(\pi)(0.5) = 1144 \text{ lb.}$$

The maximum internal pressure, $(P_{\max})_{\text{weld}}$, that the weld can withstand is then found by dividing the weld strength, F_{wa} , by tube area over which the internal pressure will act.

$$\begin{aligned} (P_{\max})_{\text{weld}} &= \frac{F_{wa}}{\pi(D^2/4)} = \frac{(1144)(4)}{\pi(0.5)^2} \\ &= 5,826 \text{ psi.} \end{aligned}$$

Because the nozzle will be subjected to the same internal pressure as the main container, its strength under that loading will next be evaluated. The maximum allowable internal pressure in the nozzle will be obtained by applying Eq. (1) to the nozzle dimensions. Eq. (2) will not be evaluated at this condition because the circumferential pressure stress is the limiting case in a cylinder exposed to internal pressure loading. Applying Eq. (1) produces the allowable internal pressure in the nozzle.

$$\begin{aligned} P_1 &= \frac{(15,700)(0.65)(0.047)}{0.25 + (0.6)(0.047)} \\ &= 1724 \text{ psi at } 300^\circ\text{F.} \end{aligned}$$

Because the value P_1 is less than $(P_{\max})_{\text{weld}}$, it represents the limiting case for this nozzle. The margin of safety for this nozzle is then

$$MS = (1724/100) - 1 = 17 \text{ at } 300^\circ\text{F}$$

and the integrity of the nozzle under the maximum pressure loading is assured.

2.10.1.3.2. Nozzle with 1/2-in. x 0.065-in. Wall. Figure 2-23 shows the method used to attach the 0.065 and 0.156 in. nozzles to the main assembly. The attachment is made via fillet welds on either side of the cap. The minimum weld thickness is limited to 70% of the nozzle wall thickness by the restrictions of Reference 1 and this value will be used in the investigation which follows.

The strength of the nozzle-end cap weld connection is given by

$$F_w = 0.7 (t_{\text{wall}})(S_{wf}) (\text{length})(2 \text{ welds})$$

where

$$t_{\text{wall}} = 0.065 \text{ in.}$$

$$\text{length} = \pi(0.5 \text{ in.}) = 1.57 \text{ in.}$$

$$F_w = \text{weld strength, lb.}$$

Figure 2-23. Typical nozzle penetration at end cap.

This becomes

$$F_w = 0.7(0.065)(4439)(1.57)(2) \\ = 635 \text{ lb at } 300^\circ\text{F.}$$

The maximum internal pressure that the weld can withstand is then

$$(P_{\max})_{\text{weld}} = \frac{F_w}{\pi D^2/4} = \frac{(635)(4)}{\pi(0.5)^2} \\ = 3234 \text{ psi at } 300^\circ\text{F.}$$

The pressure capacity of the nozzle body as a pressure vessel is found by applying Eq. (1).

$$P_1 = \frac{15,700(0.65)(0.065)}{0.25 + (0.6)(0.065)} \\ = 2295 \text{ psi at } 300^\circ\text{F.}$$

The limiting case for this nozzle is determined by P_c . The margin of safety is then

$$MS = (2295/100) - 1 \\ = 22 \text{ at } 300^\circ\text{F.}$$

2.10.1.3.3. Nozzle with 1/2-in. x 0.156 In. Wall. Analysis of the capacity of this nozzle follows the procedure used in the previous case. Figure 2-22 represents the weld arrangement at this penetration.

The strength, F_w , of the weld connection is found as

$$F_w = 0.7(0.156)(4439)(1.57)(2) \\ = 1522 \text{ lb at } 300^\circ\text{F.}$$

The weld can therefore safely resist a container internal pressure of

$$(P_{\max})_{\text{weld}} = \frac{1522 \times 4}{\pi(0.5)^2} \\ = 7751 \text{ psi at } 300^\circ\text{F.}$$

The capacity, P_1 , of the nozzle body as a pressure vessel is obtained through application of Eq. (1) to the tube dimensions. This gives

$$P_1 = \frac{15,700(0.65)(0.156)}{0.25 + (0.6)(0.156)} \\ = 4633 \text{ psi at } 300^\circ\text{F.}$$

Because P_1 is less than $(P_{\max})_{\text{weld}}$, it represents the limiting condition for this nozzle. The margin of safety is

$$\text{MS} = (4633/100) - 1 \\ = 45 \text{ at } 300^\circ\text{F.}$$

The ability of the nozzle to withstand the maximum pressure application has been demonstrated.

2.10.1.4. Summary. Table 2-11 summarizes the results of the analysis of the pressure-containing capacity of the Model AL-M1 configuration-5 inner container. Since the maximum internal pressure to which the container will be exposed is 100 psi at 300°F the design is shown to be adequate.

The overall limiting pressure capability is shown to be that of the end cap. Its value is 290 psi at an operating temperature of 300°F. The overall margin of safety is, therefore,

$$\text{MS} = (290/100) - 1 = 1.90$$

This margin of safety, although it seems small, shows that the container can withstand almost three times the actual pressure. The design is satisfactory.

TABLE 2-11

RESULTS OF INTERNAL PRESSURE STUDY FOR
CONFIGURATION-5 INNER CONTAINER

<u>Component</u>	<u>Allowable Pressure at 300°F (psi)</u>
Main Body Cylinder	420 Circumferential 875 Longitudinal
End Caps	290
Nozzles:	
1/2 x 0.047 in.	1724
1/2 x 0.065 in.	2295
1/2 x 0.156 in.	4633

2.10.2. Load Resistance from Section 2.1.2.

2.10.2.1. Drum Evaluation. Stresses in the drum resulting from the uniform load are determined, as recommended by Shappert [29], from the following equation:

$$S = MC/I = M/Z,$$

where

S = stress (psi),

M = maximum bending moment,
M = 5 WL/8 (in.-lb),

Z = I/C = section modulus of drum

$$= \pi(R_o^4 - R_i^4) / 4R_o$$

$$\approx \pi R_o^2 t \text{ (in.}^3\text{) for a large diameter, thin-walled cylinder,}$$

W = weight of drum, W = 550 lb,

L = length of drum, L = 34.875 in.,

R_o = outside radius of drum, R_o = 11.25 in., and

t = thickness of drum, t = 0.06 in.

The computed maximum bending moment is

$$M = 5(550)(34.875)/8$$

$$= 12,000 \text{ in.-lb}$$

$$Z = \pi R_o^2 t = \pi (11.25)^2 (0.06) = 23.85 \text{ in.}^3$$
$$S = 12,000/23.85 = 503 \text{ psi}$$

2.10.3. Program Input/Output from Section 2.7.3.2

```

;
; ----- Use Up & Down Arrows, Ins , Del to Edit Data ----- ;
;
;      Internal Pressure    100 ;
;      External Pressure   0 ;
;           Inner Radius    3.175 ;
;           Outer Radius    3.3125 ;
;      Closed Ends (Y/N)   Y ;
;           Elastic Modulus 2.76E7 ;
;           Poisson's Ratio .305 ;
;           Allowable Stress 11800 ;
;
;

```

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```
Radial Stress = -100
Hoop Stress = 2360.149
Axial Stress = 1130.075
Radial Displacement = 2.750113E-04
Factor of Safety = 5.538471
```

