OCT 07 1996
Sta. 37 (20)

ENGINEERING DATA TRANSMITTAL

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5. Proj./Prog./Dept./Div.: 84100	6. Design Authority/ Design Agent/Cog. Engr.: H. E. Adkins, Jr.	7. Purchase Order No.: NA
8. Originator Remarks: The attached safety evaluation for packaging is being submitted for approval and release.		9. Equip./Component No.: NA
		10. System/Bldg./Facility: B Plant
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15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-TP-SEP-050	NA	0	Safety Evaluation for Packaging for Onsite Transfer of B Plant Organic Waste	SQ	1,2	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
1	1	Design Authority JG Field		10/3/96	G1-11	1	1	J Greenborg		10/7/96	H0-35
1	1	Design Agent JG Field		10/3/96	G1-11	1	1	SS Shiraga		10/3/96	G1-11
1	1	Cog.Eng. HE Adkins, Jr.			G1-11	1	1	MM Serkowski		10/3/96	S4-66
1	1	Cog. Mgr. JG Field		10/3/96	G1-11						
1	1	QA CR Hoover		10/3/96	G1-11						
1	1	Safety DW McNally		10/7/96	G1-11						
1	1	RL Clawson		10/3/96	G1-13						
1	1	JR Green		10/3/96	G1-11						

18.	19.	20.	21. DOE APPROVAL (if required)
H. E. Adkins, Jr. — 10/3/96 Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	J. G. Field — 10/3/96 Design Authority/ Cognizant Manager / Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

Safety Evaluation for Packaging for Onsite Transfer of B Plant Organic Waste

H. E. Adkins, Jr.
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 618183 UC: 513
Org Code: 84100 Charge Code: KN38B
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Key Words: tank, radioactive organic liquid waste, organic loading pad, storage pad

Abstract: This safety evaluation for packaging authorizes the use of a 17,500-L (4,623-gal) tank manufactured by Brenner Tank, Incorporated, to transport up to 16,221 L (4,285 gal) of radioactive organic liquid waste. The waste will be transported from the organic loading pad to a storage pad. Both pads are within the B Plant complex, but approximately ¼ mi apart.

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OCT 07 1996
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Release Approval Date

Release Stamp

Approved for Public Release

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CONTENTS

PART A: DESCRIPTION AND OPERATIONS

CONTENTS (cont.)

PART B: PACKAGE EVALUATION

CONTENTS (cont.)

LIST OF TABLES

LIST OF TERMS

ALARA	as low as reasonably achievable
μCi/mL	microcuries per milliliter
Ci	curie
Ci/g	curies per gram
cm	centimeter
cm^3	cubic centimeter
cm^3/h	cubic centimeters per hour
DOT	U.S. Department of Transportation
dpm/cm^2	disintegrations per minute per square centimeter
ft	foot
g	gram
gal	gallon
g/cm^3	grams per cubic centimeter
in.	inch
ISO	International Standards Organization
kg	kilogram
L	liter
lb	pound
LSA	low specific activity
km/h	kilometers per hour
kPa	kilopascal
m	meter
MeV	megaelectronvolts
MPa	megapascal
mph	miles per hour
mrem/h	millirem per hour
mSv/h	millisevert per hour
MTIU	metric tonne of initial uranium
oz	ounce
psi	pounds per square inch
psig	pounds per square inch gage
rem/h	rem per hour
SEP	safety evaluation for packaging
SI	standard international system of units
W	watt

SAFETY EVALUATION FOR PACKAGING FOR ONSITE TRANSFER OF B PLANT ORGANIC WASTE

PART A: DESCRIPTION AND OPERATIONS

1.0 INTRODUCTION

1.1 GENERAL INFORMATION

The purpose of this safety evaluation for packaging (SEP) is to authorize the use of a 17,500-L (4,623-gal) tank manufactured by Brenner Tank, Incorporated, to transport up to 16,221 L (4,285 gal) of radioactive organic liquid waste. This liquid waste was originally stored in cells 27 and 28 within the B Plant canyon. The tank containing the waste will be transported from the organic loading pad to a storage pad. Both pads are within the B Plant complex, but approximately ¼ mi apart. The tank was previously certified for offsite shipment of low specific activity material as is presented in Part A, Section 2.1, of this SEP; however, the tank has since been modified to allow for passive venting during storage. The tank will be sealed during any transport operations.

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2.0 PACKAGING SYSTEM

2.1 CONFIGURATION AND DIMENSIONS

The tank assembly was manufactured by Brenner Tank, Incorporated. It consists of a cylindrical tank shell with hemispherical heads and an International Standards Organization (ISO) twist-lock-compatible frame assembly. The twist-lock corner fittings provide a means for tiedown and mate with corresponding fittings on an ISO-compatible trailer. The tank modifications include the addition of two filtered vents that will bolt to existing flanges. In its original configuration, the tank met the requirements of the *Specification for ISO Tank Container Greater than 1000 Gallons Internal Volume for Shipment of Nitrating Liquids Greater than 50% Nitric Acid* (WHC 1994) and was certified by the American Bureau of Shipping to meet the following codes, specifications, and performance criteria (the certification is presented in Part A, Section 10.0):

- American Bureau of Shipping rules for the certification of cargo containers
- International Convention for Safe Containers
- International Maritime Dangerous Goods Code for International Maritime Organization Type 1 (Type 1 portable tanks)
- International Regulation Concerning the Carriage of Dangerous Goods Code/European Agreement Concerning International Transportation of Dangerous Goods by Rail
- American Association of Railroads 600
- Customs/Transportation International Routier
- U.S. Department of Transportation (DOT) Specification 51 (49 CFR 178.245)
- Transport Canada 51
- Design temperatures -28.8 °C (-20 °F) to 121 °C (+250 °F)
- Design pressure 0.69 MPa (100 psig)
- Test pressure 1.06 MPa (154 psig).

Dimensions are as follows:

- Outside shell length (includes heads): 591.66 cm (232 15/16 in.)
- Outside shell diameter: 200.57 cm (78.965 in.)
- Shell thickness (minimum): 0.75 cm (0.295 in.)
- Head thickness (minimum): 1.11 cm (0.438 in.)
- Capacity (maximum): 17,500 L (4,623 gal).

The modifications consist of the following:

- Adding a 30.48-cm- (12-in.-) square Flanders Nuclear Grade Super Flow high-efficiency particulate air filter (Model N2N2, Size CC-D) to the existing air inlet valve
- Adding 12.7-cm- (5-in.-) long, 6.35-cm- (2.5-in.-) inside diameter extension from the air inlet valve into the interior of the tank
- Replacing the pressure vent assembly with a valve and filter (same valve and filter used on the air inlet valve, but with no extension into the tank)
- Adding a hydrogen vent to the top of the large and small spilldam assemblies.

2.2 MATERIALS OF CONSTRUCTION

The tank shell is constructed of 304 or 304L stainless steel. The frame assembly is constructed from various grades of carbon or high-strength low-alloy steel.

2.3 DESIGN AND FABRICATION METHODS

The tank assembly was designed and fabricated per ASME (1992).

2.4 WEIGHTS AND CENTER OF GRAVITY

The center of gravity of the loaded tank is assumed to be at the geometric center of the shell. The maximum gross weight per the certificate of approval (see Part A, Section 10.0) is 30,480 kg (67,200 lb). Actual weights will be less and are approximately as follows:

- Tank assembly: 4,604 kg (10,150 lb)
- Payload (conservatively assumes 17,500 L [4,623 gal] and a specific gravity of 1): 25,876 kg (38,581 lb).

2.5 CONTAINMENT BOUNDARY

The containment boundary consists of the following:

- Shell walls and heads
- 69.85-cm (27.5-in.) blind manhole flange
- 3.81-cm (1.5-in.) blind top discharge flange
- Blind process control flange

- Air inlet valve
- Valve that will bolt to the flange for the pressure vent/telltale gauge/burst disc assembly (this valve will be identical to the valve used on the air inlet valve).

2.6 VOLUME (CAVITY SIZE)

The tank has a capacity of 17,500 L (4,623 gal). Maximum allowable waste volume will be 16,221 L (4,285 gal).

2.7 HEAT DISSIPATION

There are no special features required to dissipate heat. Passive heat dissipation is sufficient (see Part B, Section 7.0).

2.8 SHIELDING

Shielding is provided by the tank shell and heads. See Part B, Section 4.0, for dose rates.

2.9 LIFTING DEVICES

There are four twist-lock attachments at the top corners of the frame assembly.

2.10 TIEDOWN DEVICES

The tank will be attached to the trailer via the four twist-lock fittings on the bottom of the frame assembly.

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3.0 PACKAGE CONTENTS

3.1 GENERAL DESCRIPTION

The tank is authorized for up to 16,221 L (4,285 gal) of radioactive organic liquid waste from the B Plant canyon.

3.2 CONTENTS RESTRICTIONS

The isotopic content contained in the liquid is limited to that presented in Table A3-1. There shall be no additional radioactive or hazardous component contained within the liquid.