```
Radial Stress = 0
Hoop Stress = 2260.149
Axial Stress = 1130.075
Radial Displacement = 2.712589E-04
Factor of Safety = 6.028568
```

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References.

1. ASME Boiler and Pressure Vessel Code, 1974 Edition.
2. R. Barron, Cryogenic Systems, McGraw-Hill, New York, N.Y., 1966.
3. American Society for Metals, ASM Metals Reference Handbook, American Society for Metals, Metals Park, Ohio, 1983.
4. Metals Handbook, American Society for Metals, Metals Park, Ohio, 1980.
5. Parker Seal Group, Parker O-Ring Handbook, Lexington, KY, 1982.
6. Parker Seal Group, "Technical Report KK 1793", Lexington, KY, January 21, 1986.
7. W. R. Holman and R. T. Longland, Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers Up to Four Inches Thick, NUREG/CR-1815, Lawrence Livermore National Laboratory, August 1981.
8. J. R. Gaskill and R. D. Taylor, An Improved Shipping Container for Fissile Material, UCRL-14903, University of California (June 3, 1968).
9. Memo, Christine M. Wires to J. N. Crawford, September 13, 1984.
10. F. E. Adcock and W. F. Wackler, RFD Container - Model 1518 for Fissile Class II and Class III Shipments, RFP-1042, Dow Chemical Co., Rocky Flats (April 8, 1968).
11. F. E. Adcock, J. D. McCarthy, and W. F. Wackler, Rocky Flats Model 2030-1 Container (AEC-AL USA/5332/BLF) Safety Analysis Report for Packaging (SARP), RFP-1867 Rev. 1, Dow Chemical Co., Rocky Flats (February 27, 1974).
12. Memo, Christine M. Wires to J. F. Griffin, August 7, 1984.
13. U. S. Department of Energy, A Manual for the Prediction of Blast and Fragment Loadings on Structures, DOE/TIC-11268, November 1980.
14. L. B. Shappert, "A Guide to the Design of Shipping Casks for the Transportation of Radioactive Material", ORNL-TM-681, Oak Ridge National Laboratory, April 1965.
15. H. G. Clarke, Jr. and S. P. Carfagno, "Structural Integrity of Shipping Containers for Radioactive Materials, Part VIII. Experimental Study of Crushing Impact", NYO-2539-7, Franklin Institute Research Laboratories, October 1968.
16. F. E. Adcock, J. T. Byrne, and R. L. Delnay, "Plutonium Oxide Shipping Packages," RFP-501, Dow Chemical Company, April 1965.
17. R. R. Sandberg, "Safety Analysis Report on Model UC-609 Shipping Package", UCRL-52424, Lawrence Livermore Laboratory, August 1977.

18. G. G. Chalfant, "Safety Analysis Report - Packages USA/9965/B(U)F (DOE-SR), USA/9966/B(U)F(DOE-SR), USA/9967/B(U)F(DOE-SR), USA/9968/B(U)F(DOE-SR) (Packaging of Fissile and Other Radioactive Materials)", DPSPU-83-124-1, E. I. duPont deNemours and Co., Inc.
19. H. R. Dyer and W. T. Mee, "Safety Analysis Report for Packaging (Oak Ridge Y-12 Plant Model DT-2 Package for Enriched Uranium)", Y/DD-152, Oak Ridge Y-12 Plant, June 1974.
20. H. R. Dyer, "Safety Analysis Report for Packaging (Oak Ridge Y-12 Plant Model DT-5 Package for Enriched Uranium)", Y/DD-153, Oak Ridge Y-12 Plant, July 1974.
21. B. B. Klima, L. B. Shappert, R. D. Seagren, and W. D. Box, "Safety Analysis Report for Packaging (SARP) of the Oak Ridge National Laboratory Foamglas Shipping Container (Revision 1)", ORNL-5407/R1, Oak Ridge National Laboratory, January 1979.
22. H. R. Dyer, "Safety Analysis Report for Packaging (Oak Ridge Y-12 Plant Model DT-7 Package for Enriched Uranium)", Y/DD-160, Oak Ridge Y-12 Plant, December 1974.
23. C. M. Hopper, "Safety Analysis Report for Packaging (Oak Ridge Y-12 Plant Model DT-14 Package for Enriched Uranium)", Y/DD-244, Oak Ridge Y-12 Plant, January 1978.
24. R. G. Taylor, "Safety Analysis Report for Packaging (Oak Ridge Y-12 Plant Model DT-14A Package for Enriched Uranium)", Y/DD-326, Oak Ridge Y-12 Plant, January 1984.
25. L. G. Roome et al. Safety Analysis Report for Packaging (SARP): USA/5790/BLF (DOE-AL) and USA/5791/BLF (DOE-AL) MLM-2242 (Rev. 1), January 25, 1980.
26. "Stresspac", Engineering Software Co., 1405 Porto Bellow, Arlington, Texas (1983).
27. Baumeister and Marks, Standard Handbook for Mechanical Engineers, 7th Ed., McGraw-Hill, New York.
28. Bowser-Morner, Inc., "Report of Immersion Test on One Shipping Container," Report #8803195, March 22, 1988.
29. L. B. Shappert, Cask Designers Guide, ORNL-NSIC-68, Union Carbide Corp., Oak Ridge, Tennessee (February, 1970), p.143.

3. THERMAL EVALUATION

3.1. Discussion

The 9507 package is designed to ensure safe containment of its contents under both normal conditions of transport and hypothetical accident conditions, as specified in 10 CFR Part 71. The package is insulated to provide protection for the inner container at hypothetical accident fire conditions. The type of insulation and the thickness are selected to preclude overheating when containing the maximum permissible decay heat load.

The internal pressure capability of each container is sufficient to contain the pressure buildup resulting from heating the atmospheric air, which is trapped during packaging operations, to the maximum temperatures at accident conditions.

The minimum decay heat load assumed in this evaluation is 0 for all configurations. The maximum heat load is 3.3 W for configuration 5.

3.2. Summary of Thermal Properties of Materials

The thermal conductivities, specific heats, and densities of all materials used in the thermal evaluation are summarized in Table 3-1.

TABLE 3-1

THERMAL PROPERTIES OF MATERIALS

<u>Material</u>	<u>Thermal Conductivity (Btu/hr ft°F)</u>	<u>Specific Heat (Btu/lb °F)</u>	<u>Density (lb/ft³)</u>
Carbon steel	37 (a)	0.10(b)	484 (b)
Stainless steel 316L	9.4 (c)	0.12(c)	501 (d)
Superex insulation	0.045(e)	0.25(e)	24 (e)
Firedike insulation	0.033(e)	Not Avail.	19.2(e)
Auratone Firecode insulation	0.028(e)	Not Avail.	25.6(e)

(a)Reference 1, p. 210.

(b)Reference 1, p. 205.

(c)Reference 2, Vol. 3, p. 35.

(d)Reference 2, Vol. 3, p. 34.

(e)Data supplied by manufacturer.

3.3. Technical Specifications of Components

The configuration-5 inner container has four penetrations; two are sealed by Cajon VCR blind glands and Nupro bellows valves (#SS-8BG-TSW), one is sealed by a Cajon VCR blind gland, and one is sealed by a Precise Sensors pressure transducer (#70101-200). The Cajon fittings use nickel gaskets. The above four penetrations are covered with an O-ring-sealed cap. This cap is penetrated by two Swagelok quick-disconnect fittings (#SS-QC-4-BL-400). Pressure and temperature limits for all these fittings are listed in Table 3-2.

Properties of insulating materials used in these packages are summarized in Table 3-1.

TABLE 3-2

OPERATING LIMITS FOR PACKAGE COMPONENTS

<u>Component</u>	<u>Maximum Temperature (°F)</u>	<u>Maximum Pressure (psig)</u>
Cajon VCR blind gland	1000	2800
Nupro bellows valves	600	1000
Precise Sensors pressure transducer	350	800
Swagelok quick-disconnects	250 ^(a)	250

(a) With Buna O-rings; 450°F with Viton O-rings.

3.4. Thermal Evaluation for Normal Conditions of Transport

3.4.1. Thermal Model

3.4.1.1. Analytical Model. The procedure for calculating the temperatures resulting from direct sunlight consists of determining the heat load from the sun. This is used to calculate the resulting external drum surface temperature which is required to dissipate the solar heat load to 100°F ambient air. The temperature increases resulting from the solar heat load throughout each package are less than, or equal to, the corresponding increase at the drum surface. Therefore, the assumption that these temperature increases are equal throughout each package provides conservative estimates of the inner container temperatures.

Shappert's [3] approach establishes the average solar heat load over a 24-hr period as 42 W/ft² of projected surface area. For a 24-hr period, this exposure is equivalent to 933 gcal/cm², higher than the highest value suggested in the table in 10 CFR 71.71(c)(1). Therefore, it is conservative. The maximum possible projected surface area is estimated based on viewing the container, when in an upright position, at an angle perpendicular to a diagonal drawn through the drum. The resulting temperature increase at the drum surface is determined by linear extrapolation of the experimental steady-state temperature profile data.

Solar heat load for the 9507 package [3]:

$$\begin{aligned} A &= [D^2 + H^2]^{1/2} \times D \\ &= [(1.89 \text{ ft})^2 + (2.90 \text{ ft})^2]^{1/2} \times 1.89 \text{ ft} \\ &= 6.54 \text{ ft}^2 \\ Q_S &= A \times Q_A \\ &= (6.54 \text{ ft}^2)(42 \text{ W/ft}^2) \\ &= 275 \text{ W} \end{aligned}$$

where

A = maximum projected surface area

D = drum outer diameter

H = drum height

Q_A = solar heat load per unit area, and

Q_S = total solar heat load.

3.4.1.2. Test Model

3.4.1.2.1. Purpose. The steady-state temperature profile was determined to ensure compliance with DOT, DOE, and NRC regulatory requirements. Also, the steady-state results were used to determine the maximum heat load capability of each package.

3.4.1.2.2. Test Equipment and Procedures. Two separate tests were performed to determine the steady state temperatures of the inner container outside surface and drum outside surface for the AL-M1 package. The configuration-5 inner container surface temperature and all AL-M1 outside drum surface temperatures are based on measurements made for a similar 55-gal package designated USA/5791/BLF(ERDA-AL). The equipment used for this testing is illustrated in Figure 3-1, and the procedures and detailed results are presented in the SARP [4] for the 5791 package.

3.4.2. Maximum Temperatures

3.4.2.1. Test Results. The experimentally determined steady state temperatures are presented in Table 3-3 and shown graphically in Figure 3-2. All temperatures listed in the table have been adjusted to an ambient temperature of 100°F to represent normal conditions of transport on a hot day for comparison of the resulting package temperatures with DOT and DOE/NRC regulations.

DRUM AND INNER CONTAINER SURFACE TEMPERATURES AT 100°F AMBIENT

(a) Add 2.5°F for Firecode insulation in insulating spacer.

The exterior drum temperature data obtained for the 55-gal 5791 package are directly applicable to all AL-M1 configurations, since they are also 55-gal drum packages. It was found that the exterior surface temperature increased 8.6°F above ambient at a heat load of 66.5 W. This is interpolated linearly to obtain the resulting temperature increases of 1.3°F at a 10-W heat load and essentially no increase at a 3.3-W heat load.

The inner container exterior temperature data obtained for the 55-gal 5791 are conservative (high) when applied to the AL-M1 configuration-5 package. These data were linearly interpolated to obtain a value of 16°F for a 3.3-W heat load. Thus, the maximum temperature at 100°F ambient is estimated to be 116°F.

Auratone Firecode has a lower thermal conductivity than Firedike insulation. Therefore, when Firedike is replaced by Firecode in the insulating spacer for configuration 5, the steady-state inner container temperature can be expected to increase. The 5791 package was tested with both types of insulation [5]. With 6 in. of insulation replaced, the estimated temperature increase for a 42-W load was 30°F [6]. It is then quite conservative to estimate the configuration 5 temperature increase with a 3.3-W heat load as 2.5°F. The thermal conductivity of Superex insulation is higher than that of Firedike. Therefore, it is conservative to assume that inner container temperatures of normal conditions of transport remain constant when Superex is substituted for Firedike in the insulating spacer.

In conclusion, it was found that the steady state temperatures of the AL-M1 packages are well within safe limits. The maximum temperature in shade for the exterior drum surface shown in Table 3-3 is less than the permitted maximum accessible external surface temperature of 122°F. Another significant result was that there was no evidence that the heating and cooling caused any misfit, galling, or other damage.

For the 55-gallon outer container, the solar heat load is calculated to be 275 W. Since the drum surface temperature increased 8.6°F above ambient when 66.5 W was dissipated, the surface temperature increase is estimated to be 36°F due to the solar heat load. The temperatures at 100°F ambient in shade and in direct sunlight are summarized in Table 3-3.

3.4.3. Minimum Temperatures

The minimum temperature of each component in this analysis will be assumed to be the ambient temperature. According to 10 CFR 71 the minimum ambient temperature to be considered due to normal conditions of transport is -40°F. Therefore, this will be the minimum temperature used in this analysis.

3.4.4. Maximum Internal Pressures

The maximum internal pressure for the inner container can be simply estimated from the ideal gas law:

$$\frac{P_2}{P_1} = \frac{T_2}{T_1}$$

For a conservative estimate, the inner container is assumed to be loaded at a pressure of 1 atm absolute (14.7 psia), at the minimum design temperature of -40°F. If the container holds the maximum permissible heat load, and is assumed to be subjected to direct sunlight at an ambient temperature of 100°F, the maximum internal pressure for normal conditions of transport will be reached. The maximum pressures are summarized in Table 3-4.

At the calculated temperatures and pressures, no phase change or decomposition of the contents or packaging materials will occur, and no gas generation will take place.

TABLE 3-4

MAXIMUM INTERNAL PRESSURE IN THE INNER CONTAINER
UNDER NORMAL CONDITIONS OF TRANSPORT

<u>Configuration</u>	<u>Maximum Contents Heat Load (W)</u>	<u>Loading Temperature (°F)</u>	<u>Maximum Inner Container Temperature at 100°F in Direct Sun (°F)</u>	<u>Maximum Internal Pressure (psi)</u>
5	3.3	-40	161 ^(a)	7.0 ^(b)

(a) Add 2.5°F for Firecode insulation in insulating spacer.

(b) Add 0.1 psi for Firecode insulation in insulating spacer.

3.4.5. Maximum Thermal Stresses

The limiting combination of thermal gradient and isothermal stresses is achieved in direct sunlight at 100°F ambient temperature. The resulting temperature distribution is as given in section 3.4.2 and Table 3-3. Temperature differences within the package under normal conditions of transport are small and corresponding stresses are insignificant. Differential thermal expansion is negligible.

3.4.6. Evaluation of Package Performance for Normal Conditions of Transport

The heat input from the sun will not cause the inner container temperatures to exceed design capabilities. In fact, the inner container is designed to withstand hypothetical accident fire conditions, as discussed elsewhere in this report. The effectiveness of the steel drum and insulation is not expected to be reduced as a result of the sun. The pressure capabilities of the inner container as determined in section 2.1.2 are more than adequate to contain the maximum internal pressures expected under normal conditions of transport.

The maximum temperatures that could be reached in direct sun at 100°F are summarized in Table 3-5.

TABLE 3-5

MAXIMUM TEMPERATURES UNDER
NORMAL CONDITIONS OF TRANSPORT^(a)

<u>Configuration</u>	Maximum Contents Heat Load (W)	Maximum Temperatures (°F)		
		<u>Inside Inner Container</u>	<u>Inner Container Surface</u>	<u>Drum Exterior</u>
5	3.3	161 ^(b)	152 ^(b)	136

(a) Direct sun at 100°F ambient containing maximum contents heat load.

(b) Add 2.5°F for Firecode insulation in insulating spacer.

3.5. Hypothetical Accident Thermal Evaluation

3.5.1. Thermal Model

3.5.1.1. Analytical Model. Not applicable.

3.5.1.2. Test Model. The package was prepared for testing as detailed in section 2.7. This test requires exposure to a thermal environment in which the heat input to the package is not less than that which would result from exposure of the whole package to a thermal radiation environment of 1475°F for 30 min with an emissivity coefficient of 0.9, assuming the surfaces of the package have an absorption coefficient of 0.8. The package may not be cooled artificially until 3 hr after the test period unless it can be shown that the temperature on the inside of the package has begun to fall in <3 hr.

The fire test facility at MRC-Mound was designed to meet the DOT/DOE hypothetical accident conditions. To simulate actual conditions, the test facility provides an open, aviation-gasoline-fueled fire. The facility has been improved several times over the years to improve control and reduce smoke.

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Configuration-5 was fire tested in a facility that had been improved by a water spray system that virtually eliminates smoke, as seen in Figure 3-3.

Wind effects are reduced by 8-ft high firebrick walls on three sides. On the fourth side is a 4-ft wall that permits viewing and ease of handling the shipping containers. The base of the fire pit is poured concrete measuring 10 x 10 x 0.5 ft deep [7]. Fuel and seven water spray nozzles are located in the fire pit base, which is flooded with water 5 in. deep to avoid excessively heating the pit. A 5-HP fan supplies $\sim 8000 \text{ ft}^3/\text{min}$ of air through the air manifold outlets located in two opposing 8-ft sides just above the fire pit.

The 100-octane aviation gasoline is continuously gravity-fed to the distribution system from a 5000-gal, buried tank located ~ 100 ft from the first pit. The gasoline floats to the surface of the water and burns. The nozzle spray is directed horizontally, providing complete coverage of the burning aviation fuel surface. The water spray reduces the smoke plume far below maximum allowable EPA requirements.

The flame temperatures obtained throughout the test are plotted as a function of time in Figure 3-4. The temperatures were measured at the side of configuration-5. Chromel/alumel thermocouples and a multipoint recorder were used to monitor the tests. The flame reached the required $1475^\circ\text{F} < 2 \text{ min}$ after ignition.

Throughout the course of the tests, it was necessary to closely monitor the temperatures and adjust the fuel flow rates. The fire burned for 32 to 34 min for the tests, and the flames burned out within a few seconds after the fuel flow was stopped. No artificial cooling was used. During the configuration-5 test the flame temperature ranged between 1225°F and 1578°F , fluctuating in the neighborhood of 1475°F . Fuel consumption was somewhat over 200 gal for each of the tests. All thermocouples functioned properly during the configuration-5 test.

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Figure 3-3. Improved fire test facility during burn for configuration 5.

Figure 3-4. Thermal test flame temperatures.
(Note: Configuration-1 and -3 results will be deleted from the final version of this document.)

3.5.2. Package Conditions and Environment

The 30-ft free drop caused obvious minor damage to the exterior drum surfaces, but did not damage the inner container in any way that would decrease the containment capabilities. Figure 2-12 was taken immediately following the free drop and puncture tests for the configuration-1 package. It shows that the drum closure ring at the point of impact was displaced, relative to the upright position, a distance of 3 in. vertically and 1 in. horizontally.

Figure 2-14 shows the damage to the lid. It was difficult to lift out the configuration-1 inner container and spacer because the insulated drum assembly was slightly out of round. The configuration-3 and configuration-5 drum assemblies sustained essentially the same damage as the configuration-1 drum assembly.

No damage was found on the configuration-5 inner container. The puncture test slightly dented the exterior drum surfaces but caused no observable damage internally. Displacement was ~1 in. for the configuration-5 drum. Such damage probably had little, if any, effect on the package thermal performance.

3.5.3. Package Temperatures

Temperatures as a function of time in the thermal test are shown in Figure 3-7.

3.5.4. Maximum Internal Pressures

The contents of configuration-5 are tritiated water. The heat load from tritium decay to helium-3 for the maximum amount of tritium is 3.3 W. The formation of helium-3 from natural tritium decay amounts to a generation rate of <4 L/yr for 100,000 Ci of tritium. With a void volume of 20% in the sorbent, the pressure in the 10-L inner container would thus rise only about 30 psi/yr.

The tritium must be in the form of tritiated water (HTO); organic compounds, e.g., decontamination solvents such as alcohol, must not be present in amounts >1% of the water contents of the package. This limitation ensures that excessive pressure buildup due to radiolysis will not occur over long storage periods. No unsafe pressure increase will occur at these specified concentration levels of tritium and organic compounds.

The internal pressure buildup due to radiolysis is an increase toward an equilibrium partial pressure of hydrogen formed by dissociation of water due to energy absorbed from the β emissions of radioactive tritium. The magnitude of this pressure buildup is a function of time and of type and concentration of organic compound contaminant. It is not expected to exceed 40 psi and will typically be 10 psi or less after several months when organic compound contaminant levels are below 1%, as suggested above.

Thus, the total pressure in the configuration-5 inner container several months after loading and sealing will (at normal conditions) be roughly the sum of three partial pressures. These are (1) air or inert gases trapped in the container at the time of loading, (2) helium-3 decay product, and

(3) hydrogen from radiolysis. At that time the pressure could be expected to be 15 to 20 psig.

During hypothetical accident fire conditions this pressure would rise for two reasons. First, the heating of the gaseous contents to 277°F would increase the absolute partial pressures to ~43.7 psia. Second, the vapor pressure of the sorbed water would become significant at the elevated temperature. The vapor pressure of free liquid water forms an upper limit for the vapor pressure of sorbed water. At 277°F this is 47 psia.

Firedike, Auratone Firecode, and Superex are all insulation materials composed of mineral fibers, with a high SiO₂ content. Refractory materials of similar composition show reported specific heat values of 0.20 to 0.25 Btu/lb°F [8,9]. Therefore, in the absence of measured values for Firedike and Auratone Firecode, it is reasonable to assume that the specific heat is the same for the three above insulating materials.

Substituting Auratone Firecode for Firedike insulation in the insulating spacer reduces the overall thermal conductivity of the package. Therefore, for equal specific heat values, inner container temperatures under hypothetical accident conditions will be somewhat lower in this case. For a conservative approximation, they are assumed to remain the same.

Superex insulation has a higher thermal conductivity than Firedike. Substituting this material in the insulating spacer will produce higher temperatures in the inner container under hypothetical accident conditions. To calculate this increase, the container is modeled as an infinitely long, hollow cylinder of insulation. If the minimum temperature in the package occurs at the inside surface of the insulation, the numerical results of Geckler [10] can be applied to the solution of this problem. A high rate of convective heat transfer at the outer container surface was assumed (Biot number = 100). This is a reasonable assumption under the turbulent conditions of the hypothetical accident fire.

If the heat capacities of the two insulating materials are roughly the same, the thermal diffusivity increases by 9.3% on changing from Firedike to Superex. In this case, interpolating the results of Geckler's calculations gives a temperature increase at the inner container surface of 13°F if the package insulation is changed from all Firedike to all Superex. It is conservative to assume the same temperature increase inside the inner container.

In summary, a configuration-5 container that is loaded and sealed and then subjected to hypothetical accident fire conditions several months later is expected to have a maximum internal pressure of substantially less than 100 psig. Calculated maximum temperatures and pressures are summarized in Table 3-6.

Molecular sieve pellets, silica gel, and Florco commercial clay absorbent are acceptable sorbents for use in the configuration-5 inner container. None of these materials will damage this inner container at 300°F.

3.5.5. Maximum Thermal Stresses

The most severe thermal stress conditions occur near the end of the thermal test, when inner container temperatures are highest.

TABLE 3-6

MAXIMUM INTERNAL PRESSURE DURING
HYPOTHETICAL ACCIDENT THERMAL TEST^(a)

Config- uration	Maximum Contents Heat Load (W)	Maximum Internal Temperature of Inner Container (°F)	Maximum Temperature Rise Due to Thermal Accident Test (°F)	Maximum Internal Temperature (°F)	Maximum Internal Pressure (psig)
5	3.3	125	152	277 ^(b)	76.0 ^(c)

(a) Calculated at an ambient temperature of 100°F. Inner container loaded at -40°F.

(b) Add 13°F for Superex insulation in the insulating spacer.

(c) Add 0.4 psi for Superex insulation in the insulating spacer.

3.5.6. Evaluation of Package Performance for Hypothetical Accident Thermal Conditions

The temperatures for the configuration-5 thermal test were monitored by thermocouples and recorded on a multipoint strip chart. The results are shown in Figure 3-5. The maximum temperature reached on the surface of the inner container was 252°F at the top cap.

In summary, the thermal test did not cause any observable damage to the inner container. The temperature reached 268°F in configuration 5. The maximum temperature within the inner container stayed below 300°F so that selection of this temperature for the safety evaluation of the radioactive materials to be shipped provides an adequate margin of safety.

The maximum temperatures reached during the thermal accident tests are summarized in Table 3-4. The maximum temperatures inside the inner container will result in the maximum pressures listed in Table 3-6. These pressures are below the allowable pressure of 290 psig, as determined in section 2.1.2. Therefore, pressures reached during hypothetical accident conditions will not adversely affect package performance.

The maximum surface temperature of the inner container is <300°F for configuration 5. At 300°F, the seal life of a neoprene O-ring is >1000 hr. Therefore, no breach of containment will result from thermal accident conditions.

3.6. Appendix

Not applicable.

Figure 3-5. Fire test results for configuration 5.

TABLE 3-7

MAXIMUM TEMPERATURES REACHED DURING
HYPOTHETICAL ACCIDENT THERMAL TEST^(a)

Configuration 5

<u>Location</u>	<u>Maximum Normal Temperature (°F)</u>	<u>Maximum Temperature Rise Due to Thermal Accident Test (°F)</u>	<u>Maximum Accident Temperature (°F)</u>
Inside Inner Container	125	152	277 ^(b)
Outside Surface Inner Container	116	152	268 ^(b)
Drum Exterior	100	1390	1490

(a) Ambient temperature of 100°F, containing maximum contents heat load.

(b) Add 13°F for Superex insulation in the insulating spacer.

References

1. American Society for Metals, ASM Metals Reference Book, American Society for Metals, Metals Park, Ohio, 1983.
2. Metals Handbook, American Society for Metals, Metals Park, Ohio, 1980.
3. L. B. Shappert, Cask Designers Guide, ORNL-NSIC-68, Union Carbide Corp., Oak Ridge, Tenn. (February 1970), p. 143.
4. L. G. Roome, R. A. Watkins, R. E. Bertram, and H. B. Kreider, Safety Analysis Report for Packaging (SARP): USA/5790/BLF(DOE-AL) and USA/5791/BLF(DOE-AL), MLM-2242 (Rev.1), Mound Facility, Miamisburg, Ohio, January 1980.
5. J. N. Rigano, R. A. Watkins, and H. B. Kreider, "Temperature Tests of the USA/5791/BLF (DOE-AL) Shipping Container with Auratone Firecode Insulation," MLM-2868, Mound Facility, Miamisburg, Ohio, October 1981.
6. J. F. Griffin, memo to H. B. Kreider, 1 April 1982.
7. H. Williams and J. F. Griffin, "Smokeless Gasoline Fire Test", Fourth International Symposium on the Packaging and Transportation of Radioactive Materials, Miami Beach, Fla., September 22-27, 1974, MLM-2159.
8. Standard Handbook for Mechanical Engineers, T. Baumeister (ed.), McGraw-Hill, New York, 1963.
9. Chemical Engineers Handbook, R. H. Perry and C. H. Chilton (eds.), 5th Ed., McGraw-Hill, New York, 1973.
10. R. D. Geckler, Jet Propulsion, 25, 31-35 (1955).

4. CONTAINMENT

4.1. Containment Boundary

The inner containment vessel of the 9507 package provides the containment boundary. These vessels have been proven capable of retaining their contents both under conditions of normal transport and hypothetical accident conditions.

4.1.1. Containment Vessel