Table A3-1. B Plant Organic Waste Source Term. (2 sheets total)

Isotope	Alpha yield	Beta yield	Ci/MTIU 12% N fuel	Adjusted activity (µCi/mL)	Reduced Cs activity (µCi/mL)	Total activity (Ci)
^{85}Kr		1.000	5.03 E+02	6.49 E-01	6.49 E-01	1.13 E+01
^{90}Sr		1.000	5.78 E+03	7.45 E+00	7.45 E+00	1.30 E+02
^{90}Y		1.000	5.78 E+03	7.45 E+00	7.45 E+00	1.30 E+02
^{93}Zr		1.000	1.71 E-01	2.21 E-04	2.21 E-04	3.84 E-03
^{99}Tc		1.000	1.26 E+00	1.62 E-03	1.62 E-03	2.83 E-02
^{106}Ru		1.000	5.23 E+01	6.75 E-02	6.75 E-02	1.18 E+00
^{106}Rh		1.000	5.23 E+01	6.75 E-02	6.75 E-02	1.18 E+00
^{113m}Cd			2.35 E+00	3.04 E-03	3.04 E-03	5.29 E-02
^{125}Sb		0.999	1.25 E+02	1.61 E-01	1.61 E-01	2.80 E+00
^{125m}Te			3.04 E+01	3.92 E-02	3.92 E-02	6.83 E-01
^{134}Cs		1.000	1.27 E+02	1.64 E-01	1.21 E-02	2.10 E-01
^{137}Cs		1.000	7.29 E+03	3.89 E+00	2.86 E-01	4.98 E+00
^{137m}Ba			6.90 E+03	3.68 E+00	2.71 E-01	4.71 E+00
^{144}Ce		1.015	2.79 E+01	3.60 E-02	3.60 E-02	6.26 E-01
^{144}Pr		1.000	2.79 E+01	3.60 E-02	3.60 E-02	6.26 E-01
^{144m}Pr			3.35 E-01	4.32 E-04	4.32 E-04	7.52 E-03
^{147}Pm		1.000	1.96 E+03	2.52 E+00	2.52 E+00	4.39 E+01
^{151}Sm		1.000	8.95 E+01	1.15 E-01	1.15 E-01	2.01 E+00
^{152}Eu		0.710	6.51 E-01	8.41 E-04	8.41 E-04	1.46 E-02
^{154}Eu		1.000	8.80 E+01	1.14 E-01	1.14 E-01	1.98 E+00
^{155}Eu		1.010	3.48 E+01	4.49 E-02	4.49 E-02	7.82 E-01
^{234m}Pa		1.001	3.32 E-01	1.52 E-06	1.52 E-06	2.65 E-05
^{234}Th		1.000	3.32 E-01	1.52 E-06	1.52 E-06	2.65 E-05
^{234}U	1.000		4.23 E-01	1.9 E-06	1.94 E-06	3.38 E-05
^{237}U		1.010	1.09 E-01	5.00 E-07	5.00 E-07	8.71 E-06

Table A3-1. B Plant Organic Waste Source Term. (2 sheets total)

^{238}U	1.002		3.32 E-01	1.52 E-06	1.52 E-06	2.65 E-05
^{238}Pu	1.000		4.77 E+01	2.19 E-04	2.19 E-04	3.81 E-03
^{239}Pu	0.999		1.10 E+02	5.05 E-04	5.05 E-04	8.79 E-03
^{240}Pu	1.000		5.82 E+01	2.67 E-04	2.67 E-04	4.65 E-03
^{241}Pu	0.000	1.000	4.45 E+03	2.04 E-02	2.04 E-02	3.55 E-01
^{241}Am	1.000		9.29 E+01	4.26 E-04	4.26 E-04	7.42 E-03
^{242m}Am	0.005		1.08 E-01	4.96 E-07	4.96 E-07	8.64 E-06
^{242}Am		0.827	1.08 E-01	4.93 E-07	4.93 E-07	8.59 E-06
Total activity						3.37 E+02
Total beta		2.64 E+04 Ci		2.28 E+01	1.90 E+01	3.32 E+02
Total alpha		3.10 E+02 Ci		1.42 E-03	1.42 E-03	2.47 E-02

MTIU = Metric tonne of initial uranium.

4.0 TRANSPORT SYSTEM

4.1 TRANSPORT VEHICLE

The tank shall be transported on a trailer of appropriate capacity for the maximum gross package weight. The trailer shall have twist-lock devices that interlock with the twist-lock fasteners on the package.

4.2 TIEDOWN SYSTEM

Tiedown shall be via the twist-lock fasteners.

4.3 SPECIAL TRANSFER REQUIREMENTS

The following special transfer requirements shall be met.

- Only up to 16,221 L (4,285 gal) of radioactive organic liquid waste will be allowed. This is to provide proper inner ventilation space during storage.
- The section of the road on which the shipment will be transported shall be closed to the public and nonessential workers.
- All workers involved in transport, including the driver, shall be qualified Hanford Site radiological workers.
- Dose rates shall be below 2.0 mSv/h (200 mrem/h) at the surface of the vehicle, 0.10 mSv/h (10 mrem/h) at 2.0 m (6.56 ft) from the vehicle edge, and 0.05 mSv/h (5 mrem/h) at the driver location or any normally occupied space provided the worker is a Hanford Site radiological worker.
- The 2.0-m (6.56-ft) dose rate may exceed the limit of 0.10 mSv/h (10 mrem/h) and may be up to 0.35 mSv/h (35 mrem/h) provided all special requirements above are met (roads closed to public and nonessential workers, qualified radiological workers only).
- When stationary, the controls specified in HSRCM-1, *Hanford Site Radiological Control Manual*, apply, including any posting for personnel exclusion areas.
- The transport vehicle shall conform to DOT annual inspection requirements found in 49 CFR 396.3, "Inspection, Repair, and Maintenance," and 49 CFR 396.17, "Periodic Inspection."
- Prior to loading of tank and subsequent transport, the tank assembly (tank and frame including twist-locks) shall be visually inspected to ensure that there is no damage or deterioration.
- Transport vehicle speed will be limited to 48.3 km/h (30 mph) unless a lower speed is posted.

- The tank will not be transferred during periods of inclement weather; i.e., winds in excess of 48.3 km/h (35 mph), heavy rain, blowing dust or fog that results in poor visibility, or slippery roads.
- The requirements of WHC-CM-2-14, *Hazardous Material Packaging and Shipping*, shall be met.
- During transfer conditions, removable contamination on the exterior surfaces of the tanks shall not exceed the DOT limits shown in Table A4-1 when measured per 49 CFR 173.443(a).
- Tank valves shall be closed during transport and only for a maximum allowable time of 150 hours.

Table A4-1. Removable External Radioactive Contamination--Wipe Limits.

Contaminant	Maximum permissible limit (dpm/cm^2)
Beta-gamma emitting radionuclides; all radionuclides with half lives less than ten days; natural uranium; natural thorium; ^{235}U, ^{238}U, ^{232}Th, ^{228}Th, and ^{230}Th when contained in ores or physical concentrates.	22
All other alpha-emitting radionuclides.	2.2

5.0 ACCEPTANCE OF PACKAGING FOR USE

The tanks shall be inspected prior to shipping to ensure that there is no damage or deterioration that would impair the function of the tank. The gaskets and sealing surfaces shall be inspected prior to loading to ensure that they are clean and free from large scratches, dents, or other deformations that would prevent them from sealing.

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6.0 OPERATING REQUIREMENTS

6.1 GENERAL REQUIREMENTS

All packaging and shipping operations shall be as required by WHC-CM-2-14 and this SEP. All operations shall follow the Hanford Site "Master Safety Rules" referenced in WHC-CM-1-10, *Safety Manual*, and the applicable Occupational Safety and Health Administration standards per 29 CFR 1910.

6.2 LOADING AND LIFTING THE PACKAGE

The tank shall be loaded while in place on the trailer. The tank may be lifted at the destination using appropriate lifting devices that attach to the top corner twist-lock fittings. All lifting equipment shall meet the requirements of the *Hanford Site Hoisting and Rigging Manual* (DOE-RL 1993).

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7.0 QUALITY ASSURANCE

7.1 GENERAL REQUIREMENTS

The cognizant facility Quality Assurance personnel are responsible for the following.

1. Verifying that the tank assembly is in unimpaired physical condition and displays no visual defects that could adversely affect the performance of the packaging.

2. Verifying that all special packaging instructions (as applicable) for filling, closing, and preparing the tank for shipment have been followed.

3. Ensuring that appropriate documentation is prepared and retained in accordance with WHC-CM-2-14; WHC-CM-4-2, *Quality Assurance*; and *Quality Assurance Program Plan for the Hazardous Materials Transportation and Packaging Program* (WHC 1995).

7.2 SEP CONTROL SYSTEM

This SEP will expire immediately following the shipment or one year from the document release date, whichever is first.

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8.0 MAINTENANCE

This SEP authorizes only a single transfer of the tank, and as a result, there are no transportation maintenance requirements. The tank must meet the requirements of Part A, Section 5.0, prior to shipping.

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9.0 REFERENCES

29 CFR 1910, 1996, "Occupational Safety and Health Standards," *Code of Federal Regulations*, as amended.

49 CFR 173, 1996, "Transportation," *Code of Federal Regulations*, as amended.

49 CFR 396, 1996, "Inspection, Repair, and Maintenance," *Code of Federal Regulations*, as amended.

ASME, 1992, *ASME Boiler and Pressure Vessel Code*, Section VIII, Division I, American Society of Mechanical Engineers, New York, New York.

DOE-RL, 1993, *Hanford Site Hoisting and Rigging Manual*, DOE/RL-92-36, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

HSRCM-1, *Hanford Site Radiological Control Manual*, Pacific Northwest Laboratory, Richland, Washington.

WHC-CM-1-10, *Safety Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-2-14, *Hazardous Material Packaging and Shipping*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, *Quality Assurance*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *Quality Assurance Program Plan for the Hazardous Materials Transportation and Packaging Program*, WHC-IP-0705, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-S-0269, 1994, *Specification for ISO Tank Container Greater than 1000 Gallons Internal Volume for Shipment of Nitrating Liquids Greater than 50% Nitric Acid*, Westinghouse Hanford Company, Richland, Washington, February 28.

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10.0 APPENDIX: CERTIFICATION

American Bureau of Shipping

Tank Container Certificate of Approval

Design Type No.: AB / 079/82-04

Certificate No.: 95CH0060-A

Issued pursuant to authority delegated by the US Department of Transportation. Identification No.: 107-81-01*

Manufacturer & address: BRENNER TANK INC., FOND DU LAC, WI	Serial No. 60601
Owner & address: U.S. DEPARTMENT OF ENERGY, RICHLAND WA	Operating No. WHCU 016 175 6

This is to certify that the tank container identified above has been inspected at each stage of manufacture and that its construction, including details of design, materials and workmanship, conforms to the ABS Rules for the Certification of Cargo Containers, to the International Convention of Safe Containers and to the following:
IMO TYPE 1 (IMDG), RID/ADR, AAR 600, CUSTOMS/TIR, US DOT SPEC 51**, AND TRANSPORT CANADA TC 51 **

TANK CHARACTERISTICS MODEL 17,500

Design code: ASME CODE, SECTION VIII, DIV. 1 MAWP tank: 100/-15* (psig) 6.9/*-1.034 (bar)

Design temperatures: min -28.9 (°C); max 121 (°C) MAWP heating system: N/A (psig) N/A (bar)

Dimensions: OAL 232.936 (in); OD 78.965 (in) Capacity: 17,500 (lt) 4623 (US gallons)

Materials: shell SA-240, T-304 heads SA-240, T-304

Min. thickness: shell 0.285" heads 0.412"

Equiv. mild steel thickness: 9.61 (mm) 0.378 (in) Corrosion allowance: 0.635 (mm) 0.025" (in)

Safety relief devices: (1) 2.5" FORT VALE SUPER-MAXI PRESSURE RELEIF VALVE WITH RUPTURE DISC IN SERIES #8333432

Set pressures: pressure 110 PSIG vacuum N/A rupture 110 psig Total capacity 12,520 SCFM (80%)

CONTAINER CHARACTERISTICS

Overall dimensions: length 20' width 8' height 8'6" MGW: 30,480 (kg) 67,200 (lb)

Insulation & cladding: NONE Tare wt: 4604 (kg) 10150 (lb)

Equipment: (2) 1.5" DURCO PLUG VALVES IN TOP DISCHARGE AND AIR LINE Payload 25876 (kg) 57050 (lb)

Prototype unit test reference: BV TEST REPORT NO. BVCT 927785 (certificate no.) 3 JUNE 1992 (date)

Hydraulic test pressure and date for this container: 154 PSIG 28 JUNE 1995

Leak test pressure and date for this container: 14.5 PSIG 30 JUNE 1995

MANUFACTURER'S STATEMENT

I hereby affirm that the tank container described above has been manufactured according to the drawings listed below, as approved by ABS on 06 MAY 1995 (date) T-3/1384 (reference), under the effective quality control of the manufacturer identified above.

Drawing nos: TC-D-0046 Signed: [signature] date 6/30/95

Comments: THIS TANK CONTAINER IS NOT FITTED WITH INTERMEDIATE LOAD TRANSFER ZONES AND IS TO BE TRANSPORTED BY HIGHWAY ON A SUITABLE CHASIS.

Issued on: 30 JUNE 1995 (date) at FOND DU LAC, WI (place) by Harold E. Richardson (Surveyor)

HAROLD E. RICHARDSON
AMERICAN BUREAU OF SHIPPING

NOTE This Certificate evidences compliance with one or more of the Rules, guides, standards or other criteria of American Bureau of Shipping and is issued solely for the use of the Bureau, its committees, its clients or other authorized entities. This Certificate is a representation only that the tank container specified herein has been found to comply with one or more of the Rules, guides, standards or other criteria of American Bureau of Shipping. The validity, applicability and interpretation of this Certificate is governed by the Rules and standards of American Bureau of Shipping who shall remain the sole judge thereof. Nothing contained in this Certificate or in any Report issued in contemplation of this Certificate shall be deemed to relieve any designer, builder, owner, manufacturer, seller, supplier, repairer, operator or other entity of any warranty express or implied.

CTR AB 380 10/92

*Applies to IM portable tanks only.

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PART B: PACKAGE EVALUATION

1.0 INTRODUCTION

1.1 SAFETY EVALUATION METHODOLOGY

The tank was analyzed against the requirements of WHC-CM-2-14, *Hazardous Materials Packaging and Shipping*, for onsite transportation of Type B material. The onsite normal transfer conditions are analyzed, and the tanks meet the criteria for those conditions. Accident conditions were not analyzed because prior to modification the tank was certified for offsite shipment of this type of payload. The primary purpose of this safety evaluation for packaging (SEP) is to address modifications to the tank, problems associated with hydrogen generation, capability to ship a payload less than 80% by volume, and to address dose rates which exceed normal specified limits.

1.2 EVALUATION SUMMARY AND CONCLUSION

The tank is safe for the onsite transportation of organic waste as demonstrated by this SEP.

The contents evaluated as acceptable is 16,500 L (4,600 gal) of organic waste from the B Plant canyon. However, only 16,221 L (4,285 gal) will be allowed to provide proper vent space during storage. The contents evaluation is presented in Part B, Section 2.0.

A radiological risk evaluation was not performed because there is no need to address accident conditions based on the payload meeting low specific activity (LSA)-II.

Containment is maintained throughout all normal transfer conditions. The containment evaluation is presented in Part B, Section 3.0.

The shielding evaluation demonstrates that the tanks can be transferred in a manner consistent with as low as reasonably achievable (ALARA) practices. The tank shielding and payload, coupled with special transfer requirements as outlined in Part A, Section 4.3, meet the onsite dose rate requirements for shipping LSA-II material. The shielding evaluation is presented in Part B, Section 4.0.

Subcriticality is maintained in all conditions due to the small quantity of fissile materials. The criticality analysis is presented in Part B, Section 5.0

The structural evaluation concludes that the loaded tank can be loaded, lifted, and transported safely. The structural evaluation is presented in Part B, Section 6.0.

The thermal evaluation indicates that heat generation is not a concern due to the very small amount of thermal energy created by the payload. The thermal evaluation is presented in Part B, Section 7.0.

Gas generation analyses show that the equilibrium hydrogen concentration in the tank will be 2% (with the filters open), and once the filter isolation valves are closed for shipping, it will take 150 hours to reach 2.5% hydrogen concentration within the gaseous layer. The gas generation analyses are presented in Part B, Section 8.0.

The tiedown analysis shows that the system meets the U.S. Department of Transportation (DOT) requirements for load securement. The tiedown analysis is presented in Part B, Section 9.0.

1.3 REFERENCES

WHC-CM-2-14, *Hazardous Materials Packaging and Shipping*, Westinghouse Hanford Company, Richland, Washington.

2.0 CONTENTS EVALUATION

2.1 CHARACTERIZATION

A maximum of 16,221 L (4,285 gal) of organic waste will be transferred from the B Plant canyon to the B Plant organic tank storage pad. The waste consists of 70% normal paraffin hydrocarbon, 10% tributyl phosphate, and 20% di-2 ethylhexyl phosphoric acid. The liquid has a specific gravity of 0.85 and is contaminated with the radioactive source term shown below.

NOTE: For source term determination, a payload of 17,413 L (4,600 gal) was assumed, for conservatism.

2.1.1 Source Term

The spreadsheet Quattro[1] Pro was used to extract isotopic information from a brace of laboratory analyses that reported merely the total alpha, beta, and gamma counts. A quick check of the relative influence of the various isotopes to the total gamma-ray spectrum was made using the program ISOSHLD (Engel et al. 1966, Simmons et al. 1967, Rittmann 1995).

2.1.1.1 Assumptions. The following assumptions were made.

- The gamma-ray count is entirely the result of ^{137m}Ba. The use of this assumption implicitly assumes that the detector used discriminates against gamma-ray energies lower than 0.66 MeV and that the interference from other gamma rays and/or Bremsstrahlung at this energy is negligible.

- The mix of isotopes is that of 10-year aged 12% ^{240}Pu N Reactor fuel. This is a conservative assumption.

2.1.1.2 Input Data. Two organic waste samples are analyzed, and the results are averaged. They are then used in the tabulation of Table B2-1. A more thorough description of the input can be found in *Source Term for the B-Plant Organic Waste* (Goldberg 1996), which develops the activity concentration. The data from that reference are multiplied by the assumed payload volume, 1.7413×10^7 cm^3 (4.6×10^3 gal), to obtain the total source.

2.1.1.3 Calculations and Results. The averaged laboratory results are entered into a Quattro Pro spreadsheet using a disk operating system-based personal computer. The beta ray and alpha branching ratios are entered as given in *Radioactive Decay Data Tables* (Kocher 1981). The activity per metric tonne of N Reactor fuel for each isotope is taken from *ORIGEN2 Predictions of N Reactor Fuel Actinide Composition* (Hedengren and Goldberg 1987) and *ORIGEN2 Predictions of N Reactor Fuel Fission Product Composition* (Hedengren and Goldberg 1985) and then entered into column four of the spreadsheet.

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[1] Quattro is a trademark of Borland.

The total activities of the alpha particle-emitting radioisotopes are then normalized to the average measured alpha particle activity, and the activity of the nonalpha particle-emitting actinides is scaled similarly. The ^{137m}Ba activity is then normalized to the average measured gamma-ray activity. The ^{137}Cs activity is then scaled to reflect the fact that it is in secular equilibrium with ^{137m}Ba.

The beta particle activities from the ^{137}Cs and from the actinides are then subtracted from the measured beta particle activity, and the remainder of the beta particle emitters are scaled such that the total beta particle activity would equal the average measured value. These values are tabulated in the column of Table B2-1 labeled "Adjusted activity."

The sixth column of the table is obtained by reducing the cesium concentration so that the ^{137m}Ba activity concentration is reduced to 0.286 μCi/mL. This is due to planned washing of the waste for cesium removal. The ^{134}Cs, ^{137}Cs, and ^{137m}Ba are affected. It is assumed that no other radioisotopes would be affected by this washing process.

The final column is obtained by multiplying the activity concentration in the previous column by the volume of the tank.

2.1.2 Source Term Classification

The inventory listed in Table B2-1 will be transported in one shipment. It qualifies as LSA-II per 49 CFR 173.403. LSA-II classification is determined in the following manner. A liquid is defined by DOT as LSA-II if it contains less than 10^{-5} A_2s per gram. In addition, the external dose rate must not exceed 10 mSv/h (1 rem/h) at 3 m (9.84 ft) from the unshielded material, and the payload may not exceed 100 times the A_2 quantity.

The number of A_2s in the mixture is determined, as shown in Table B2-2, by dividing the activity of the radionuclide by the A_2 value for the radionuclide. The fraction of A_2s is summed to give the total A_2s in the liquid. This sum is 56.9, which is less than the allowable 100 A_2s.

The number of A_2s is then divided by 10^{-5} and the mass in grams (1.75×10^7 g). The resulting number (0.33) is less than 1.0, indicating that the liquid qualifies as LSA-II.

Finally, the dose rates off of the unshielded material are calculated and are shown to be less than 10 mSv/h (1 rem/h) at 3 m (9.84 ft) (see Part B, Section 4.0).

Table B2-1. B Plant Organic Waste Source Term.