Inner container dimensions are summarized in Table 4-1. Maximum allowable temperatures, pressures, and decay heat of contents are summarized in Table 4-2.

TABLE 4-1

INNER CONTAINER DIMENSIONS

<u>Configuration</u>	<u>Inner Diameter (in.)</u>	<u>Wall Thickness (in.)</u>	<u>Minimum Inside Height (in.)</u>
5	6.36	0.134	12.0

TABLE 4-2

DESIGN SPECIFICATIONS FOR CONTAINMENT VESSELS

<u>Configuration</u>	<u>Maximum Allowable External Temperatures (°F)</u>		<u>Maximum Allowable Pressure^(a) (psig)</u>		<u>Maximum Decay Heat (W)</u>
	<u>Normal Transport^(b)</u>	<u>Accident Conditions</u>	<u>Internal</u>	<u>External</u>	
5	138	300	290	152	3.3

(a) At 300°F.

(b) To maintain outer container surface temperatures below 122°F.

4.1.2. Containment Penetrations.

The configuration-5 inner container has four penetrations: two are sealed by Cajon VCR blind glands and Nupro bellows valves (#SS-8BG-TSW), one is sealed by a Cajon VCR blind gland, and one is sealed by a Precise Sensors pressure transducer (#70101-200). The gaskets for the Cajon fittings are nickel. The above four penetrations are covered by an O-ring-sealed cap. This cap is penetrated by two Swagelok quick-disconnect fittings (#SS-QC-4-BL-400). Pressure and temperature limits for all these fittings are listed in Table 4-3.

TABLE 4-3

OPERATING LIMITS FOR CONTAINMENT PENETRATIONS

<u>Component</u>	<u>Maximum Temperature (°F)</u>	<u>Maximum Pressure (psig)</u>
Cajon VCR blind gland 316 SS	1000	2800
Nupro bellows valves 316 SS	600	1000
Precise Sensors pressure transducer	350	800
Swagelock quick-disconnects 316 SS	250 ^(a)	250

(a) With Buna O-rings; 450°F with Viton O-rings.

4.1.3. Seals and Welds

Requirements for welds on carbon steel are detailed in drawing SPA-760488 in Appendix 1.3. Requirements for welds on the stainless steel inner containers for the 9507 package are detailed in drawing 1-14841, found in Appendix 8.2.

The O-ring seals used in the inner containers are neoprene rubber for configuration 5. The properties of these seals are summarized in Table 4-4.

TABLE 4-4

O-RING MINIMUM SPECIFICATIONS

<u>Material</u>	<u>Hardness Shore A (pts)</u>	<u>Tensile Strength (psi)</u>	<u>Elongation (%)</u>	<u>Seal Life (hr)</u>	
				<u>At 138°F</u>	<u>At Accident Conditions</u>
Neoprene	70(a)	1450(a)	250(a)	>1000(b)	>1000(b,c)

(a) ASTM D2000 3BC715 A14, B34, E014, E034 Spec.

(b) Parker O-Ring Handbook, Parker Seal Group, ORD5700, Lexington, KY, 1982, p. A3-36.

(c) 300°F.

4.1.4. Closure

The body of the configuration-5 vessel has two penetrations for loading and unloading of the contents. These penetrations are sealed by bellows valves (Nupro #SS-8-BG-TSW) that are leak-tight to $0.0004 \mu\text{ft}^3/\text{hr}$. One penetration is additionally sealed by a blind gland with a nickel gasket, and the other by a blind female nut with a nickel gasket.

4.2. Requirements for Normal Conditions of Transport

4.2.1. Containment of Radioactive Material

Section 51 of 10 CFR 71 requires loss of radioactive material to be $<10^{-6} \text{ A}_2/\text{hr}$ under normal conditions of transport. The A_2 quantity for tritium is listed in Table 4-5.

TABLE 4-5

CONTAINMENT CRITERIA FOR NORMAL CONDITIONS OF TRANSPORT

<u>Isotope</u>	<u>A_2 Quantity^(a) (Ci)</u>	<u>Maximum Loss (Ci/hr)</u>
^3H	1000	1×10^{-3}

(a) 10 CFR 71, p. 719, Table A-1.

4.2.2. Pressurization of Containment Vessel

The quantity of tritium to be shipped in each configuration-5 container is arbitrarily limited to a maximum of 100,000 Ci or about 10 g of tritium. This quantity does not generate enough heat from radioactive decay (3.3 W) to cause any significant temperature rise in the inner container. The formation of helium-3 from natural tritium decay amounts to a generation rate of $<4 \text{ L/yr}$ for 100,000 Ci of tritium. With a void volume of 20% in the sorbent, the pressure in the 10-L inner container would thus rise only $\sim 30 \text{ psi/yr}$.

The tritium must be in the form of tritiated water (HTO); organic compounds, e.g., decontamination solvents such as alcohol, must not be present in amounts $>1\%$ of the water content of the package. This limitation ensures that excessive pressure buildup due to radiolysis will not occur over long storage periods. No unsafe pressure increase will occur at these specified concentration levels of tritium and organic compounds.

The internal pressure buildup due to radiolysis is an increase toward an equilibrium partial pressure of hydrogen formed by dissociation of water due to energy absorbed from the β emissions of radioactive tritium. The magnitude of this pressure buildup is a function of time and of type and concentration of organic compound contaminant. It is not expected to exceed 40 psi and will typically be 10 psi or less after several months, when organic compound contaminant levels are below 1%, as suggested above.

4.2.3. Containment Criterion

The inner container of configuration 5 must pass a helium leak test with no detectable leak $>1 \times 10^{-6}$ std. cm³/sec when filled with 15 psig helium. Fulfillment of these requirements demonstrates that the containment criteria of section 4.2.1 are satisfied.

4.3. Containment Requirements for Hypothetical Accident Conditions

The total pressure in the configuration-5 inner container several months after loading and sealing will (at normal conditions) be roughly the sum of three partial pressures. These are (1) air or inert gases trapped in the container at the time of loading, (2) helium-3 decay product, and (3) hydrogen from radiolysis. At that time the pressure could be expected to be 15 to 20 psig.

During hypothetical accident fire conditions this pressure would rise for two reasons. First, the heating of the gaseous contents to 255°F will increase the absolute partial pressures by a factor of ~1.39. Second, the vapor pressure of the sorbed water would become significant at the elevated temperature. The vapor pressure of free liquid water forms an upper limit for the vapor pressure of sorbed water. At 277°F this is 46.9 psia.

In summary, a configuration-5 container that is loaded and sealed and then subjected to hypothetical accident fire conditions several months later is expected to have a maximum internal pressure of substantially less than 100 psig. The exact magnitude of this pressure depends upon several variables. Therefore, safe practice dictates:

1. Content of organic compounds, such as alcohol, below 1% of water content;
2. Loading at 1 atm or less;
3. Normal shipment within 30 days after loading; or,
4. If shipment is not made within 30 days, the internal pressure must be measured (i.e., using the built-in pressure transducer). If, at that time the pressure is >10 psig, then steps must be taken to reduce the pressure to a maximum of 1 atm prior to shipment; and
5. Occasional monitoring of internal pressure during extended storage periods.

Since the maximum acceptable pressure inside the configuration-5 vessel is 290 psig, a pressure of 100 psig would not significantly reduce the package effectiveness.

4.3.1. Fission Gas Products

Not applicable.

4.3.2. Containment of Radioactive Material

Section 51 of 10 CFR 71 requires loss of radioactive material to be less than A₂ per week under hypothetical accident conditions. The A₂ quantity for tritium is listed in Table 4-5.

4.3.3. Containment Criterion

AL-M1 configuration 5 has been demonstrated to satisfy the requirements of 10 CFR 71.51 for containment of radioactive material under hypothetical accident conditions. This is demonstrated by this package passing the water immersion test at the end of the sequence of hypothetical accident tests with no leakage. In addition, after the immersion test, the inner container was reassembled and found to be helium leak-tight.

The configuration-5 inner container was helium leak checked after the hypothetical accident test sequence and no leaks were detected. A sniffer probe technique was used at 10 psig, as before the accident sequence, and it demonstrated that no leaks $< 1 \times 10^{-6}$ STP cm^3/s were present. It was concluded that the container was leakproof and had satisfactorily met all test requirements.

4.4. Special Requirements

Not Applicable.

4.5. Appendix

Not Applicable.

5. SHIELDING EVALUATION

Not applicable.

Configuration 5 of the AL-M1 shipping container is used to transport tritiated water only. The maximum energy of the beta particle for tritium is 18 keV with an average energy of ~16 keV. The shielding provided by the primary containment is sufficient to attenuate the beta radiation to nonmeasurable levels at the outer surface.

6. CRITICALITY EVALUATION

Not applicable.

The tritium shipped in AL-M1 configuration 5 is not capable of becoming critical.

7. OPERATING PROCEDURES

Practices and procedures for safely handling and properly packaging radioactive materials at MRC-Mound are covered in three basic program documents, which are described below (other DOE sites utilizing Type B nuclear packagings are expected to have equivalent arrangements).

- (1) Nuclear Packaging Manual, MD-10279. This manual has been developed to serve as a consistent and definitive reference for packaging radioactive products and materials for shipment, thereby providing Mound packaging personnel with instructive guidelines for packaging radioactive materials for offsite shipment, in full compliance with all applicable Department of Energy (DOE) orders, the federal regulations of both the Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT), and Mound or other agency or customer requirements.
- (2) Quality Plan for Type B Reusable Nuclear Packaging, MD-10236. This quality plan is intended to provide MRC-Mound management, the design agencies, and the Department of Energy with assurance that the reusable radioactive materials packages employed for offsite shipment meet the established specifications and requirements. All aspects of acquisition, inspection, handling, maintenance, utilization, and control for Type B nuclear shipping packages used for offsite shipment of radioactive materials, except U. S. DOT Spec. 6M (refer to Technical Manual MD-10233), are covered in this quality plan, which is structured to comply with U. S. DOE Order 5700.6, Quality Assurance Requirements (equivalent to the U. S. NRC quality program requirements of 10 CFR Part 71).
- (3) Nuclear Radiation Safety, MD-10019. This manual describes guidelines and refers to documents that describe work methods in environments where radioactive materials are present or contained, establishes responsibilities and guidelines for Mound employees in radiation areas, and ensures radiation safety in accordance with established regulatory standards within Mound's "as low as reasonably achievable" (ALARA) policy.

7.1. Procedures for Loading Packages

Operating procedures and instructions for loading or unloading nuclear packaging at MRC-Mound are contained in approved "operation sheets," which are collected into technical manuals in order to maintain publication control. Such operation sheets are formatted as instructional checklists to be completed by the operator(s) as the packages are being loaded, assembled, and shipped. Completed operation sheets, along with any related forms or documentation, are retained on file to verify compliance with applicable procedures and requirements.

The following MRC-Mound forms are included as examples of the forms to be completed during packaging activities (in the absence of printed forms, these could be copied and used as needed):

- (1) MD-70152, OP. 14 (Figure 7-1). For configuration 5 only, this is a checklist for reuse inspection and a generalized assembly procedure when either loaded (filled) or empty inner containers used for tritiated water are shipped.
- (2) MD-70152, OP. 15 (Figure 7-2) and Form MRC-ML-1245 (Figure 7-3). For all radioactive shipments, these forms are used by MRC-Mound to record surface contamination and radiation levels of the outer shipping package and to provide documentation to show compliance with all shipping regulations. Equivalent forms will be completed by other users.

Prior to each use, all Type B packaging used at MRC-Mound is inspected and accepted by Quality Control and released for use by Quality Engineering (see section 8.2).

For loading (filling) configuration-5 containers, the inner container is attached to the filling system with Cajon fittings. The inner container is loaded either by admitting tritiated water directly or by passing air containing the tritiated water vapor through the dry sorbent. In either case, the loading is done through the valve marked "to top." Direct loading with water should be done slowly, because sorbency is exothermic. The maximum loading limits are 100,000 Ci of tritium and 2000 g of water on molecular sieve or silica gel or 3000 g of water on Florco commercial clay adsorbent. The quantity of water is determined by weighing the inner container before and after loading.

After loading the configuration-5 inner container, the valves to the container are firmly closed with a wrench. Before being disconnected from the filling system, the tubing and Cajon fittings above the valves are kept under vacuum until dry. Blind Cajon nuts (caps) are inserted in each Cajon fitting to provide secondary containment. The surface of the container is then decontaminated, allowed to dry, and probed with a tritium monitor for leakage or surface offgassing. If tritium is observed, the decontamination procedure is repeated. If no tritium is detected with the monitor, then surface wipes are taken. Further decontamination is performed as needed until these wipes are below 100 dis/min beta. No detectable leakage is permitted.

The protective cover is attached to the configuration-5 inner container to protect the valves and transducer from physical damage. Through the quick-disconnect fittings, the leakage from the cover and also from the container is determined by pressurizing the cover to 20 psig. No change in pressure should be observed after 30 min. The pressure is then released through a tritium monitor. If a tritium concentration reading greater than $180 \mu\text{Ci}/\text{m}^3$ is obtained, the cap must be removed in order to identify a leak or to repeat the decontamination. The test is then repeated.