Isotope	Alpha yield	Beta yield	Ci/MTIU 12% N fuel	Adjusted activity (µCi/mL)	Reduced Cs activity (µCi/mL)	Total activity (Ci)
^{85}Kr		1.000	5.03 E+02	6.49 E-01	6.49 E-01	1.13 E+01
^{90}Sr		1.000	5.78 E+03	7.45 E+00	7.45 E+00	1.30 E+02
^{90}Y		1.000	5.78 E+03	7.45 E+00	7.45 E+00	1.30 E+02
^{93}Zr		1.000	1.71 E-01	2.21 E-04	2.21 E-04	3.84 E-03
^{99}Tc		1.000	1.26 E+00	1.62 E-03	1.62 E-03	2.83 E-02
^{106}Ru		1.000	5.23 E+01	6.75 E-02	6.75 E-02	1.18 E+00
^{106}Rh		1.000	5.23 E+01	6.75 E-02	6.75 E-02	1.18 E+00
^{113m}Cd			2.35 E+00	3.04 E-03	3.04 E-03	5.29 E-02
^{125}Sb		0.999	1.25 E+02	1.61 E-01	1.61 E-01	2.80 E+00
^{125m}Te			3.04 E+01	3.92 E-02	3.92 E-02	6.83 E-01
^{134}Cs		1.000	1.27 E+02	1.64 E-01	1.21 E-02	2.10 E-01
^{137}Cs		1.000	7.29 E+03	3.89 E+00	2.86 E-01	4.98 E+00
^{137m}Ba			6.90 E+03	3.68 E+00	2.71 E-01	4.71 E+00
^{144}Ce		1.015	2.79 E+01	3.60 E-02	3.60 E-02	6.26 E-01
^{144}Pr		1.000	2.79 E+01	3.60 E-02	3.60 E-02	6.26 E-01
^{144m}Pr			3.35 E-01	4.32 E-04	4.32 E-04	7.52 E-03
^{147}Pm		1.000	1.96 E+03	2.52 E+00	2.52 E+00	4.39 E+01
^{151}Sm		1.000	8.95 E+01	1.15 E-01	1.15 E-01	2.01 E+00
^{152}Eu		0.710	6.51 E-01	8.41 E-04	8.41 E-04	1.46 E-02
^{154}Eu		1.000	8.80 E+01	1.14 E-01	1.14 E-01	1.98 E+00
^{155}Eu		1.010	3.48 E+01	4.49 E-02	4.49 E-02	7.82 E-01
^{234m}Pa		1.001	3.32 E-01	1.52 E-06	1.52 E-06	2.65 E-05
^{234}Th		1.000	3.32 E-01	1.52 E-06	1.52 E-06	2.65 E-05
^{234}U	1.000		4.23 E-01	1.9 E-06	1.94 E-06	3.38 E-05
^{237}U		1.010	1.09 E-01	5.00 E-07	5.00 E-07	8.71 E-06
^{238}U	1.002		3.32 E-01	1.52 E-06	1.52 E-06	2.65 E-05
^{238}Pu	1.000		4.77 E+01	2.19 E-04	2.19 E-04	3.81 E-03
^{239}Pu	0.999		1.10 E+02	5.05 E-04	5.05 E-04	8.79 E-03
^{240}Pu	1.000		5.82 E+01	2.67 E-04	2.67 E-04	4.65 E-03
^{241}Pu	0.000	1.000	4.45 E+03	2.04 E-02	2.04 E-02	3.55 E-01
^{241}Am	1.000		9.29 E+01	4.26 E-04	4.26 E-04	7.42 E-03
^{242m}Am	0.005		1.08 E-01	4.96 E-07	4.96 E-07	8.64 E-06
^{242}Am		0.827	1.08 E-01	4.93 E-07	4.93 E-07	8.59 E-06
Total activity						3.37 E+02
Total beta		2.64 E+04 Ci		2.28 E+01	1.90 E+01	3.32 E+02
Total alpha		3.10 E+02 Ci		1.42 E-03	1.42 E-03	2.47 E-02

MTIU = Metric tonne of initial uranium.

Table B2-2. Low Specific Activity Determination.

Isotope	Activity (Ci)	A_2 (Ci)	A_2 fraction
^{85}Kr	1.13 E+01	2.70 E+02	4.19 E-02
^{90}Sr	1.30 E+02	2.70 E+00	4.81 E+01
^{90}Y[a]	1.30 E+02	5.41 E+00	0.00 E+00
^{93}Zr	3.84 E-03	5.41 E+00	7.10 E-04
^{99}Tc	2.83 E-02	2.43 E+01	1.16 E-03
^{106}Ru	1.18 E+00	5.41 E+00	2.18 E-01
^{106}Rh[a]	1.18 E+00	0.00 E+00	0.00 E+00
^{113m}Cd	5.29 E-02	2.43 E+00	2.18 E-02
^{125}Sb	2.80 E+00	2.43 E+01	1.15 E-01
^{125m}Te	6.83 E-01	2.43 E+02	2.81 E-03
^{134}Cs	2.10 E-01	1.35 E+01	1.56 E-02
^{137}Cs	4.98 E+00	1.35 E+01	3.69 E-01
^{137m}Ba[a]	4.71 E+00	0.00 E+00	0.00 E+00
^{144}Ce	6.26 E-01	5.41 E+00	1.16 E-01
^{144}Pr[a]	6.26 E-01	0.00 E+00	0.00 E+00
^{144m}Pr[a]	7.52 E-03	0.00 E+00	0.00 E+00
^{147}Pm	4.39 E+01	2.43 E+01	1.81 E+00
^{151}Sm	2.01 E+00	1.08 E+02	1.86 E-02
^{152}Eu	1.46 E-02	2.43 E+01	6.01 E-04
^{154}Eu	1.98 E+00	1.35 E+01	1.47 E-01
^{155}Eu	7.82 E-01	5.41 E+01	1.45 E-02
^{234m}Pa[a]	2.65 E-05	0.00 E+00	0.00 E+00
^{234}Th	2.65 E-05	5.41 E+00	4.90 E-06
^{234}U	3.38 E-05	2.70 E-02	1.25 E-03
^{237}U[a]	8.71 E-06	0.00 E+00	0.00 E+00
^{238}U	2.65 E-05	Unlimited	0.00 E+00
^{238}Pu	3.81 E-03	5.41 E-03	7.04 E-01
^{239}Pu	8.79 E-03	5.41 E-03	1.62 E+00
^{240}Pu	4.65 E-03	5.41 E-03	8.60 E-01
^{241}Pu[b]	3.55 E-01	2.70 E-01	1.31 E+00
^{241}Am	7.42 E-03	5.41 E-03	1.37 E+00
^{242m}Am	8.64 E-06	5.41 E-03	1.60 E-03
^{242}Am[a]	8.59 E-06	0.00 E+00	0.00 E+00
	Total = 2.01 E+02 (excluding daughters)		Total = 5.69 E+01 = number of A_2s
A_2 for mixture of normal form = (2.01 E+02)/(5.69 E+01) = 3.53 Ci			
HRCQ: Not HRCQ because total number of A_2s is 5.69 E+01 and total number of curies is 2.01 E+02, which is less than the HRCQ definition for normal form of 3000 A_2s or 27,000 Ci.			

HRCQ = Highway route controlled quantity.

[a]This radionuclide is a daughter as defined in 49 CFR 173.433; therefore, its activity was not included in A_1/A_2 calculations.

[b]Fissile radionuclide as defined in 49 CFR 173.403a. Total fissile = 1.46 E-01 g <15 g; therefore, fissile excepted (49 CFR 173.453a).

2.2 RESTRICTIONS

The special transfer requirements of Part A, Section 4.3, shall be met.

2.3 SIZE AND WEIGHT

The liquid payload is limited to a maximum weight of 17,500 kg (38,581 lb). This weight is calculated on the conservative assumptions of 17,500 L (4,623 gal) and a specific gravity of 1.

2.4 CONCLUSIONS

The organic waste is acceptable for transport in the tank provided the requirements of this SEP are met.

2.5 REFERENCES

49 CFR 173, 1996, "Shippers--General Requirements for Shipments and Packagings," *Code of Federal Regulations*, as amended.

Engel, R. L., J. Greenborg, and M. M. Hendrickson, 1966, *ISOSHLD - A Computer Code for General Purpose Isotope Shielding Analysis*, BNWL-236, rev. 1.98, Battelle-Northwest Laboratories, Richland, Washington. June 1966.

Goldberg, H. J., 1996, *Source Term for the B-Plant Organic Waste*, WHC-SD-WM-CN-029, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Hedengren, D. C., and H. J. Goldberg, 1987, *ORIGEN2 Predictions of N Reactor Fuel Actinide Composition*, SD-CP-TI-105, Westinghouse Hanford Company, Richland, Washington.

Kocher, D. C., 1981, *Radioactive Decay Data Tables*, DOE/TIC-11026, Technical Information Center, U.S. Department of Energy, Oak Ridge, Tennessee.

Rittmann, P. D., 1995, *ISO-PC Version 1.98 - User's Guide*, WHC-SD-WM-UM-030, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Simmons, G. L., J. J. Regimbal, J. Greenborg, E. L. Kelly, Jr., and H. H. van Tuyl, 1967, *ISOSHLD-II: Code Revision to Include Calculation of Dose Rate from Shielded Bremsstrahlung Sources*, BNWL-236, Supplement 1, Battelle-Northwest Laboratories, Richland, Washington.

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3.0 CONTAINMENT EVALUATION

3.1 INTRODUCTION

The purpose of this evaluation is to determine the ability of the B Plant organic tank to maintain it contents under onsite normal transfer conditions.

3.2 CONTAINMENT SOURCE SPECIFICATION

The authorized payload is described in Part B, Section 2.0.

3.3 NORMAL TRANSFER CONDITIONS

3.3.1 Conditions To Be Evaluated

The primary condition to be evaluated for normal transfer conditions is structural integrity.

3.3.2 Release Acceptance Criteria

The tank was certified for offsite shipping of LSA material. Because this payload is also LSA, the tank is considered to be acceptable as long as its structural capabilities are not compromised by the modifications. The modifications are described in Part A, Section 2.1.

3.4 CONTAINMENT EVALUATION AND CONCLUSIONS

The modifications are described in Part A, Section 2.1. The spilldam is not part of the containment boundary and does not provide structural integrity. Therefore, adding the vents or cover to the spilldam cannot affect containment. The filter for the air inlet valve bolts to the downstream side of the existing valve. Because this valve is closed during shipment, adding the filter does not affect containment. Adding the 12.7-cm- (5-in.-) long extension to the inside of the air inlet valve does not affect the structural integrity of the valve and therefore does not affect containment. Finally, replacing the pressure vent assembly with a valve and filter does not affect containment; the valve and filter are identical to those used on the air inlet valve, and the valve is closed during the shipment. The tank containment is considered to be adequate based on the above evaluations.

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4.0 SHIELDING EVALUATION

4.1 INTRODUCTION

This shielding evaluation supports the shipment of liquid organic waste in a tank truck. The tank truck will be used to transport the organic waste from the load-out station of B Plant to a waste interim storage area.