If the external surface of the capped configuration-5 inner container yields a surface wipe count of less than $1000 \text{ dis}/\text{min}/100 \text{ cm}^2$ beta, the container is inserted into the insulated sleeve, which is already in place in the outer 55-gal steel drum. The Cerawool insulating pads are placed on the top of the inner container and the insulating sleeve. The lid is placed on the drum and held in place with the closure ring. The shipping drum is checked for contamination to ensure compliance with U. S. DOT regulations (less than $100 \text{ dis}/\text{min}/100 \text{ cm}^2$ beta).

PROGRAM REUSABLE RADIOACTIVE SHIPPING CONTAINERS		SHEET 1 of 1	MANUAL NUMBER MD-70152	OPERATION 14
AUTHORIZATION <i>NAFAL</i>	CLASSIFICATION Unclassified	EFFECTIVITY 9-26-77	ECN(S) INCORPORATED M4-C	
OPERATION TITLE Use Inspection and Loading of AL-M1 Configuration 5				

1. IDENTIFICATION

1.1. Inner container serial number _____ and date of last interior surface evaluation _____

1.2. Outer container serial number _____

1.3. Received from _____

1.4. The following inspections and/or actions are required. Do not check off any item until the indicated action is completed and any defect found has been corrected. Indicate repair by the letters Rpr and replacement by the letters Rpl. A simple check mark is satisfactory to indicate completion of an inspection or action. Enter NA if the inspection or action does not apply.

2. INNER CONTAINER

2.1. _____ Less than 5 years since last interior surface evaluation.

2.2. _____ Regeneration temperature of sorbent.

2.3. _____ Date of regeneration.

2.4. _____ Grams of water loaded.

2.5. _____ Date loaded.

2.6. _____ Ci of tritium loaded (best estimate).

2.7. _____ Primary containment leak checked and no leak through valve.

2.8. _____ Pressure transducer operational. Primary container pressure no more than 1 atm absolute.

2.9. _____ Valves operational and closed.

2.10. _____ Cajon fitting interior dry (e.g., by evacuation).

2.11. _____ Valves capped.

2.12. _____ Exterior surfaces decontaminated.

2.13. _____ No physical damage.

2.14. _____ Welds OK.

2.15. _____ No nicks or scratches in sealing surfaces.

2.16. _____ O-rings dry, grease free, and in good condition.

2.17. _____ Protective cover installed.

2.18. _____ Cover pressurized to 20 psig. No pressure decrease in 30 minutes.

2.19. _____ Cover interior produces less than 180 $\mu\text{Ci}/\text{m}^3$ on tritium monitor when pressure released through monitor.

2.20. _____ Gross weight with cover.

3. INSULATING SLEEVE

3.1. _____ Clean and undamaged.

3.2. _____ Surface wipes less than 1000 DPM β .

3.3. _____ Cerawool pad in bottom of well in good condition.

3.4. _____ Large and small diameter Cerawool pads placed on top of inner container, in good condition.

3.5. _____ Sketch and form packed above Cerawool pads.

4. INSULATING DRUM ASSEMBLY

4.1. _____ Paint and vinyl emblem.

4.2. _____ Identification plate.

4.3. _____ Tiedown brackets (as applicable).

4.4. _____ Security seal bracket.

4.5. _____ Welds

4.6. _____ Vent not damaged or plugged.

4.7. _____ Interior dry and clean.

4.8. _____ Assembles properly.

4.9. _____ Closure ring and bolt.

4.10. _____ Old labels, adhesives, etc., removed and correct new labels applied.

DISTRIBUTION

White - Container File

Yellow - Nuclear QC

Goldenrod - Shipper File

Pink - Originator

Signature _____

Date _____

PROGRAM REUSABLE NUCLEAR PACKAGING SHIPPING CONTAINER		SHEET 1 of 1	MANUAL NUMBER MD-70152	OPERATION 15
TECH. RESP. <i>[Signature]</i>	DATE 4/10/87	QUALITY ENGINEER <i>[Signature]</i>	DATE 4/10/87	EFFECTIVITY 12-1-86
			ECN(S) INCORPORATED 860407MD-C	

OPERATION TITLE DOT Quality Requirements Check Sheet

Unclassified

DOT QUALITY REQUIREMENTS CHECK SHEET

SHIPPING REQUEST NUMBER _____ Date _____

SHIPPING CONTAINER S/N(S): _____

CHECK OFF

1. Verify that the proper packaging is being used. _____

Identity of packaging used _____

2. Verify that packaging is in unimpaired physical condition, except for superficial marks. _____

3. Verify that each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects. _____

4. For fissile material only, verify that each moderator and neutron absorber, if required, is present and in proper position. _____

5. Verify that each special instruction for filling, closing, and preparation of the packaging for shipment has been followed. _____

Operation Sheet Form number _____

6. Verify that each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed. _____

7. Verify that each packaging containing liquid in excess of an A2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.6 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement.

SARF number or other test document ID _____

8. Verify that the internal pressure of the containment system will not exceed the design pressure during transportation. _____

Explain how verified:

9. Verify that external radiation and contamination levels are within the allowable limits specified in parts 173.441 and 173.443 of 49 CFR. _____

Form 1245 ML number _____

SIGNATURE _____ DATE SIGNED _____

Issue 1

MRC-ML-128 (7-83)

Figure 7-2. Checklist for the outer package of all radioactive shipments.

MONSANTO RESEARCH CORPORATION
MRC-MOUND
MIAMISBURG, OHIO 45342

SECURITY SEAL		NUMBERS:	
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

RADIATION SURVEY INSTRUMENTS USED a -		b		c		d		e		f		g		h		i		j		k		l		m		n		o		p		q		r		s		t		u		v		w		x		y		z		aa		ab		ac		ad		ae		af		ag		ah		ai		aj		ak		al		am		an		ao		ap		aq		ar		as		at		au		av		aw		ax		ay		az		ba		bb		bc		bd		be		bf		bg		bh		bi		bj		bk		bl		bm		bn		bo		bp		bq		br		bs		bt		bu		bv		bw		bx		by		bz		ca		cb		cc		cd		ce		cf		cg		ch		ci		cj		ck		cl		cm		cn		co		cp		cq		cr		cs		ct		cu		cv		cw		cx		cy		cz		da		db		dc		dd		de		df		dg		dh		di		dj		dk		dl		dm		dn		do		dp		dq		dr		ds		dt		du		dv		dw		dx		dy		dz		ea		eb		ec		ed		ee		ef		eg		eh		ei		ej		ek		el		em		en		eo		ep		eq		er		es		et		eu		ev		ew		ex		ey		ez		fa		fb		fc		fd		fe		ff		fg		fh		fi		fj		fk		fl		fm		fn		fo		fp		fq		fr		fs		ft		fu		fv		fw		fx		fy		fz		ga		gb		gc		gd		ge		gf		gg		gh		gi		gj		gk		gl		gm		gn		go		gp		gq		gr		gs		gt		gu		gv		gw		gx		gy		gz		ha		hb		hc		hd		he		hf		hg		hh		hi		hj		hk		hl		hm		hn		ho		hp		hq		hr		hs		ht		hu		hv		hw		hx		hy		hz		ia		ib		ic		id		ie		if		ig		ih		ii		ij		ik		il		im		in		io		ip		iq		ir		is		it		iu		iv		iw		ix		iy		iz		ja		jb		jc		jd		je		jf		jg		jh		ji		jj		jk		jl		jm		jn		jo		jp		jq		jr		js		jt		ju		jv		jw		jx		jy		jz		ka		kb		kc		kd		ke		kf		kg		kh		ki		kj		kk		kl		km		kn		ko		kp		kq		kr		ks		kt		ku		kv		kw		kx		ky		kz		la		lb		lc		ld		le		lf		lg		lh		li		lj		lk		ll		lm		ln		lo		lp		lq		lr		ls		lt		lu		lv		lw		lx		ly		lz		ma		mb		mc		md		me		mf		mg		mh		mi		mj		mk		ml		mm		mn		mo		mp		mq		mr		ms		mt		mu		mv		mw		mx		my		mz		na		nb		nc		nd		ne		nf		ng		nh		ni		nj		nk		nl		nm		nn		no		np		nq		nr		ns		nt		nu		nv		nw		nx		ny		nz		oa		ob		oc		od		oe		of		og		oh		oi		oj		ok		ol		om		on		oo		op	
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Approved for Shipment:	Signature	Date
Requestor		
Nuclear Criticality		
Health Physics		

PERSONNEL INVOLVED IN LOADING OF CONTAINERS

<p>THIS SECTION MUST BE FILLED IN</p> <p>SECURITY CLASSIFICATION</p> <p>☐ CLASSIFIED - Must be signed by Authorized Classifier</p> <p>☒ UNCLASSIFIED - Must be signed by Supervisor or Designated Alternate</p>	
<p>Classification Category</p>	
<p>Authorized Signature</p>	<p>Date</p>

DISTRIBUTION:

1. Special Matl. Handling
2. Nuclear Matl. Control
3. Nuclear Criticality
4. Health Physics
5. Quality Engineering

MRC-ML-1245 (8-87)
17-1435

1. Requisite for complete Part II, except M.L. number; and Part II columns 2 and 3.
2. Health Physics complete Part II columns 4 and 5, and Part III; and Part III; and
3. Nuclear M.L. NO. insert M.L. NO.
4. Enter Security Seal numbers.
5. Nuclear Criticality complete Part II, column 6 of Special Matd. Handling complete Part IV and make For Empty Containers, no M.L. No. is to be issued.

Figure 7-3. Mound form to record contamination and radiation levels of the outer package.

As each operation is completed, Form MD-70152, OP. 14, is so marked. In addition, Form MRC-ML-1245 is completed, giving contamination levels and documentation of shipment. Closure seals and labels are attached and the configuration-5 package is ready for shipment.

7.2. Procedures for Unloading Packages

Unloading a package is basically the reverse of loading. Upon receipt, the package is surveyed for contamination before removal of the cover, and each component is checked as it is removed from the package. For a configuration-5 package, the inner container is removed from the insulating sleeve and checked for contamination, assayed by calorimetry, and then stored in a suitable controlled atmosphere enclosure until removal of the tritiated water is completed. The packaging is then placed in appropriate "hold" storage (considering internal contamination), pending reuse inspection and Quality Engineering disposition.

7.3. Preparation of Empty Packages for Transport

To be prepared for shipment, empty packaging must first be surveyed and released by Health Physics. It must then be reassembled completely, with all component parts in proper order. The radioactive material labels (i.e., yellow-III labels) should be removed, "empty" labels applied in compliance with DOT requirements, and a security seal installed as necessary.

7.4. Appendix

Not applicable.

8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests Performed Prior to First Use

Prior to the first use of AL-M1 packaging, extensive testing procedures, both destructive and nondestructive, were performed on prototype units to verify compliance with design criteria. Such tests and evaluations are described, and the results reported, in the preceding chapters of this document.

8.1.1. Visual Inspection

Visual inspections were performed on each part, component, subassembly, and assembly of each prototype test unit to assure correct fit, finish, and function, as described in preceding chapters and in appendix 8.3.

8.1.2. Structural and Pressure Tests

The structural and pressure tests are described and discussed in Chapter 2.

8.1.3. Leak Tests

Leak tests are described and discussed in the preceding chapters and in appendix 8.3.

8.1.4. Component Tests

For those components to be tested (i.e., valves, gaskets, etc.), the related tests are described and discussed in the preceding chapters. Furthermore, all aspects of acquisition, inspection, handling, storage, maintenance, utilization, and control for type B nuclear packaging or packaging components used for offsite shipment of radioactive materials (except U. S. DOT Spec. 6M) are covered under the Mound "Quality Plan for Type B Reusable Nuclear Packaging," MD-10236. This plan complies with U. S. DOE Order 5700.6b, "Quality Assurance Requirements" (equivalent to U. S. NRC quality program requirements of 10 CFR 71).

8.1.5. Tests for Shielding Integrity

Since there is no shielding installed in the AL-M1 packaging, no tests for shielding integrity are performed.

8.1.6. Thermal Acceptance Tests

Thermal performance is established in the prototype testing and qualification, which are described and reported in Chapter 3 of this report. Any damage, deviation, or inadequacy of materials, parts, or components related to the thermal characteristics of this packaging would be determined by the visual inspections; therefore, thermal acceptance testing on individual units is not performed.

8.2. Maintenance Program

Fabrication acceptance inspections are to be performed before first use of each new or remanufactured AL-M1 packaging unit. The nondestructive inspections, measurements, and determinations are specified in appendix 8.3. These include applicable visual and dimensional inspections, structural, pressure, and leak tests and examinations for fit and function of all parts, components, subassemblies, valves, gauges, gaskets, and other items that could impair the effectiveness of the packaging unit.

Reuse inspection, acceptance, and QC release for use are to be performed on each packaging unit prior to any reuse. Each AL-M1 packaging shall be disassembled, inspected, and accepted by a qualified quality control inspector (i.e., from the Mound receiving inspection group) according to the applicable inspection operation sheet (see Figure 8-1). Any indication of damage, wear, or degradation, or the defective, inadequate, or deviant condition of any item, part, component, subassembly, or assembly during this reuse inspection shall cause the packaging unit to be placed in a "hold" status pending resolution of the observed condition. The cognizant quality engineer convenes a material review board, if needed, for resolution of the nonconforming conditions. The inspection/acceptance report prepared and issued by the QC inspector is reviewed by the cognizant quality engineer, who issues a release for use, in the form of a Quality Deviation Report, of the packaging units identified as acceptable. The completed Quality Deviation Report is transmitted to, and retained on file by, the nuclear packaging group for utilization as needed.

Empty AL-M1 packaging shall be marked with "empty" labels and stored in controlled and protected areas to minimize environmental effects, pilferage, or other incidental or accidental damage. During storage, packaging is to be under the control of the nuclear materials control group.

Routine basic maintenance on AL-M1 packaging units, such as cleaning and painting, replacement of gaskets, nuts, bolts, gauges, tube fittings, etc., is the responsibility of the functional group performing the nuclear packaging operations. Such maintenance activities shall be performed in accordance with the applicable quality program requirements of MD-10236. A reuse inspection/acceptance is required prior to quality engineering release for use of repaired or corrected packaging units.

8.2.1. Structural and Pressure Tests

In addition to the reuse inspection required prior to each use (including the mass spectrometer helium leak test or tritium leak test, which are part of the loading process for configuration 5), the containment vessel for configuration 5 shall be examined at least once every 2 yr. Damage, defects, or abnormalities in the containment tank circumference weldments are determined using an x-radiographic examination equivalent to that used for the initial acceptance inspection, as described in appendix 8.3.