The contents have been classified as LSA-II. LSA-II material must have an exterior dose rate from the unshielded surface of less than 10 mSv/h (1,000 mrem/h) at 3.0 m (9.8 ft). Other limits require that normal shipments are less than 2 mSv/h (200 mrem/h) on the surface of the tank, 0.1 mSv/h (10 mrem/h) at 2 m (6.56 ft), and 0.05 mSv/h (5 mrem/h) at the driver's location or any occupied space provided that the driver or worker is a qualified Hanford Site radiological worker. To provide protection, given any particular circumstance, administrative controls are enforced (as specified in Part A, Section 4.3) to guarantee that during transportation no exposure to the public will occur and that ALARA procedures will be followed to guarantee the safety of the workers.

4.2 DIRECT RADIATION SOURCE SPECIFICATION

4.2.1 Photon Source

The source term for the shipment of the organic waste is developed in Part B, Section 2.0, and is listed in Table B4-1.

4.2.2 Beta Particle Source

The wall of the tank is 0.8 cm (5/16 in.) thick. This thickness is greater than the range of the most energetic beta particle emanating from the waste (the 2.2839 MeV beta particle from ^{90}Y). Thus, doses from the direct interaction of a receptor with beta particles will be negligible, at most.

4.2.3 Neutron Source

The concentration of neutron-emitting radionuclides indicates that the neutron dose will be negligible.

4.3 SUMMARY OF SHIELDING PROPERTIES OF MATERIALS

The computer code ISOSHLD (Engel et al. 1966, Simmons et al. 1956, Rittmann 1995) is used on a desktop disk operating system-based personal computer. The attenuation, buildup, and Bremsstrahlung properties of the materials chosen are contained therein. The problem-specific description of the calculational model is described in Part B, Section 4.4.3

Table B4-1. B Plant Organic Waste Source Term.

Isotope	Total activity (Ci)	Isotope	Total activity (Ci)
^{85}Kr	1.13 E+01	^{151}Sm	2.01 E+00
^{90}Sr	1.30 E+02	^{152}Eu	1.46 E-02
^{90}Y	1.30 E+02	^{154}Eu	1.98 E+00
^{93}Zr	3.84 E-03	^{155}Eu	7.82 E-01
^{99}Tc	2.83 E-02	^{234m}Pa	2.65 E-05
^{106}Ru	1.18 E+00	^{234}Th	2.65 E-05
^{106}Rh	1.18 E+00	^{234}U	3.38 E-05
^{113m}Cd	5.29 E-02	^{237}U	8.71 E-06
^{125}Sb	2.80 E+00	^{238}U	2.65 E-05
^{125m}Te	6.83 E-01	^{238}Pu	3.81 E-03
^{134}Cs	2.10 E-01	^{239}Pu	8.79 E-03
^{137}Cs	4.98 E+00	^{240}Pu	4.65 E-03
^{137m}Ba	4.71 E+00	^{241}Pu	3.55 E-01
^{144}Ce	6.26 E-01	^{241}Am	7.42 E-03
^{144}Pr	6.26 E-01	^{242m}Am	8.64 E-06
^{144m}Pr	7.52 E-03	^{242}Am	8.59 E-06
^{147}Pm	4.39 E+01		

4.4 NORMAL TRANSFER CONDITIONS

4.4.1 Conditions To Be Evaluated

The anterior-to-posterior effective dose equivalent is calculated at contact and at distances of 2 m (6.56 ft) and 6 m (19.69 ft) from the surface of the container. These calculations are carried out for distances off the side of the container as well as for distances off the end face. For purposes of LSA classification, the dose is also calculated at 3 m (9.84 ft), assuming no shielding is present.

4.4.2 Acceptance Criteria

Transportation safety requires dose rate limits of 200 mrem/h on the surface of the vehicle (including the top and underside), 10 mrem/h at any point 2 m (6.56 ft) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle), and 5 mrem/h at any normally occupied space (taken to be 6 m [19.69 ft]) provided the space is occupied by a qualified Hanford Site radiological worker. In addition, LSA-II requires that the dose rate be less than 10 mSv/h (1,000 mrem/h) at 3 m (9.84 ft) from the unshielded material. To provide protection, administrative controls are enforced to guarantee no exposure to the public, and ALARA procedures will be followed to protect the worker (Part A, Section 4.3).

4.4.3 Shielding Model

The computer code ISOSHLD (Engel et al. 1966, Simmons et al. 1956, Rittmann 1995) is used on a desktop disk operating system-based personal computer. This code performs a point kernel integration over the source region and sums the contributions of each of the point kernels to the dose at a point detector. The program also accounts for Bremsstrahlung produced by β-particles.

The nitric acid tank, manufactured by Brenner Tank, Incorporated, is made of steel and has a rated volume of 17,500 L (4,623 gal). It is in the shape of a right cylinder with rounded ends. For the purpose of this analysis, the model has flat ends. The dimensions used in the analysis are presented in Table B4-2.

Table B4-2. Tank Dimensions Used in Calculations.

	SI units	English units
Inner diameter	199.1 cm	78.38 in.
Length	559.8 cm	220.4 in.
Volume	17,413 L	4,600 gal
Wall thickness	0.8 cm	5/16 in.

SI = Standard international system of units.

The steel density is assumed to be 7.85 g/cm^3. This is conservative because various types of stainless steel can be denser than this. The density of the waste material is assumed to be 0.85 g/cm^3.

4.5 SHIELDING CALCULATIONS

The ISOSHLD results are as shown in Table B4-3.

Table B4-3. Effective Dose Equivalent.

	Center of side mSv/h (mrem/h)	Center of end mSv/h (mrem/h)	Limits mSv/h (mrem/h)
Contact	1.4 (140)	0.72 (72)	2.0 (200)
2 m (6.56 ft) from surface	0.31 (31)*	0.20 (20)*	0.10 (10)
6 m (19.69 ft) from surface (driver's location)	NA	0.046 (4.6)	0.05 (5)
3 m (9.84 ft) from unshielded material	0.45 (45)	0.27 (27)	1.0 (1000)

ALARA = As low as reasonably achievable.
*Administrative controls are enforced to guarantee no exposure to the public, and ALARA procedures will be followed to protect the worker (Part A, Section 4.3).

The source term used in the analysis has a high degree of uncertainty, but is expected to be the bounding case. Therefore, administrative controls are enforced to guarantee the safety of the worker and no exposure to the public. These controls are specified in Part A, Section 4.3.

4.6 REFERENCES

49 CFR 173.401, 1994, "Shippers--General Requirements for Shipments and Packagings," .401, "Scope," *Code of Federal Regulations*, as amended.

49 CFR 173.441, 1994, "Shippers--General Requirements for Shipments and Packagings," .441, "Radiation Level Limitations," *Code of Federal Regulations*, as amended.

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Hedengren, D. C., and H. J. Goldberg, 1985, *ORIGEN2 Predictions of N Reactor Fuel Fission Product Composition*, SD-CP-TI-117, Westinghouse Hanford Company, Richland, Washington.

Hedengren, D. C., and H. J. Goldberg, 1987, *ORIGEN2 Predictions of N Reactor Fuel Actinide Composition*, SD-CP-TI-105, Westinghouse Hanford Company, Richland, Washington.

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Simmons, G. L., J. J. Regimbal, J. Greenborg, E. L. Kelly, Jr., and H. H. van Tuyl, 1967, *ISOSHLD-II: Code Revision to Include Calculation of Dose Rate from Shielded Bremsstrahlung Sources*, BNWL-236, Supplement 1, Battelle-Northwest Laboratories, Richland, Washington.

4.7 APPENDICES

4.7.1 Checklist for Independent Technical Review

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

DOCUMENT REVIEWED
NUMBER: 8M730-HJG-96-011
TITLE: SHIELDING ANALYSES FOR THE SHIPMENT OF B-PLANT ORGANIC WASTE
AUTHOR(s): H. J. Goldberg

I. Method(s) of Review

- (X) Input data checked for accuracy
- ( ) Independent calculation performed
  - ( ) Hand calculation
  - ( ) Alternate computer code: ____
- ( ) Comparison to experiment or previous results
- (X) Alternate method (define) Writing checked for correctness

II. Checklist (either check or enter NA if not applied)

- (NA) Task completely defined
- (NA) Activity consistent with task specification
- (NA) Necessary assumptions explicitly stated and supported
- (X) Resources properly identified and referenced
- (X) Resource documentation appropriate for this application
- (X) Input data explicitly stated
- (X) Input data verified to be consistent with original source
- (NA) Geometric model adequate representation of actual geometry
- (NA) Material properties appropriate and reasonable
- (NA) Mathematical derivations checked including dimensional consistency
- (NA) Hand calculations checked for errors
- (NA) Assumptions explicitly stated and justified
- (NA) Computer software appropriate for task and used within range of validity
- (NA) Use of resource outside range of established validity is justified
- (NA) Software runstreams correct and consistent with results
- (NA) Software output consistent with input
- (NA) Results consistent with applicable previous experimental or analytical findings
- (NA) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- (NA) Conclusions consistent with analytical results and established limits
- (NA) Uncertainty assessment appropriate and reasonable
- ( ) Other (define) ____

III. Comments: ____

IV. REVIEWER: D. E. Lesser DATE: 6-25-96

DOCUMENT REVIEWED
NUMBER: 8M730-HJG-96-011
TITLE: SHIELDING ANALYSES FOR THE SHIPMENT OF B-PLANT ORGANIC WASTE
AUTHOR(s): H. J. Goldberg

I. Method(s) of Review

- (✓) Input data checked for accuracy
- ( ) Independent calculation performed
  - ( ) Hand calculation
  - (✓) Alternate computer code: Microshield
- ( ) Comparison to experiment or previous results
- ( ) Alternate method (define)

II. Checklist (either check or enter NA if not applied)

- (✓) Task completely defined
- (✓) Activity consistent with task specification
- (✓) Necessary assumptions explicitly stated and supported
- (✓) Resources properly identified and referenced
- (✓) Resource documentation appropriate for this application
- (✓) Input data explicitly stated
- (✓) Input data verified to be consistent with original source
- (✓) Geometric model adequate representation of actual geometry
- (✓) Material properties appropriate and reasonable
- (✓) Mathematical derivations checked including dimensional consistency
- (✓) Hand calculations checked for errors
- (✓) Assumptions explicitly stated and justified
- (✓) Computer software appropriate for task and used within range of validity
- (NA) Use of resource outside range of established validity is justified
- (✓) Software runstreams correct and consistent with results
- (✓) Software output consistent with input
- (✓) Results consistent with applicable previous experimental or analytical findings
- (✓) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- (✓) Conclusions consistent with analytical results and established limits
- (✓) Uncertainty assessment appropriate and reasonable
- ( ) Other (define)

III. Comments:

IV. REVIEWER: [signature] DATE: 25 June 96

4.7.2 Computer Input Files

Input File (D:\ISOSHLD\INPUT\B_PLANT.) is shown below:

```
0         2 B-PLANT ORGANIC WASTE SOURCE TERM
POINT SOURCE DOSE AT ONE METER
 &INPUT NEXT=1, IGEOM=3, NSHLD=1, JBUF=1, IPRNT=0,
  X=100., T(1)=0.02, DUNIT=1, OPTION =1,
  ICONC=0, SFACT=17.413,
  WEIGHT(055)=6.5E-01, WEIGHT(082)=7.5E+00, WEIGHT(084)=7.5E+00,
  WEIGHT(102)=2.2E-04, WEIGHT(141)=1.6E-03, WEIGHT(170)=6.8E-02,
  WEIGHT(172)=6.8E-02, WEIGHT(206)=3.0E-03, WEIGHT(269)=1.6E-01,
  WEIGHT(270)=3.9E-02, WEIGHT(319)=1.2E-02, WEIGHT(335)=2.9E-01,
  WEIGHT(336)=2.7E-01, WEIGHT(376)=3.6E-02, WEIGHT(377)=3.6E-02,
  WEIGHT(388)=2.5E+00, WEIGHT(403)=1.2E-01, WEIGHT(408)=8.4E-04,
  WEIGHT(415)=1.1E-01, WEIGHT(418)=4.5E-02, WEIGHT(533)=1.5E-06,
  WEIGHT(530)=1.5E-06, WEIGHT(520)=1.9E-06, WEIGHT(491)=5.0E-07,
  WEIGHT(526)=1.5E-06, WEIGHT(492)=2.2E-04, WEIGHT(493)=5.1E-04,
  WEIGHT(494)=2.7E-04, WEIGHT(495)=2.0E-02, WEIGHT(496)=4.3E-04,
  WEIGHT(498)=5.0E-07, WEIGHT(499)=4.9E-07, &
1 SOURCE 9 1.2
TANK SOURCE DOSE AT CONTACT - SIDE - (CHECK FOR MEAN FREE PATH)
 &INPUT NEXT=1, IGEOM=7, NSHLD=2, JBUF=2, IPRNT=0,
  X=100.8, T(1)=99.5, T(2)=0.794, SLTH=559.84, Y=279.92,
  ICONC=1, SFACT=1., DUNIT=1, OPTION =1,
  NPSI=15, NTHETA=19, DELR=2.,
  WEIGHT(055)=6.5E-01, WEIGHT(082)=7.5E+00, WEIGHT(084)=7.5E+00,
  WEIGHT(102)=2.2E-04, WEIGHT(141)=1.6E-03, WEIGHT(170)=6.8E-02,
  WEIGHT(172)=6.8E-02, WEIGHT(206)=3.0E-03, WEIGHT(269)=1.6E-01,
  WEIGHT(270)=3.9E-02, WEIGHT(319)=1.2E-02, WEIGHT(335)=2.9E-01,
  WEIGHT(336)=2.7E-01, WEIGHT(376)=3.6E-02, WEIGHT(377)=3.6E-02,
  WEIGHT(388)=2.5E+00, WEIGHT(403)=1.2E-01, WEIGHT(408)=8.4E-04,
  WEIGHT(415)=1.1E-01, WEIGHT(418)=4.5E-02, WEIGHT(533)=1.5E-06,
  WEIGHT(530)=1.5E-06, WEIGHT(520)=1.9E-06, WEIGHT(491)=5.0E-07,
  WEIGHT(526)=1.5E-06, WEIGHT(492)=2.2E-04, WEIGHT(493)=5.1E-04,
  WEIGHT(494)=2.7E-04, WEIGHT(495)=2.0E-02, WEIGHT(496)=4.3E-04,
  WEIGHT(498)=5.0E-07, WEIGHT(499)=4.9E-07, &
  SOURCE 2 0.85
1 STEEL  9           7.85
TANK SOURCE DOSE AT ONE METER - SIDE
 &INPUT NEXT=4, OPTION=0, X=200., &
TANK SOURCE DOSE AT TWO METERS - SIDE
 &INPUT NEXT=4, X=300., &
TANK SOURCE DOSE AT SIX METERS - SIDE
 &INPUT NEXT=4,X=700., &
```

```
TANK SOURCE DOSE AT CONTACT - END - (CHECK FOR MEAN FREE PATH)
 &INPUT NEXT=1, IGEOM=7, NSHLD=2, JBUF=2, IPRNT=0,
  X=561.2, T(1)=559.84, T(2)=0.794, SLTH=99.5,
  ICONC=1, SFACT=1., DUNIT=1, OPTION =1,
  NTHETA=19, DELR=2.,
  WEIGHT(055)=6.5E-01, WEIGHT(082)=7.5E+00, WEIGHT(084)=7.5E+00,
  WEIGHT(102)=2.2E-04, WEIGHT(141)=1.6E-03, WEIGHT(170)=6.8E-02,
  WEIGHT(172)=6.8E-02, WEIGHT(206)=3.0E-03, WEIGHT(269)=1.6E-01,
  WEIGHT(270)=3.9E-02, WEIGHT(319)=1.2E-02, WEIGHT(335)=2.9E-01,
  WEIGHT(336)=2.7E-01, WEIGHT(376)=3.6E-02, WEIGHT(377)=3.6E-02,
  WEIGHT(388)=2.5E+00, WEIGHT(403)=1.2E-01, WEIGHT(408)=8.4E-04,
  WEIGHT(415)=1.1E-01, WEIGHT(418)=4.5E-02, WEIGHT(533)=1.5E-06,
  WEIGHT(530)=1.5E-06, WEIGHT(520)=1.9E-06, WEIGHT(491)=5.0E-07,
  WEIGHT(526)=1.5E-06, WEIGHT(492)=2.2E-04, WEIGHT(493)=5.1E-04,
  WEIGHT(494)=2.7E-04, WEIGHT(495)=2.0E-02, WEIGHT(496)=4.3E-04,
  WEIGHT(498)=5.0E-07, WEIGHT(499)=4.9E-07, &
  SOURCE 2 0.85
1 STEEL  9           7.85
TANK SOURCE DOSE AT ONE METER - END
 &INPUT NEXT=4, OPTION=0, X=660., &
TANK SOURCE DOSE AT TWO METERS - END
 &INPUT NEXT=4, X=760., &
TANK SOURCE DOSE AT SIX METERS - END
 &INPUT NEXT=4,X=1160., &
DATS ALL PHOLQUES!!!!!!!
 &INPUT NEXT=6, &
```

Input File (D:\ISOSHLD\INPUT\B_PLANT.) is shown below:

```
0         2 B-PLANT ORGANIC WASTE SOURCE TERM
POINT SOURCE DOSE AT ONE METER
 &INPUT NEXT=1, IGEOM=3, NSHLD=1, JBUF=1, IPRNT=0,
  X=100., T(1)=0.02, DUNIT=1, OPTION =1,
  ICONC=0, SFACT=17.413,
  WEIGHT(055)=6.5E-01, WEIGHT(082)=7.5E+00, WEIGHT(084)=7.5E+00,
  WEIGHT(102)=2.2E-04, WEIGHT(141)=1.6E-03, WEIGHT(170)=6.8E-02,
  WEIGHT(172)=6.8E-02, WEIGHT(206)=3.0E-03, WEIGHT(269)=1.6E-01,
  WEIGHT(270)=3.9E-02, WEIGHT(319)=1.2E-02, WEIGHT(335)=2.9E-01,
  WEIGHT(336)=2.7E-01, WEIGHT(376)=3.6E-02, WEIGHT(377)=3.6E-02,
  WEIGHT(388)=2.5E+00, WEIGHT(403)=1.2E-01, WEIGHT(408)=8.4E-04,
  WEIGHT(415)=1.1E-01, WEIGHT(418)=4.5E-02, WEIGHT(533)=1.5E-06,
  WEIGHT(530)=1.5E-06, WEIGHT(520)=1.9E-06, WEIGHT(491)=5.0E-07,
  WEIGHT(526)=1.5E-06, WEIGHT(492)=2.2E-04, WEIGHT(493)=5.1E-04,
  WEIGHT(494)=2.7E-04, WEIGHT(495)=2.0E-02, WEIGHT(496)=4.3E-04,
  WEIGHT(498)=5.0E-07, WEIGHT(499)=4.9E-07, &
1 SOURCE 9 1.2
TANK SOURCE DOSE AT CONTACT - SIDE - (CHECK FOR MEAN FREE PATH)
 &INPUT NEXT=1, IGEOM=7, NSHLD=2, JBUF=2, IPRNT=0,
  X=100.8, T(1)=99.5, T(2)=0.794, SLTH=559.84, Y=279.92,
  ICONC=1, SFACT=1., DUNIT=1, OPTION =1,
  NPSI=15, NTHETA=19, DELR=2.,
  WEIGHT(055)=6.5E-01, WEIGHT(082)=7.5E+00, WEIGHT(084)=7.5E+00,
  WEIGHT(102)=2.2E-04, WEIGHT(141)=1.6E-03, WEIGHT(170)=6.8E-02,
  WEIGHT(172)=6.8E-02, WEIGHT(206)=3.0E-03, WEIGHT(269)=1.6E-01,
  WEIGHT(270)=3.9E-02, WEIGHT(319)=1.2E-02, WEIGHT(335)=2.9E-01,
  WEIGHT(336)=2.7E-01, WEIGHT(376)=3.6E-02, WEIGHT(377)=3.6E-02,
  WEIGHT(388)=2.5E+00, WEIGHT(403)=1.2E-01, WEIGHT(408)=8.4E-04,
  WEIGHT(415)=1.1E-01, WEIGHT(418)=4.5E-02, WEIGHT(533)=1.5E-06,
  WEIGHT(530)=1.5E-06, WEIGHT(520)=1.9E-06, WEIGHT(491)=5.0E-07,
  WEIGHT(526)=1.5E-06, WEIGHT(492)=2.2E-04, WEIGHT(493)=5.1E-04,
  WEIGHT(494)=2.7E-04, WEIGHT(495)=2.0E-02, WEIGHT(496)=4.3E-04,
  WEIGHT(498)=5.0E-07, WEIGHT(499)=4.9E-07, &
  SOURCE 2 0.85
1 STEEL  9           7.85
TANK SOURCE DOSE AT ONE METER - SIDE
 &INPUT NEXT=4, OPTION=0, X=200., &
TANK SOURCE DOSE AT TWO METERS - SIDE
 &INPUT NEXT=4, X=300., &
TANK SOURCE DOSE AT SIX METERS - SIDE
 &INPUT NEXT=4,X=700., &

TANK SOURCE DOSE AT CONTACT - END - (CHECK FOR MEAN FREE PATH)
 &INPUT NEXT=1, IGEOM=7, NSHLD=2, JBUF=2, IPRNT=0,
  X=561.2, T(1)=559.84, T(2)=0.794, SLTH=99.5,
```

```
  ICONC=1, SFACT=1., DUNIT=1, OPTION =1,
  NTHETA=19, DELR=2.,
  WEIGHT(055)=6.5E-01, WEIGHT(082)=7.5E+00, WEIGHT(084)=7.5E+00,
  WEIGHT(102)=2.2E-04, WEIGHT(141)=1.6E-03, WEIGHT(170)=6.8E-02,
  WEIGHT(172)=6.8E-02, WEIGHT(206)=3.0E-03, WEIGHT(269)=1.6E-01,
  WEIGHT(270)=3.9E-02, WEIGHT(319)=1.2E-02, WEIGHT(335)=2.9E-01,
  WEIGHT(336)=2.7E-01, WEIGHT(376)=3.6E-02, WEIGHT(377)=3.6E-02,
  WEIGHT(388)=2.5E+00, WEIGHT(403)=1.2E-01, WEIGHT(408)=8.4E-04,
  WEIGHT(415)=1.1E-01, WEIGHT(418)=4.5E-02, WEIGHT(533)=1.5E-06,
  WEIGHT(530)=1.5E-06, WEIGHT(520)=1.9E-06, WEIGHT(491)=5.0E-07,
  WEIGHT(526)=1.5E-06, WEIGHT(492)=2.2E-04, WEIGHT(493)=5.1E-04,
  WEIGHT(494)=2.7E-04, WEIGHT(495)=2.0E-02, WEIGHT(496)=4.3E-04,
  WEIGHT(498)=5.0E-07, WEIGHT(499)=4.9E-07, &
  SOURCE 2 0.85
1 STEEL  9          7.85
TANK SOURCE DOSE AT ONE METER - END
 &INPUT NEXT=4, OPTION=0, X=660., &
TANK SOURCE DOSE AT TWO METERS - END
 &INPUT NEXT=4, X=760., &
TANK SOURCE DOSE AT SIX METERS - END
 &INPUT NEXT=4,X=1160., &
DATS ALL PHOLQUES!!!!!!!
 &INPUT NEXT=6, &
```