RECEIVING INSPECTION/PRODUCT ACCEPTANCE
OPERATION SHEET

COMPONENT	DRAWING NO.	ISSUE	P R NO.	QC NUMBER
9507 SHIPPING CONTAINER (USED)	1-14946 AYD740425	A. C		

REUSABLE
NUCLEAR SHIPPING
CONTAINERS

MANUAL NO.	OP.	ISSUE	SHEET
MD30072	9507A	1	1 of 2

APPROVAL/EFFECTIVITY/SIGNATURES			
PRODUCT ENGINEER	DATE	QC ENGINEER	DATE
<i>Mark Williams</i>	6/10/86	<i>Adde</i>	6/3/86

VENDOR:

(USE BLACK INK)

ATTRIBUTES		SAMPLE	ACCEPT	NEEDS MATERIAL REVIEW	ACCEPTANCE			REMARKS
					EQUIPMENT	DRAWING NO.	RECORD ISSUE	
	HEALTH PHYSICS SURVEY							
1	Exterior wipe before opening package	100%			Appropriate Alpha, Beta or Gamma Radiation Detection Instruments			
2	Interior direct survey or wipe test as components are opened	100%						
3	Wipe test survey inside inner container	100%						
4	Exterior finish	100%			Visual			No severe rusting, scrapes, scratches, gouge which compromise metal thickness
5	Dents and deformities	100%			Visual			Do not interfere with function/contents
6	Gasket	100%			Visual			Good condition, flexible make good seal
7	Identification plate	100%			Visual			Note serial number
8	Weld, seam	100%			Visual			No split
9	Closure ring and locking device	100%			Visual			Good working condition
10	Vents	100%			Visual			Blow air

MRC-ML-8117

Figure 8-1. MD-30072, Op. 9507A, sheets 1 and 2.

RECEIVING INSPECTION/PRODUCT ACCEPTANCE
OPERATION SHEET

REUSABLE
NUCLEAR SHIPPING
CONTAINERS

COMPONENT	DRAWING NO.	ISSUE	P R NO.	QC NUMBER
9507 SHIPPING CONTAINER (USED)	1-14946	A		
	AYD740425	C		

MANUAL NO.	OP.	ISSUE	SHEET
MD30072	9507A	1	2 of 2

APPROVAL/EFFECTIVITY/SIGNATURES			
PRODUCT ENGINEER	DATE	QC ENGINEER	DATE
<i>W. Williams</i>	4/10/86	<i>J. Bell</i>	4/13/86

VENDOR:

(USE BLACK INK)

ATTRIBUTES		SAMPLE	ACCEPT	NEEDS MATERIAL REVIEW	ACCEPTANCE			REMARKS
					EQUIPMENT	DRAWING NO.	RECORD ISSUE	
11	Cylinder support	100%			Visual			Clean and no physical damage
	INNER CONTAINER							
12	Foreign materials	100%			Visual			No foreign material inside inner container
13	Gage	100%			Functional Check			Working condition
14	Valve	100%			Functional Check			Working condition
15	Weld	100%			Visual			No cracks
16	"O"-Ring	100%			Visual			No cracks and in good condition
17	Cap screws	100%			Visual			Not galled
18	Sealing surface	100%			Visual			Clean and smooth
	ASSEMBLY							
19	Drum insulation, inner container	100%			Functional fit			All three items fit together
20	Overall condition of container assembly	100%			Visual			Good condition

MRC-ML-8117

Figure 8-1 (continued)

Upon completion of this testing with acceptable findings, the cognizant quality engineer shall issue an acceptance report and release for use to the nuclear packaging group and shall also ensure that the vessels are permanently and legibly marked with the acceptance date of test, the facility where the test was performed, and the name of the responsible quality engineer.

8.2.2. Leak Tests

Tritium leak tests for configuration 5 are part of the loading processes and are described in the respective loading operation sheets included in Chapter 7.

8.2.3. Subsystem Maintenance

There are no subsystems in the AL-M1 packaging.

8.2.4. Valves, Rupture Disks, and Gaskets on Containment Vessel

Valves and gaskets on containment vessels are inspected visually and functionally for each usage and are replaced as needed. There are no rupture disks in the AL-M1 package.

8.2.5. Shielding

There is no shielding installed in the AL-M1 packaging.

8.2.6. Thermal

Any damage, deviation, or inadequacy of materials, parts, or components related to the thermal characteristics of this packaging would be determined by visual examination during reuse inspections.

8.2.7. Miscellaneous

There are no additional tests specified for the AL-M1 packaging.

8.3. Appendix

8.3.1. DWG #1-14946, Issue B, 25 shts (requires ACO rev. to issue C).

8.3.2. DWG #1-14841, Issue G, 6 shts.

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FSCM NO.: 14065
REVISION NO: ACO LD2-14876-M57
DATE: JANUARY 26, 1987
ENGINEER: M. WILLIAMS, MD *M. Williams*
DES. MGR: F. MORRIS, MD *F. Morris*

1-14946.

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PROGRAM: NUCLEAR SHIPPING CONTAINER
TITLE: AL-M1 ACCEPTANCE AND REUSE INSPECTION

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(NOTE: THIS IS A RETYPE OF ISSUE B DUE TO LOST ORIGINALS.)

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Division ii	-	Acceptance Inspection Criteria 8
Division iii	-	Acceptance Inspection Data Sheets 18
Division iv	-	Use and Reuse Inspection Check Sheets 24

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1. GENERAL.

- 1.1 Scope. This is an inspection requirement document for the AL-M1 radioactive materials shipping container. Three different AL-M1 packages are designated as configurations-1, -3, and -5.
- 1.2 This document defines the complete receiving acceptance inspection and reinspection prior to reuse as required by DOE Manual, Chapter 0529, including responsibilities, inspection criteria, and documentation records. The purpose of this document is to establish an effective system for ensuring compliance with the drawings, specifications, and design intent.

2. INTRODUCTION.

- 2.1 The AL-M1 shipping containers are designed to be used in the off-site transport of special nuclear materials, namely plutonium-239, uranium-235, and tritium. These containers meet the safety requirements of the Department of Energy and the unique requirements of the various materials which are shipped in them.
- Three types of AL-M1 packages, designated configurations-1, -3 and -5, are used. The packages are illustrated in Figures 1, 2, and 3. All three configurations utilize a 55-gal steel outer drum assembly lined internally with 3-1/2 in. of insulation to protect the inner container from impact and fire. The configuration-1 primary containment vessel is a 9-1/2 in. I.D. stainless steel inner container sealed with a silicone or viton o-ring. A spacer is provided which centers the inner container within the insulated drum assembly. A vent is provided through the lid of the drum for release of any vapors. The configuration-3 primary containment vessel is basically the same as configuration-1, except that it is aluminum and the 13 in. I.D. precludes use of a spacer between it and the insulated drum assembly. These two configurations, 1 and 3, are for shipment of plutonium-239 and/or uranium-235. The configuration-5 is for sorbed tritiated water and has a primary container of substantially different design. It is a cylinder of 6-5/8 in. O.D. by 23-7/8 in. overall height made of 316L stainless steel. An insulating spacer is used with this configuration.

FIGURE 1 - Sketch of AL-M1 configuration-1.

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FIGURE 2 - Sketch of AL-M1 configuration-3.

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FIGURE 3 - Sketch of AL-M1 configuration-5

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3. APPLICABLE DOCUMENTS.

3.1 Monsanto Research Corporation Drawings.

AYD740425 - Model AL-M1 Insulated Drum Assembly
AYD740426 - Model AL-M1 Configuration-1 Final Assembly
AYD740427 - Model AL-M1 Configuration-3 Final Assembly
AYD760626 - Model AL-M1 Configuration-5 Insulating Spacer
AYE740198 - Model AL-M1 Configuration-5 Inner Container
1-14841 - Welding and Inspection of 300 Series Stainless Steel Containers
1-14958 - Welding and Inspection of Aluminum Containers

3.2 Other Documents.

- 1) DOE Manual, Chapter 0529.
- 2) J. F. Griffin, D. A. Edling, and C. D. Winemiller, Safety Analysis Report for Packaging (SARP): Model AL-M1 Nuclear Packaging, MLM-1981 (Nov. 30, 1972), 80 pp.
- 3) R. A. Watkins, et al., Safety Analysis Report for Packaging (SARP) Model AL-M1 Nuclear Packaging, MLM-2447 (Sept. 30, 1977).

GENERAL PROVISIONS.

- 4.1 Responsibilities. The manufacturer is responsible for ensuring that all specific requirements are met and shall utilize accepted quality control measures during manufacture. Monsanto Research Corporation reserves the right to audit the manufacturer's facilities and procedures as required. MRC Engineering is responsible for establishing inspection criteria for receiving acceptance and reuse, and for providing this document.

MRC Nuclear Operations Quality Control is responsible for auditing the Quality Control Program and review of applicable drawings and specifications to ensure that the Quality Control Program is carried out as defined. MRC Nuclear Operations Cost and Reporting Group is responsible for the receiving acceptance inspection and retaining appropriate files to document the inspections. MRC container users are responsible for providing necessary information pertinent to the materials to be shipped, appropriate loading procedures for these materials, and the initiation of procurement and reuse inspection activities in cooperation with MRC Nuclear Cost and Reporting Group.

- 4.2 Inspection and Acceptance. Each container shall be examined and tested for defects in accordance (as applicable) with the specifications of MRC Drawing Nos. 1-14958 and 1-14841 as well as the criteria and check sheets of Division ii, iii, and iv of this document (MRC Drawing No. 1-14946).
- 4.2.1 Definition of Defects. Defects are classified as critical, major, or minor. A critical defect is a defect that judgment and experience indicate is likely to result in hazardous or unsafe conditions for individuals using or depending on the container for its intended purpose. A major defect is a defect, other than critical, that is likely to result in failure or to reduce materially the usability of the container for its intended purpose. A minor defect is a defect that is not likely to reduce materially the usability of the container for its intended purpose, or is a departure from established standards having little bearing on the effective use of the container.
- 4.2.2 Inspection of Major Assemblies. This inspection shall consist of visual, dimensional, and functional examination and tests of major assemblies which make up a complete container. The major assemblies to be inspected are listed below:
- MRC Dwg. No. AYD740425 - AL-M1 Insulated Drum Assembly (Common to Configurations-1, -3, and -5)
MRC Dwg. No. AYD740426 - AL-M1 Configuration-1 Inner Container
MRC Dwg. No. AYD740427 - AL-M1 Configuration-3 Inner Container
MRC Dwg. No. AYE740198 - AL-M1 Configuration-5 Inner Container
MRC Dwg. No. AYD760626 - AL-M1 Configuration-5 Insulating Spacer
- 4.2.3 Inspection of Final Assembly. The final assembly shall be examined visually and functionally with regard to meeting the requirements of the Final Assembly. Defects which shall be cause for rejection are listed in Division ii.
- 4.2.4 Sampling Plan. Each new shipping container shall be inspected for all attributes listed in Division ii.
- 4.3 Inspection Record. The fabricator is required to submit a completed "Fabrication and Inspection Certificate" (MRC-ML-5537 for aluminum or MRC-ML-6202 for stainless steel) as shown in MRC Drawing No. 1-14958 or 1-14841.

PART A - INSULATED DRUM ASSEMBLY (MRC DWG AYD740425)1. IDENTIFICATION.

- 1.1 Note the drum assembly identification markings on Inspection Data Sheet.
- 1.2 Note the assembly manufacturer (vendor).

2. VENDOR CERTIFICATION.

- 2.1 Vendor has certified by letter that all items are as specified per MRC Dwg. AYD740425 or MRC engineering approved equal. (Major)
- 2.2 Vendor has certified cylinder well (MRC Dwg. Detail 17) successfully passed the hydrostatic test (Dwg. AYD740528, Note 3) prior to installation into insulated drum assembly. (Major)

3. VISUAL INSPECTION.

- 3.1 Security seal channels are welded to the closure ring and the closure ring bolt has hole for security seal. (Major)
- 3.2 Drum permanent head marked in accordance with R. M. Graziano's Tariff No. 31. For DOT 6C drums this is "DOT-6C880" and "16/55/year" as in Section 178.99-9. For DOT 17C drums this is "company symbol DOT 17C 16 55 year month" as in Section 178.115-10.
- 3.3 Drum (DOT 6C only) has two I-bar rolling hoops held in place by a corrugation on each side. (Major)
- 3.4 Name tag attached and as specified per MRC Dwg. 1-14599. (Major)
- 3.5 Blue paint on drum exterior acceptable. (Minor)
- 3.6 Two Monsanto Company symbols (Red) located as shown on drawing. (Minor)
- 3.7 Workmanship acceptable with no sharp edges or burrs. (Critical)
- 3.8 Adhesive (General Electric RTV) seal completely around interface of cylinder well (MRC dwg. Detail 17) and drum (MRC Dwg. Detail 1). (Major)

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3.9 Insulated drum assembly undamaged. (Major)

4. DRUM ASSEMBLY DIMENSIONAL INSPECTION.

4.1 Guard extends above vent. (Major)

4.2 Cylinder well diameter is 14-7/8 in minimum. (Major)

4.3 Cylinder well inside height of 14-7/8 diameter section is 27-1/8 in minimum. (Major)

5. DRUM ASSEMBLY FUNCTIONAL INSPECTION.

5.1 Vent not plugged as determined by flow check. (Major)

5.2 Drum completely closed and opened successfully. (Major)

5.3 Drum tagged and dated to indicate inspection results satisfactory.
(Minor)

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PART B - CYLINDER SUPPORT (SPACER) FOR CONFIGURATION-1
INNER CONTAINER - MRC DRAWING NO. AYD740530

1. I D E N T I F I C A T I O N.

- 1.1 Note the Cylinder Support Serial Number on the Inspection Data Sheet.
- 1.2 Note the spacer manufacturer (vendor).

2. V E N D O R C E R T I F I C A T I O N.

- 2.1 Vendor has certified that cylinder support is manufactured per MRC Dwg. AYD740530 of the materials specified. (Major)

3. C Y L I N D E R S U P P O R T V I S U A L I N S P E C T I O N.

- 3.1 Workmanship acceptable and no sharp edges or burrs. (Critical)

4. C Y L I N D E R S U P P O R T F U N C T I O N A L I N S P E C T I O N.

- 1 Cylinder support fits into cylinder well and configuration-1 inner container fits into cylinder support. (Major)
- 4.2 Cylinder support tagged and dated to indicate inspection results satisfactory. (Minor)

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PART C- CONFIGURATION-1
INNER CONTAINER MRC DRAWING NO. AYD740426

1. IDENTIFICATION.

- 1.1 Note the Serial Number on the Inspection Data Sheet.
- 1.2 Note the manufacturer (vendor).

2. VENDOR CERTIFICATION AND TEST SAMPLES.

- 2.1 Vendor completed "Fabrication and Inspection Certification" Form No. MRC-ML5537. (Major)