5.0 CRITICALITY

The definition of fissile materials in 49 CFR 173.401 lists the following isotopes: ^{233}U, ^{235}U, ^{238}Pu, ^{239}Pu, and ^{241}Pu. The plutonium isotope inventory to be shipped is taken from Table B2-1. However, the activities of ^{233}U and ^{235}U are below the cutoff level used in the development of the source as discussed in Part B, Section 2.0, and are therefore not reported in that section. The activities of these two isotopes shown in Table B5-1 are therefore developed using the same methodology as discussed in Part B, Section 2.0. The masses of all of the radionuclides listed in Table B5-1 are found by multiplying the activities by the specific activities as taken from *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors* (ANSI/ANS 1983). The resulting total fissile isotope mass in the shipment is less than 15 g (0.21 oz). Therefore, the shipment is fissile excepted, and criticality safety is not an issue.

Table B5-1. Masses of Fissile Isotopes.

Isotope	Specific activity (Ci/g)	Total activity (Ci)	Total mass (g)
^{233}U	9.64 E-03	2.05 E-05	2.13 E-03
^{235}U	1.92 E-06	1.26 E-06	6.56 E-01
^{238}Pu	1.71 E+01	3.81 E-03	2.23 E-04
^{239}Pu	6.20 E-02	8.79 E-03	1.42 E-01
^{241}Pu	1.03 E+02	3.55 E-01	3.45 E-03
Total			8.04 E-01

5.1 REFERENCES

49 CFR 173.401, 1994, "Shippers--General Requirements for Shipments and Packagings," .401, "Scope," *Code of Federal Regulations*, as amended.

ANSI/ANS, 1983, *Nuclear Criticality Safety in Operations With Fissionable Material Outside Reactors*, ANSI/ANS 8.1-1983, American National Standards Institute, New York, New York.

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6.0 STRUCTURAL EVALUATION

6.1 INTRODUCTION

This evaluation determines the structural adequacy of the B Plant organic tank.

6.2 STRUCTURAL EVALUATION OF PACKAGE

6.2.1 Structural Design and Features

Specifications for the tank are as described in Part A, Section 2.0.

6.2.2 Mechanical Properties of Materials

The tank heads and shell are certified to have a minimum 206.84-MPa (30,000-psi) yield strength and a 517.11-MPa (75,000-psi) ultimate tensile strength.

6.2.3 Chemical and Galvanic Reactions

The tank shell and heads are manufactured from 304 stainless steel. This material is compatible with the organic waste and is used for many of the B Plant components that handle this material, including the storage cells.

6.2.4 Size of Package and Cavity

See Part A, Section 2.0.

6.2.5 Weights and Center of Gravity

See Part A, Section 2.4

6.2.6 Tamper-Indicating Feature

Tamper-indicating features will not be required for transportation due to the short length of the trip and the controlled environment of the Hanford Site; however, tamper-indicating features may be added at the storage location.

6.2.7 Positive Closure

The tank has no openings below the surface of the liquid. Top openings are either flanged or valved and provide positive closure.

6.2.8 Lifting and Tiedown Devices

See Part A, Sections 2.9 and 2.10.

6.2.9 Brittle Fracture

The tank is certified for a minimum design temperature of -28.9 °C (-20 °F).

6.3 NORMAL TRANSFER CONDITIONS

6.3.1 Conditions To Be Evaluated

The tank, in its original configuration, was certified to meet DOT requirements for offsite shipping of LSA material. No additional structural evaluations will be performed because the payload weighs less than the certified payload (lower specific gravity); the payload meets LSA requirements (see Part B, Section 2.1.2); and the modifications do not affect the structural integrity of the tank (see Part B, Section 3.4).

It should be noted that to meet these DOT requirements, the tank must be at least 80% full during transport to prevent load shift and potential tipping. Since there is a possibility that the tank may be less than 80% full, speed restrictions are imposed. See Part A, Section 4.3.

6.4 STRUCTURAL EVALUATION AND CONCLUSIONS

It is concluded that the tank meets the requirements for normal and accident conditions because in its original configuration the tank was certified to meet DOT requirements for offsite shipping of LSA material, the B Plant payload weighs less (lower specific gravity) and meets LSA requirements, and the modifications do not affect the structural integrity of the tank.

7.0 THERMAL EVALUATION

7.1 INTRODUCTION

The purpose of this evaluation is to show that the B Plant organic tank is not threatened by heat generated by the payload during normal transfer conditions.

7.2 THERMAL SOURCE SPECIFICATION

The Radcalc program was used to determine the total heat generation from all isotopes in the payload (see Part B, Section 8.3). The majority of the heat is generated by ^{90}Sr (0.87 W), and the total payload heat generation is less than 1 W.

7.3 SUMMARY OF THERMAL PROPERTIES OF MATERIALS

The tank is certified for a maximum temperature of 121 °C (250 °F).

7.4 THERMAL EVALUATION AND CONCLUSIONS

The amount of thermal output from the waste is negligible (less than 1 W per package). Therefore, the payload will not cause the tank to exceed the requirements of 49 CFR 173.442, or the maximum certified temperature of the tank 121 °C (250 °F), and no further thermal evaluation is required.

7.5 REFERENCES

49 CFR 173.442, 1994, "Shippers--General Requirements for Shipments and Packagings," .442, "Thermal Limitations," *Code of Federal Regulations*, as amended.

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8.0 PRESSURE AND GAS EVALUATION

8.1 GAS GENERATION

The purpose of this evaluation is to predict hydrogen gas generation rate and pressure buildup in the tank. Equilibrium hydrogen concentration with open filters will also be determined.

8.2 PACKAGE PRESSURE AND FLAMMABLE GAS CONCLUSIONS

The analysis presented in Section 8.3.1 shows that the hydrogen generation rate is 43.5 cm^3/h. The pressure increase from the hydrogen is also considered. The analysis presented in Part B, Section 8.3.1, shows that the pressure would increase by 2.6 kPa, based on an increase in hydrogen concentration of 2.5%. The actual pressure increase will be much less than this because the increase in hydrogen concentration is limited to 0.5%. Because the tank is certified for a gauge pressure of 689 kPa (100 psi), the pressure increase from hydrogen is not a concern.

8.3 APPENDIX: HYDROGEN GENERATION EVALUATIONS

ENGINEERING SAFETY EVALUATION

Subject Hydrogen Gas Generation in a 4600 Gallon B Plant Organic Tank Page 1 of 3
Originator J. R. Green Date 06/18/96
Checker J. B. Mercado Date 06/18/96

I. **Objectives:**

4600 gallons of liquid waste will be shipped in B Plant organic tanks from B Plant to storage. Calculations of the hydrogen generation rate, the time to 2.5% H_2 gas concentration by volume, and the decay heat from the inventory are required to ensure transportation safety.

II. **Reference:**

Green, J. R., K. Hillesland, V. E. Roetman, and J. G. Field, 1995, *Radcalc for Windows*, Version 1.0, Westinghouse Hanford Company, Richland, Washington.

III. **Results and Conclusions:**

A 4600 gallon B Plant organic tank with 23 gallons of head space containing 70% normal paraffin hydrocarbon (NPH), 20% tributyl phosphate (TBP), and 10% di-2 ethylhexyl phosphoric acid (D2EHPA) will reach 2.5% H_2 gas concentration by volume in 2.14 days (51 hours). The hydrogen gas generation rate is 43.5 cc/h. The decay heat generates 0.974 W. The tank primarily contains a straight-chain hydrocarbon, accordingly the G-value for the calculation was based on the straight-chain hydrocarbon hexane. The values used will result in conservative results.

IV. **Engineering Evaluation:**

The computer code Radcalc for Windows (Green et al. 1995) was used to calculate the production of hydrogen gas in a 4600 gallon tank. The information supplied for the analysis follows:

Waste Volume	4600 gallons		
Total Tank Volume	4623 gallons		
Waste Density	0.85 g/cc		
Waste Matrix	70% NPH	20% TBP	10%D2EHPA
Radioactive Components	See Table 1.		