- 2.2 Vendor weld sample satisfactory. (Major).

3. INNER CONTAINER VISUAL INSPECTION.

- 3.1 Compound gage is 30 in. vacuum/60 psig pressure. (Major)
- 3.2 Valve is 1/4 in. needle valve with pipe cap. (Major)
- 3.3 Silicone or viton o-ring with nominal 9-3/4 in. I.D. x 10 in. O.D. (Major)
- 3.4 O-ring groove and cover plate sealing surfaces free of nicks or scratches. (Major)
- 3.5 Workmanship acceptable and no sharp edges or burrs. (Critical)
- 3.6 Welds appear acceptable. (Major)
- 3.7 Inner container undamaged. (Major)

4. INNER CONTAINER DIMENSIONAL INSPECTION.

- 4.1 Cover plate thickness is 1/2 in. minimum. (Major)
- 4.2 Bottom plate thickness is 1/2 in. minimum. (Major)
- 4.3 Flange thickness is 1/2 $\pm$ 1/64 in. (Major)
- 4.4 Body wall thickness is 0.250 $\pm$ 0.005 in. (Major)

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- 4.5 Top ring, brace, and cross brace are $3/8 \pm 1/64$ in. diameter. (Major)
- 4.6 Socket head screws are stainless steel $5/16$ in. diameter x 18 threads per in. x 1 in. long. (Major)
- 4.7 Overall dimensions as specified per MRC Drawing AYD740426.

Total assembled height is $22-1/2 \pm 3/64$ in. (Major)

I.D. of body is 9.500 ± 0.005 in. (Major)

O.D. of top ring is $14-5/8 \pm 1/64$ in. (Major)

5. INNER CONTAINER FUNCTIONAL INSPECTION.

- 5.1 Valve operates properly. (Major)
- 5.2 Pressure gage operates properly. (Major)
- 5.3 Inner container completely disassembled and assembled satisfactorily. (Major)
- 5.4 Helium leak test performed with no detectable leak greater than 1×10^{-5} std. cm^3/sec when filled to 15 ± 1 psig helium.
- 5.5 Inner container tagged and dated to indicate inspection results satisfactory.

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PART D - CONFIGURATION-3
INNER CONTAINER MRC DRAWING NO. AYD740427

1. I D E N T I F I C A T I O N .

- 1.1 Note the Serial Number on the Inspection Data Sheet.
- 1.2 Note the manufacturer (vendor).

2. V E N D O R C E R T I F I C A T I O N A N D T E S T S A M P L E S .

- 2.1 Vendor completed "Fabrication and Inspection Certification" Form No. MRC-ML5537. (Major)
- 2.2 Vendor weld sample satisfactory. (Major).

3. I N N E R C O N T A I N E R V I S U A L I N S P E C T I O N .

- 3.1 Compound gage is 30 in. vacuum/60 psig pressure. (Major)
- 3.2 Valve is 1/4 in. needle valve with pipe cap. (Major)
- 3.3 Silicone or viton o-ring with nominal 13-1/8 in. I.D. x 13-3/8 in. O.D. (Major)
- 3.4 O-ring groove and cover plate sealing surfaces free of nicks or scratches. (Major)
- 3.5 Verify existence of "legs" with handle holes per Details 2A and 2B of MRC Drawing AYD740531 and "legs" on bottom of container per Details 4D and 4E of MRC Drawing AYD740532. (Major)
- 3.6 Workmanship acceptable and no sharp edges or burrs. (Critical)
- 3.7 Welds appear acceptable. (Major)
- 3.8 Inner container undamaged. (Major)

4. I N N E R C O N T A I N E R D I M E N S I O N A L I N S P E C T I O N .

- 4.1 Cover plate thickness is 1/2 in. minimum. (Major)
- 4.2 Bottom plate thickness is 3/8 in. minimum. (Major)

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- 4.3 Body wall thickness is 1/4 in. minimum. (Major)
- 4.4 Leg thickness is 1/4 in. minimum. (Major)
- 4.5 Helium leak test performed with no detectable leak greater than 1×10^{-5} std. cm³/sec when filled to 15 $\pm$ 1 psig helium. (Major)
- 4.6 Inner container tagged and dated to indicate inspection results satisfactory. (Major)
- 5. FINAL CONTAINER ASSEMBLY.
- 5.1 Weight of assembled container is 365 $\pm$ 25 lb. (Minor)
- 5.2 Shipping container functional assembly and disassembly satisfactory. (Major)

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PART E - CONFIGURATION-5
INNER CONTAINER MRC DRAWING NO. AYE740198

1. I D E N T I F I C A T I O N .

- 1.1 Note the container identification number on the inspection sheet.
- 1.2 Note the manufacturer (vendor).

2. V E N D O R C E R T I F I C A T I O N A N D T E S T S A M P L E S .

- 2.1 Vendor properly completed "Fabrication and Inspection Certification" Form No. MRC-ML6202. (Major)
- 2.2 Vendor weld sample satisfactory. (Major).
- 2.3 Vendor helium leak test accepted by MRC representative. (Major)

3. I N N E R C O N T A I N E R V I S U A L I N S P E C T I O N .

- 3.1 Pressure transducer is Precise Sensors, Inc., Model #70101-200 or MRC Engineering approved equal. (Major)
- 3.2 Valves are Nupro #SS-8BG-TSW. (Major)
- 3.3 Bail has shape which will self center lifting hook. (Minor)
- 3.4 Bottom dished cap does not protrude beyond bottom skirt ring. (Minor)
- 3.5 No protrusion of top closure nut, bail, or quick disconnect fittings above top lip of container cap. (Major)
- 3.6 O-ring sealing surfaces free of nicks or scratches. (Major)
- 3.7 "Radioactive Material" labels on top cap and container side are acceptable. (Major)
- 3.8 Container identification labels on top cap, container side, and container top are acceptable. (Major)
- 3.9 Welds appear acceptable. (Major)

3.10 Container undamaged. (Major)

3.11 Workmanship acceptable and no sharp edges or burrs. (Critical)

4. I N N E R C O N T A I N E R D I M E N S I O N A L I N S P E C T I O N .

4.1 Container with cap overall height 23.9 in. maximum. (Major)

4.2 Container diameter 6.685 in. maximum. (Major)

4.3 Cajon disconnect fittings center to center horizontal separation 4.31 ± 0.05 in. (Major)

4.4 Cajon disconnect fittings vertical separation between sealing surfaces 0.75 ± 0.05 in. (Major)

4.5 Primary container wall thickness 0.120 in. minimum. For example, as measured with ultrasonic technique. (Major)

5. I N N E R C O N T A I N E R F U N C T I O N A L I N S P E C T I O N .

5.1 Valves operate properly. (Major)

5.2 Pressure transducer functions properly. (Major)

5.3 Container protective cap removed and replaced satisfactorily. (Major)

5.4 Container fits into calorimeter sleeve satisfactorily. (Major)

5.5 Bail functions satisfactorily. (Minor)

5.6 Quick disconnect fittings function satisfactorily. (Major)

5.7 No detectable helium leak in primary container greater than 1×10^{-6} std. cm^3/sec at 15 psi pressure difference between interior and exterior. (Critical)

6. T A G .

6.1 Inner container tagged and dated to indicate satisfactory inspection results. (Major)

PART F - CONFIGURATION-5
INSULATING SLEEVE MRC DRAWING AYD760626

1. I D E N T I F I C A T I O N .

1.1 Note the fabricator (MRC or vendor) on the inspection sheet.

2. I N S U L A T I N G S L E E V E V I S U A L I N S P E C T I O N .

2.1 Firedike securely glued with no visible gaps. (Major)

2.2 Firedike not crushed or broken. (Major).

2.3 Workmanship acceptable and no sharp edges or burrs. (Major)

3. D I M E N S I O N A L I N S P E C T I O N .

3.1 Inside diameter: 6.75 in. minimum. (Major)
7.00 in. maximum. (Minor)

3.2 Outside diameter: 14.25 in. minimum. (Minor)
14.75 in. maximum. (Major)

3.3 Overall height 25.25 $\pm$ 0.25 in. (Major)

3.4 Well depth 24.25 in. minimum without pad. (Major)

4. T A G .

4.1 Sleeve tagged and dated to indicate satisfactory inspection results.
(Minor)

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AL-M1 INSULATED DRUM ASSEMBLY
ACCEPTANCE INSPECTION DATA SHEET

(MRC Drawing AYD740425 and
Ref. Section III, Part A of Drawing No. 1-14946)

1. I D E N T I F I C A T I O N .

- 1.1 Drum Identification _____
1.2 Vendor _____

2. V E N D O R C E R T I F I C A T I O N .

- 2.1 _____ Letter certifies specified items.
2.2 _____ Well hydrostatic test certified.

3. V I S U A L .

- 3.1 _____ Provision for security seal.
3.2 _____ Permanent head marking.
3.3 _____ Roolling hoops.
3.4 _____ Name tag.
3.5 _____ Blue exterior paint.
3.6 _____ Red Monsanto symbols.
3.7 _____ Workmanship OK and no sharp edges or burrs.
3.8 _____ RTV seal.
3.9 _____ No damage.

4. D I M E N S I O N A L .

- 4.1 _____ Guard above vent.
4.2 _____ Well diameter 14-7/8 in. minimum.
4.3 _____ Well depth 27-1/8 in. minimum.

5. F U N C T I O N A L .

- 5.1 _____ Vent open.
5.2 _____ Drum closed and opened successfully.
5.3 _____ Drum dated and tagged as OK.

COMMENTS

Signature of Inspector _____ Date _____

DISTRIBUTION: White - Nuclear QC
Yellow - Shipping Container Eng.
Pink - File

MRC-ML-4378

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SPACER FOR AL-M1 CONFIGURATION-1
ACCEPTANCE INSPECTION DATA SHEET

(MRC Drawing AYD740530 and
Ref. Section III, Part B of Drawing No. 1-14946)

1. IDENTIFICATION.

1.1 _____ Serial number.

1.2 _____ Vendor.

2. VENDOR CERTIFICATION.

2.1 _____ Materials as specified.

3. VISUAL.

3.1 _____ Workmanship OK and no sharp edges or burrs.

4. FUNCTIONAL.

4.1 _____ Spacer fits into drum well and inner container fits into spacer.

4.2 _____ Spacer dated and tagged as OK.

COMMENTS

Signature of Inspector _____ Date _____

DISTRIBUTION: White - Nuclear QC
Yellow - Shipping Container Eng.
Pink - File

MRC-ML-6373

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INNER CONTAINER FOR AL-M1 CONFIGURATION-1
ACCEPTANCE INSPECTION DATA SHEET

Ref. MRC Drawing No. AYD740426 and
Section III, Part C of Drawing No. 1-14946

1. I D E N T I F I C A T I O N

1.1 _____ Serial number.

1.2 _____ Vendor.

2. V E N D O R C E R T I F I C A T I O N.

2.1 _____ Form 6202 completed.

2.2 _____ Weld sample acceptable.

3. V I S U A L.

3.1 _____ Gage is 30 in. vac/60 psig.

3.2 _____ Valve is 1/4 in. needle with pipe cap.

3.3 _____ O-ring is nominal 9 3/4 in. I.D. x 10 in. O.D.

3.4 _____ O-ring sealing surfaces OK.

3.5 _____ Workmanship OK and no sharp edges or burrs.

3.6 _____ Welds appear acceptable.

3.7 _____ Inner container undamaged.

4. D I M E N S I O N A L.

4.1 _____ Cover plate 1/2 in. thick, minimum.

4.2 _____ Bottom plate 1/2 in. thick, minimum.

4.3 _____ Flange 1/2 $\pm 1/64$ in.

4.4 _____ Body wall thickness 0.250 ± 0.005 in.

4.5 _____ Top ring and braces 3/8 $\pm 1/64$ in. diameter.

4.6 _____ Stainless socket head screws 5/16 x 18 x 1.

4.7 _____ Overall height 22-1/2 $\pm 3/64$ in., body I.D. 9.500 ± 0.005 , top ring O.D. 14-5/8 $\pm 1/64$ in.

5. F U N C T I O N A L.

5.1 _____ Valve operate properly.

5.2 _____ Pressure gage operates properly.

5.3 _____ Disassembled and assembled satisfactorily.

5.4 _____ No He Leak greater than 1×10^{-5} at 15 psig.

5.5 _____ Dated and tagged as OK.

COMMENTS

Signature of Inspector _____

Date _____

MRC-ML4374

DISTRIBUTION: White - Nuclear OC

Yellow - Shipping Container Eng.

Pink - File

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INNER CONTAINER FOR AL-M1 CONFIGURATION-3
ACCEPTANCE INSPECTION DATA SHEET

Ref. MRC Drawing No. AYD740427 and
Section III, Part D of Drawing No. 1-14946

1. I D E N T I F I C A T I O N .

1.1 _____ Serial number.

1.2 _____ Vendor.

2. V E N D O R C E R T I F I C A T I O N .

2.1 _____ Form 6202 completed.

2.2 _____ Weld sample acceptable.

3. V I S U A L .

3.1 _____ Gage is 30 in. vac/60 psig.

3.2 _____ Valve is 1/4 in. needle with pipe cap.

3.3 _____ O-ring nominal I.D. 13 1/8 in. and O.D. 13 3/8 in.

3.4 _____ O-ring sealing surfaces OK.

3.5 _____ "Legs" as specified.

3.6 _____ Workmanship OK and no sharp edges or burrs.

3.7 _____ Welds appear acceptable.

3.8 _____ Inner container undamaged.

4. D I M E N S I O N A L .

4.1 _____ Cover plate 1/2 in. thick, minimum.

4.2 _____ Bottom plate 3/8 in. thick, minimum.

4.3 _____ Body wall 1/4 in. thick, minimum.

4.4 _____ Leg 1/4 in. thick, minimum.

4.5 _____ No He leak greater than 1×10^{-5} at 15 psig.

4.6 _____ Dated and tagged as OK.

5. F I N A L A S S E M B L Y .

5.1 _____ Assembled weight 365 $\pm$ 25 lb.

5.2 _____ Functional assembly and disassembly OK.

COMMENTS

Signature of Inspector _____ Date _____

DISTRIBUTION: White - Nuclear QC
Yellow - Shipping Container Eng.
Pink - File

MRC-ML-6375

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INSULATING SLEEVE FOR AL-M1 CONFIGURATION-5
ACCEPTANCE INSPECTION DATA SHEET

(Ref. MRC Drawing No. AYD 760626 and
Section III, Part F of Drawing No. 1-14946)

1. I D E N T I F I C A T I O N.

1.1 _____ Fabricator or vendor.

2. V I S U A L.

2.1 _____ Firedike well glued with no gaps.

2.2 _____ Firedike not crushed.

2.3 _____ Workmanship acceptable and no sharp edges or burrs.

3. D I M E N S I O N A L.

3.1 _____ I.D. 6.75 in., minimum and 7.00 in. maximum.

3.2 _____ O.D. 14.25 in., minimum and 14.75 in. maximum.

3.3 _____ Overall height 25.25 ± 0.25 in.

3.4 _____ Well depth 24.00 in., minimum.

4. T A G.

4.1 _____ Dated and tagged as OK.

COMMENTS

Signature of Inspector _____ Date _____

DISTRIBUTION: White - Nuclear QC
Yellow - Shipping Container Eng.
Pink - File

MRC-ML-6376

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INNER CONTAINER FOR AL-M1 CONFIGURATION-5
ACCEPTANCE INSPECTION DATA SHEETRef. MRC Drawing No. AYE740198 and
Section III, Part E of Drawing No. 1-149461. IDENTIFICATION.

- 1.1 Identification number _____
- 1.2 Vendor _____

2. VENDOR CERTIFICATION.

- 2.1 _____ Form 6202 completed.
- 2.2 _____ Weld sample acceptable.
- 2.3 _____ Vendor He leak test accepted.

3. VISUAL.

- 3.1 _____ Pressure transducer is Model #70101-200.
- 3.2 _____ Valves Nupro #SS-8BG-TSW.
- 3.3 _____ Bail shaped to take lifting hook.
- 3.4 _____ Bottom dished cap does not protrude.
- 3.5 _____ No protrusions above top lip of cap.
- 3.6 _____ O-ring sealing surfaces satisfactory.
- 3.7 _____ "Radioactive Material" labels on side and cap top.
- 3.8 _____ I.D. labels on side, vessel top, and cap top.
- 3.9 _____ Welds appear acceptable.
- 3.10 _____ Container undamaged.
- 3.11 _____ Workmanship acceptable and no sharp edges or burrs.

4. DIMENSIONAL.

- 4.1 _____ Overall height 23.9 in., maximum.
- 4.2 _____ Diameter 6.685 in., maximum.
- 4.3 _____ Cajon center to center 4.31 ±0.05 in.
- 4.4 _____ Cajon vertical separation 0.75 ±0.05 in.
- 4.5 _____ Vessel wall 0.120 in. thick, minimum.

5. FUNCTIONAL.

- 5.1 _____ Valves operate properly.
- 5.2 _____ Pressure transducer functions properly.
- 5.3 _____ Cap removed and replaced satisfactorily.
- 5.4 _____ Container fits into calorimeter sleeve.
- 5.5 _____ Bail functions satisfactorily.
- 5.6 _____ Quick disconnects function properly.
- 5.7 _____ No He leak greater than 1×10^{-6} at 15 psig.

6. TAG.

- 6.1 _____ Dated and tagged as acceptable.

COMMENTS

Signature of Inspector _____ Date _____

DISTRIBUTION: White - Nuclear QC
Yellow - Shipping Container Eng.
Pink - File

MRC-ML-8377

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Issue BMONSANTO RESEARCH CORPORATION
MOUND LABORATORY**SHIPPING CONTAINER**
OPERATION SHEET

PROGRAM Reusable Radioactive Shipping Containers		SHEET 1 of 1	MANUAL NUMBER MD-70152	OPERATION 3
AUTHORIZATION <i>W.T. Carr</i>	CLASSIFICATION Unclassified	EXPIRATION 9-26-77	EQUIPMENT INCORPORATED M4-C	
OPERATION TITLE Use Inspection and Loading of AL-M1 Configuration 1 or 3				

USE INSPECTION

New _____ Reuse _____ Configuration (1 or 3) _____ Serial No. _____

I. CONTAMINATION LEVEL ACCEPTABLE (REUSE ONLY) _____ Initials _____ Date _____

II. CHECK LIST

The following inspections and/or actions are required. Do not check off any item until indication action is completed and any defect found has been corrected. Indicate repair by the letters Rpr and replacement by the letters Rpl. A simple check mark is satisfactory to indicate completion of an inspection or action. Enter NA if the inspection or action does not apply.

A. Insulated Drum Assembly

1. Labels, adhesives, etc. removed _____	8. Vent _____
2. Vinyl emblem _____	9. Closure ring _____
3. Paint _____	10. Closure bolt _____
4. Identification plate _____	11. Interior dry and clean _____
5. Tie-down brackets _____	12. Vent not plugged _____
6. Security seal bracket _____	13. Assembles properly _____
7. Welds _____	

B. Cylinder Support (Configuration 1)

1. Clean and undamaged _____
2. Functional fit (drum and inner container) _____

C. Inner Container (Configuration 1 and 3)

1. No physical damage _____	7. Braces and fixtures _____
2. Gage _____	8. No nicks or scratches in sealing surfaces _____
3. Valve _____	9. Valve operational _____
4. O-ring _____	10. Pressure gage operational _____
5. Cap screws _____	11. Passes helium leak test (1 x 10 ⁻⁵ std cc/sec at 15 psig) _____
6. Welds _____	

Signature _____ Date _____

LOADING PROCEDURE

1. Radioactive material form (solid, liquid or gas).	_____
2. Check and lubricate inner container O-ring.	_____
3. Close and cap inner container check valve(s).	_____
4. Place sketch within insulated drum.	_____
5. Close drum.	_____
6. Install lead wire seal.	_____
7. Apply labels (Radioactive).	_____

Signature _____ Date _____

DISTRIBUTION:

White	- Container File
Yellow	- Nuclear QC
Goldseal	- Shipper File
Pink	- Originator

MNC-ML-128

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MONSANTO RESEARCH CORP
MOUND LABORATORY

SHIPPING CONTAINER

OPERATION SHEET

PROGRAM REUSABLE RADIOACTIVE SHIPPING CONTAINERS		SHEET 7 of 1	MANUAL NUMBER MD-70152	OPERATION 14
AUTHORIZATION <i>Art. 117</i>	CLASSIFICATION Unclassified	EFFECTIVITY 9-26-77	ECHM INCORPORATED M4-C	
OPERATION TITLE Use Inspection and Loading of AL-M1 Configuration 5				

1. IDENTIFICATION

1.1. Inner container serial number _____ and date of last interior surface evaluation _____

1.2. Outer container serial number _____

1.3. Received from _____

1.4. The following inspections and/or actions are required. Do not check off an item until the indicated action is completed and any defect found has been corrected. Indicate repair by the letter Rpr and replacement by the letter Rpl. A simple check mark is satisfactory to indicate completion of an inspection or action. Enter NA if the inspection or action does not apply.

2. INNER CONTAINER

2.1. _____ Less than 5 years since last interior surface evaluation.

2.2. _____ Regeneration temperature of sorbent.

2.3. _____ Date of regeneration.

2.4. _____ Grams of water loaded.

2.5. _____ Date loaded.

2.6. _____ Ci of tritium loaded (best estimate).

2.7. _____ Primary containment leak checked and no leak through valve.

2.8. _____ Pressure transducer operational. Primary container pressure no more than 1 atm absolute.

2.9. _____ Valves operational and closed.

2.10. _____ Capon fitting interior dry (e.g., by evacuation).

2.11. _____ Valves capped.

2.12. _____ Exterior surfaces decontaminated.

2.13. _____ No physical damage.

2.14. _____ Welds OK.

2.15. _____ No nicks or scratches in sealing surfaces.

2.16. _____ O-rings dry, grease free, and in good condition.

2.17. _____ Protective cover installed.

2.18. _____ Cover pressurized to 20 psig. No pressure decrease in 30 minutes.

2.19. _____ Cover interior produces less than 100 uCi/m³ on tritium monitor when pressure released through monitor.

2.20. _____ Gross weight with cover.

3. INSULATING SLEEVE

3.1. _____ Clean and undamaged.

3.2. _____ Surface wipes less than 1000 DPM/g.

3.3. _____ Carawool pad in bottom of well in good condition.

3.4. _____ Large and small diameter Carawool pads placed on top of inner container, in good condition.

3.5. _____ Sketch and form packed above Carawool pads.

4. INSULATING DRUM ASSEMBLY

4.1. _____ Paint and vinyl emblem.

4.2. _____ Identification plate.

4.3. _____ Tie-down brackets (as applicable).

4.4. _____ Security seal bracket.

4.5. _____ Welds

4.6. _____ Vent not damaged or plugged.

4.7. _____ Interior dry and clean.

4.8. _____ Assembles properly.

4.9. _____ Closure ring and bolt.

4.10. _____ Old labels, adhesives, etc., removed and correct new labels applied.

DISTRIBUTION

White - Container File
Yellow - Nuclear QC
Gold/leaded - Shipper File
Pink - Originator

Signature _____
Date _____

MSC-84-128

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FSCM NO.: 14065
 REVISION NO: ACO870980MD-II
 DATE: MAY 29, 1987
 ENGINEER: M. WILLIAMS, MD
 DES. MGR: F. MORRIS, MD

1-14841

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PROGRAM: NUCLEAR PACKAGING CONTAINER
 TITLE: WELDING & INSPECTION OF 300 SERIES STAINLESS STEEL CONTAINERS

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1. GENERAL.

- 1.1 Scope. This specification defines requirements for welding, visual, dye penetrant, and radiographic examinations of the welds; helium leak testing to ensure leak tight welds, fittings, and closures; and certification to ensure that all requirements have been met. This specification applies to 300 series stainless steel containers with wall thickness of 0.05 to 0.25 in. and is a supplement to the container drawings.
- 1.2 All sections of this specification must be complied with unless specifically exempted in writing. Compliance with this specification does not relieve the vendor of the responsibility for quality results.

2. WELDING.

- 2.1 Welding process to be used -- Gas Tungsten Arc ("GTA" was formerly called "TIG").
- 2.2 Welding filler material - The specific welding filler material to be used depends on the particular type of stainless steel base metal and shall be used as specified below:

Type of Stainless Steel Base Metal (AISI)	Specified Welding Filler Material (AWS-ASTM Classification)
301, 302, 304, 308	ER308
304L	ER308L
309	ER309
310	ER310
316	ER316
316L	ER316L
317	ER317
330	ER330
321	ER321 or ER347
347	ER347

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- 2.3 Shielding gas - Welding grade argon or helium shall be used on the welding torch and on the underside of the weld to completely protect the weld and hot base metal from the room atmosphere.
- 2.4 Welding current - Direct current straight polarity welding current shall be used.
- 2.5 Cleaning procedures - The base material at and adjacent to the weld joint and the filler material shall be cleaned prior to welding using the following procedures:
- 2.5.1 Lightly hand sand with 220 grit garnet paper.
- 2.5.2 Clean with acetone or MEK on a clean cloth followed by reagent grade isopropyl alcohol on a clean cloth.
- 2.5.3 Blow off all lint with clean shop air.
- 2.5.4 Maintain this state of cleanliness until the welds are completed.
- 2.6 Welds - The fillet weld shall have continuous complete fusion at the root of the weld joint. The butt weld shall have continuous complete penetration through the tube wall. (Standard AWS welding symbols have been used on the drawing.)
- 2.7 Welding operator qualifications - It shall be the responsibility of the vendor to assure that the assigned welding operators are competent, experienced and qualified to perform GTA welding on 300 series stainless steel.
- 2.8 Sample - The vendor shall submit one weld sample using the GTA welding process as specified, certified to be of the quality and appearance of welding to be performed on the containers. The sample must be welded simulating job conditions.
- The sample will be used by MRC as a reference for acceptance or rejection of the material and workmanship.
- 2.9 Heat treatment - Containers fabricated of 316 or 317 stainless steel must be given a full anneal at 1950 to 2050°F and containers fabricated of 316L stainless steel must be stress relieved at 1600°F ±30°F after welding. Since the purpose of the heat treatments is to obtain maximum corrosion resistance in the welds and the base metal adjacent to the welds, the heat treatment may be eliminated if the buyer has specifically stated that it is not necessary for the intended application.

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3. VISUAL EXAMINATIONS.

- 3.1 A detailed visual inspection of each entire weld shall be made using magnifying equipment with a 4X to 20X magnification reading glass. Any defect greater than those listed in 3.2 to 3.7 shall be cause for rejection.
- 3.2 Cracks - There shall be no cracks in the welds or in the adjacent base metal.
- 3.3 Surface Pores - There shall be no surface pores greater than 0.012 in. diameter.
- 3.4 Surface Contour - The surface of the weld shall be uniform in appearance.
- 3.5 Weld Size - The fillet weld shall be gaged to assure that it meets or exceeds the drawing requirement.
- 3.6 Overlaps - There shall be no cold overlaps on the base metal.
- 7 Undercuts - There shall be no undercuts.

4. DYE PENETRANT EXAMINATION.

- 4.1 A detailed fluorescent dye penetrant examination of each entire weld shall be made. Any defect greater than those listed in 4.2 and 4.3 shall be cause for rejection.
- 4.2 Cracks - There shall be no crack indications in the welds or adjacent base metal.
- 4.3 Surface Pores - There shall be no surface pores greater than 0.012 in. diameter.
- 4.4 Dye penetrant examination to be made prior to exterior surface finishing such as glass bead finishing.

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5. RADIOGRAPHIC EXAMINATION.

- 5.1 A detailed radiographic inspection shall be made on each weld utilizing either x-rays or gamma rays to detect discontinuities on the interior of the weld. Two percent penetrameters shall be employed to verify the radiographic quality level of each procedure. Any defect greater than those listed in 5.2 through 5.6 shall be cause for rejection.
- 5.2 Cracks - There shall be no cracks in the welds or in the adjacent base metal.
- 5.3 Lack of Fusion - There shall be no indications of lack of fusion in the weld.
- 5.4 Incomplete Penetration - There shall be no evidence of lack of weld joint penetration.
- 5.5 Tungsten Inclusions - Tungsten inclusions shall be evaluated the same as porosity.
- 6 Porosity - The following are the acceptance criteria for internal weld porosity. All pores must be generally circular in shape with no sharp corners or tails. There shall be no radiographically detectable pore with a diameter greater than 40% of the thickness, t , of the thinnest member. The total projected area of all the pores in one inch of weld length shall not exceed 5% of the vertical cross sectional area of t square inches (1 inch length times the thickness, t , of the thinnest member of base metal).

6. HELIUM LEAK TEST.

- 6.1 The container shall be successfully helium leak tested in the presence of an MRC representative.
- 6.2 The vendor shall establish that he can obtain the services of a qualified, experienced operator and the equipment to conduct the helium leak test.
- 6.3 All welds, valves and fittings must have no detectable leak greater than 1×10^{-7} (STP) cc/sec.

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- 6.3.1 Leak testing shall be performed using both the helium envelope and sniffer probe techniques.
- 6.3.2 An elastomer o-ring (such as viton) seal must have no detectable leak greater than 1×10^{-7} (STP) cc/sec. The entire container with this type of seal must not leak more than 1×10^{-7} (STP) cc/sec.
- 6.3.3 A metal o-ring seal (or similar metal to metal seal) must have no detectable leak greater than 1×10^{-5} (STP) cc/sec. The entire container with this type of seal must not leak more than 1×10^{-5} (STP) cc/sec.
- 6.4 The leak detector used for the test must be standardized just prior to the test against a standard leak tube in the appropriate range.
- 6.5 When the sniffer probe technique is used, the atmosphere within the container must be at least 95% helium at a minimum pressure of 15 psi above atmospheric pressure (psig). This atmosphere shall be established by evacuating and back filling with helium.

C E R T I F I C A T I O N .

- 7.1 The "Fabrication and Inspection Certification" form (MRC-ML-6202) shall be completed by an appropriate vendor representative and transmitted to MRC Engineering. This shall constitute certification of the container meeting minimum requirements.
- 7.2 The "Fabrication and Inspection Certification" Sheet 6, shall be signed and dated when all the necessary operations for that particular item have been completed. It is intended that the inspection will be performed in the sequence listed.

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300 SERIES STAINLESS STEEL CONTAINERS
FABRICATION AND INSPECTION CERTIFICATION

CONTAINER IDENTIFICATION NUMBER _____

CONTAINER DRAWING NO. _____

FABRICATED BY _____

NAME OF WELDER _____

	<u>SIGNATURE</u>	<u>DATE COMPLETED</u>
I.		
1. Component and materials as specified.	_____	_____
2. Welded as specified (Section 2).	_____	_____
3. Visual weld examination acceptable (Section 3).	_____	_____
4. Dye penetrant examination acceptable (Section 4).	_____	_____
5. Radiographic examination acceptable (Section 5).	_____	_____
6. Dimensions as specified.	_____	_____
7. O-ring surface finish as specified.	_____	_____
8. Container can be assembled properly.	_____	_____
9. Helium leak test acceptable (Section 6).	_____	_____
10. Container tagged and dated to indicate inspection results satisfactory.	_____	_____
II.		
Vendor review and approval	_____	_____

MRC-ML-6202

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DISTRIBUTION

External

DOE, Albuquerque Operations Office (12)

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