The following input parameters were used in the Radcalc for Windows computer code:

Waste Volume	17.4129 m^3		
Void Volume	0.0871 m^3		
Waste Weight	1.48 x 10^7 g		
Gamma Absorption Fraction Basis	LR-56		
G-value	gamma: 5	beta: 5	alpha: 20
Radioactive Components	See Table 1		

ENGINEERING SAFETY EVALUATION

Subject Hydrogen Gas Generation in a 4600 Gallon B Plant Organic Tank Page 2 of 3
Originator J. R. Green Date 06/18/96
Checker J. E. Mercado Date 06/18/96

The fraction of gammas absorbed in the waste tank is a function of energy and geometry. The most conservative values for the gamma absorption fractions contained in Radcalc for Windows are those which are calculated for the LR-56. Therefore, the LR-56 container was used to model the tank because the B Plant organic tank is not modeled within the code.

The H_2 G-value is a measure of the number of molecules of H_2 gas formed per 100 eV of energy absorbed in the waste matrix. G-values are supplied in Radcalc for Windows for a variety of material types. The liquid waste to be shipped in the tank trucks is primarily composed of a straight-chain hydrocarbon. Accordingly, the G-values for the straight-chain hydrocarbon hexane were used. These are 5 for beta and gamma, and 20 for alpha. The G-values are extremely high and will result in conservative values for the material being shipped.

The above parameters were input into Radcalc for Windows which calculated the number of days to 2.5% hydrogen gas concentration by volume to be 2.14 days (51 hours). A copy of the Radcalc input/output file is attached. The uncertainties in this analysis are represented primarily by the uncertainty of the G-value of the waste matrix. The value used is very conservative and may result in an over estimation of the quantity of hydrogen gas produced.

ENGINEERING SAFETY EVALUATION

Subject Hydrogen Gas Generation in a 4600 Gallon B Plant Organic Tank Page 3 of 3
Originator J. R. Green [signature] Date 06/18/96
Checker J. E. Mercado [signature] Date 06/18/96

Table 1. B Plant Organic Waste Source Term.

Isotope	Total Activity (Ci)	Isotope	Total Activity (Ci)
^{85}Kr	1.13 E+01	^{152}Eu	1.46 E-02
^{90}Sr	1.30 E+02	^{154}Eu	1.98 E+00
^{90}Y	1.30 E+02	^{155}Eu	7.82 E-01
^{93}Zr	3.84 E-03	^{234m}Pa	2.65 E-05
^{99}Tc	2.83 E-02	^{234}Th	2.65 E-05
^{106}Ru	1.18 E+00	^{234}U	3.38 E-05
^{106}Rh	1.18 E+00	^{237}U	8.71 E-06
^{113m}Cd	5.29 E-02	^{238}U	2.65 E-05
^{125}Sb	2.80 E+00	^{238}Pu	3.81 E-03
^{125m}Te	6.83 E-01	^{239}Pu	8.79 E-03
^{134}Cs	2.10 E-01	^{240}Pu	4.65 E-03
^{137}Cs	4.98 E+00	^{241}Pu	3.55 E-01
^{137m}Ba	4.71 E+00	^{241}Am	7.42 E-03
^{144}Ce	6.26 E-01	^{242m}Am	8.64 E-06
^{144}Pr	6.26 E-01	^{243}Am	8.59 E-06
^{144m}Pr	7.52 E-03	Total	3.37 E+02
^{147}Pm	4.39 E+01	Total Beta	3.32 E+02
^{151}Sm	2.01 E+00	Total Alpha	2.47 E-02

Heat Generated: 0.974 Watts
Partial Pressure (H2): 2.60 kPa
Total Pressure (H2 and Air): 104. kPa

Radioactive: Yes
Type Determination: B (from unity fraction 340.90)
Limited Quantity: No
LSA Determination: No (from LSA unity fraction 1.8271)
HRC Quantity Determination: No
Fissile Quantity: 0.14540 g
15g Fissile Radionuclides or Less: Yes
(Fissile Excepted per 49CFR173.453(a))
Note: Transportation classifications assume three significant figures.

Bulk Density: 0.850 g/cc

Source decayed to start of seal time:

Radionuclide:	Curies:
Kr-85	1.13e+001
Sr-90	1.30e+002
Y-90	1.30e+002
Zr-93	3.84e-003
Tc-99	2.83e-002
Ru-106	1.18e+000
Rh-106	1.18e+000
Cd-113m	5.29e-002
Sb-125	2.80e+000
Te-125m	6.83e-001
Cs-134	2.10e-001
Cs-137	4.98e+000
Ba-137m	4.71e+000
Ce-144	6.26e-001
Pr-144	6.26e-001
Pr-144m	7.52e-003
Pm-147	4.39e+001
Sm-151	2.01e+000
Eu-152	1.46e-002
Eu-154	1.98e+000
Eu-155	7.82e-001
Th-234	2.65e-005
Pa-234m	2.65e-005
U-234	3.38e-005
U-237	8.71e-006
U-238	2.65e-005
Pu-238	3.81e-003
Pu-239	8.79e-003
Pu-240	4.65e-003
Pu-241	3.55e-001
Am-241	7.42e-003
Am-242	8.59e-006
Am-242m	8.64e-006

Source decayed to end of seal time:

Radionuclide:	Curies:
Kr-85	1.13e+001
Sr-90	1.30e+002
Y-90	1.30e+002
Zr-93	3.84e-003
Nb-93m	1.09e-006
Tc-99	2.83e-002
Ru-106	1.18e+000
Rh-106	1.18e+000
Cd-113m	5.29e-002
Sb-125	2.80e+000
Te-125m	6.82e-001
Cs-134	2.10e-001
Cs-137	4.98e+000
Ba-137m	4.71e+000
Ce-144	6.23e-001
Pr-144	6.23e-001
Pr-144m	7.47e-003
Pm-147	4.38e+001
Sm-147	1.66e-012
Sm-151	2.01e+000
Eu-152	1.46e-002
Eu-154	1.98e+000
Eu-155	7.81e-001
Th-234	2.65e-005

Radcalc for Windows 1.0

Date: 06-15-96 09:51

Performed By: [signature] 6/15/96

Checked By: [signature] 6/18/96

File: BPLRC.RAD

========== Input Information ====================================

Source from input:

Radionuclide:	Curies:
Kr-85	1.13e+001
Sr-90	1.30e+002
Y-90	1.30e+002
Zr-93	3.84e-003
Tc-99	2.83e-002
Ru-106	1.18e+000
Rh-106	1.18e+000
Cd-113m	5.29e-002
Sb-125	2.80e+000
Te-125m	6.83e-001
Cs-134	2.10e-001
Cs-137	4.98e+000
Ba-137m	4.71e+000
Ce-144	6.26e-001
Pr-144	6.26e-001
Pr-144m	7.52e-003
Pm-147	4.39e+001
Sm-151	2.01e+000
Eu-152	1.46e-002
Eu-154	1.98e+000
Eu-155	7.82e-001
Th-234	2.65e-005
Pa-234m	2.65e-005
U-234	3.38e-005
U-237	8.71e-006
U-238	2.65e-005
Pu-238	3.81e-003
Pu-239	8.79e-003
Pu-240	4.65e-003
Pu-241	3.55e-001
Am-241	7.42e-003
Am-242	8.59e-006
Am-242m	8.64e-006

Waste Form: Normal
Physical Form: Liquid
Container Type: LR-56

Package Void Volume: 8.71e+004 cc
Waste Volume: 1.74e+007 cc
Waste Mass: 1.48e+007 g
Waste True Density: 0.850 g/cc

Date to begin source decay: 13:00 May. 24, 1996
Date container sealed: 13:00 May. 24, 1996
Days to decay source before seal time: 0.00 days
Calculate number of days sealed until 2.50% hydrogen is reached.

Entered G Values:

G Alpha	G Beta	G Gamma
20	5	5

Comments:
4,600 Gallons of waste consisting of:
70% Normal Parafin Hydrocarbon
20% Tributyl Phosphate
10% Di-2 ethylhexyl phosphoric acid
The majority of the material is composed of a straight-chained hydrocarbon. Accordingly the G-value for hexane was used as a bounding value.

========== Calculated Results ==================================

The sealed container will generate 2.50 % hydrogen in 2.14 days
This corresponds to date: 16:00 May. 26, 1996
H2 Volume: 2.23e+003 cc
H2 Generation Rate: 43.5 cc/hour

Pa-234m	2.65e-005
U-234	3.38e-005
Th-230	1.78e-012
Ra-226	2.26e-018
U-237	8.71e-006
Np-237	1.41e-011
U-238	2.65e-005
Pu-238	3.81e-003
Pu-239	8.79e-003
U-235	5.07e-014
Pu-240	4.65e-003
U-236	8.06e-013
Pu-241	3.55e-001
Am-241	7.42e-003
Pa-233	3.79e-013
Am-242	8.60e-006
Cm-242	6.42e-008
Pu-242	1.56e-014
Am-242m	8.64e-006

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9.0 PACKAGE TIEDOWN SYSTEM EVALUATION

9.1 SYSTEM DESIGN

The tank frame shall be attached to the trailer via the four bottom-corner fittings. The trailer shall be equipped with four twist-lock fittings. Each twist-lock shall mate with its corresponding bottom-corner fitting and shall provide a strength that is equivalent to or greater than the strength of the corner fitting.

9.2 ATTACHMENTS AND RATINGS

The tiedown system has been certified for a maximum gross weight of 30,480 kg (67,200 lb), consisting of the 4,604-kg (10,150-lb) tank assembly and the 25,876-kg (57,050-lb) original payload.

The payload for this shipment will weigh less than 17,500 kg (38,581 lb). This weight is based on the conservative assumptions that the payload will consist of a volume of 17,500 L (4,623 gal) with a specific gravity of 1. Because this is 8,376 kg (18,469 lb) less than the certified payload weight, no further analysis is required.

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Packaging Engineering	Date Oct. 2, 1996
Project Title/Work Order		EDT No. 618183
Safety Evaluation for Packaging for Onsite Transfer of B Plant Organic Waste (WHC-SD-TP-SEP-050)		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
H. E. Adkins, Jr.	G1-11	X			
R. L. Clawson	G1-13	X			
J. G. Field	G1-11	X			
J. R. Green	G1-11	X			
J. Greenborg	H0-35	X			
C. R. Hoover	G1-11	X			
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